RELATIONSHIP BETWEEN SEXUAL MINORITY COUPLES AND TOBACCO RETAILER DENSITY AND MARKETING

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ABSTRACT

Joseph G. L. Lee: Relationship between Sexual Minority Couples and Tobacco Retailer Density and Marketing
(Under the direction of Kurt M. Ribisl)

Introduction. Tobacco use is markedly higher among lesbian, gay, and bisexual (LGB) populations than heterosexuals. Higher density of tobacco retailers and more tobacco marketing is found in neighborhoods with more low-income residents and more racial/ethnic diversity. Same-sex couples tend to live in similar neighborhoods, but the association of this demographic with tobacco retailer density or marketing have not been examined.

Methods. Data come from a study of 97 US counties, with tobacco retailers geocoded to census tracts and direct observation of marketing in 2,234 retailers in 2012. In the first study, I used spatial regression to test the relationship between the rate of same-sex couple households and the number of tobacco retailers per 1,000 people in 17,667 census tracts. In the second study, I used multi-level models to test the relationship between the same-sex couple household rate in census tracts and retailers' marketing characteristics. In both studies, I examined the association of the outcome variables in sex-stratified models, including neighborhood demographics and other environmental characteristics to examine confounding.

Results. Results from spatial regression show that higher rates of both female and male same-sex couples were associated with a higher density of tobacco retailers. For female couples, the association was not significant after controlling for area-level characteristics, such as percent African American, percent Hispanic, median household income, the presence

of interstate highways, and urbanicity, which are neighborhood correlates of higher tobacco retailer density. For male couples, the association persisted after control for these characteristics. Contrary to our hypotheses, we found no evidence of tobacco industry marketing at tobacco retailers differing by rates of same-sex couples in census tracts with the exception of three findings in the opposite direction of our hypotheses.

Conclusion. Same-sex couples reside in areas with higher tobacco retailer density, but tobacco retailer marketing characteristics may not differ substantially. While LGB disparities in tobacco use may be influenced by neighborhood environment, the magnitude of the association suggests other explanations of these disparities remain important areas of research. Tobacco retailers' tobacco marketing characteristics do not differ substantially by the rate of same-sex couples in their neighborhood.

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CHAPTER 1: INTRODUCTION

Background and Problem

Tobacco dependence has become a global epidemic due to the marketing, distribution, and addictiveness of tobacco products. Indeed, a globally linked set of corporations have worked to make tobacco use normative, glamorized it, made products ubiquitous, and conducted calibrated campaigns to undermine public health interventions.[1,2] To maintain a broad and profitable market, the tobacco industry has engaged in racketeering and knowingly misled the public.[3] As a World Health Organization report notes, "Tobacco use is unlike other threats to global health. Infectious diseases do not employ multinational public relations firms. There are no front groups to promote the spread of cholera. Mosquitoes have no lobbyists."[4(p.244)] This multinational corporate enterprise is not without cost to society and to individuals. Tobacco use is a major cause of disability and premature death. Tobacco causes over 480,300 premature deaths and 5.4 million years of productive life lost *annually* in the United States.[5] Tobacco dependence is causally related to cancer incidence and myriad health morbidities.[6]

The burdens of tobacco use dependence are not shared equally across the U.S. population. Among other disparities for socioeconomic status,[7] mental health status,[8] and race/ethnicity,[9] lesbian, gay, and bisexual (LGB) people are at much higher risk of tobacco use than their straight counterparts.[10] Indeed, smoking prevalence among LGB people is over

50% higher than among straight people.[11] Data for transgender populations are scarce,[*] although disparities exist.[12] Disparities in lung health and cardiovascular disease for LGB people are also likely related to tobacco use.[13,14]

The reasons for this disparity are only partially known, and research has focused primarily on the role of discrimination, stress, and stigma,[15] specifically using the minority stress model.[16] Briefly, tobacco use is hypothesized to be more common among populations for which discrimination and stigma result in added stress. Tobacco use can serve as a coping strategy for such stress, and stress can hinder quit attempts. Other ecological approaches may also help explain higher prevalence of tobacco dependence among LGB populations than among heterosexual populations.[15] Although research has been limited, suggested determinants include the role of LGB bars and the media environment. Researchers have suggested that the role of LGB bars as safe community spaces may promote tobacco use.[17,18] In the media environment, tobacco use is highly visible in the LGB print press and in LGBT-themed movies while coverage of cessation is rare.[19-21] Similarly, in LGB news blogs discussion of the tobacco epidemic is rare and little focus is given to cessation.[22] The tobacco industry has targeted its marketing directly at LGB communities.[23,24]

Although much of the tobacco industry's targeting marketing is overt and present in the LGB press, the industry has also engaged in more subtle forms of marketing.[23] These include emphasis on LGB workplace non-discrimination policies and participation in the Human Rights Campaign's Workplace Equality Index[25] as well as sponsorship of HIV/AIDS and arts organizations.[26] In one of the industry's most clearly articulated plans to market to gay men, cleverly titled Project Sub-Culture Urban Market (SCUM), RJ Reynolds planned to

[*] Because the datasets proposed in this dissertation do not contain transgender information, I omit further discussion of transgender populations. Clear disparities exist and there is a compelling need for future research

make its products and their marketing ubiquitous in a neighborhood widely considered to be a gay enclave, San Francisco's Castro.[27] Project SCUM called for better "in store presence," "store front presence," and "consistent POS (point-of-sale)/PDI placements" with an objective to "[p]enetrate fragmented/nontraditional outlets to increase Camel's Distribution [sic] and presence."[27] It is notable that the tobacco industry, in its clearest example of marketing to LGB populations, focused on making tobacco products and marketing ubiquitous at the POS in neighborhoods where LGB people are concentrated.

This spatial component of marketing to LGB people has been largely ignored in studies of the etiology of LGB health disparities in tobacco.[15] Yet there is emerging demographic evidence that internal migration of LGB people within the United States results in the concentration of same-sex couples[†] in more diverse and lower-income neighborhoods, in regional cities, and in places where there are already more same-sex couples.[28,29] These patterns are more complex than the common view of migration of LGB people to major cities.[30] If these patterns put LGB people in spaces where there is disproportionate exposure to tobacco industry marketing, this could help explain the presence of large disparities in tobacco use for LGB populations compared to heterosexual populations.

Why the Retail Environment Matters to Tobacco Use Initiation, Dependence, and Cessation and Disparities Therein

Tobacco marketing at the point of sale (POS) is part of a broader marketing effort that is causally related to smoking initiation.[31,32] The tobacco industry spends the majority (85%) of its reported marketing dollars at the POS in the United States.[33,34] Eminent tobacco control researchers have argued that strategies can be judged by the industry's [re-]action;[35] that is, if POS marketing were not effective, corporate leaders would not invest so heavily in it[33,34] or

[†] I use the terminology "same-sex couples" to describe patterns available from the U.S. Census, which does not report on individual sexual orientation. When discussing the literature or conceptual issues, I use LGB.

protest restrictions so fervently. Two systematic reviews have synthesized the evidence of the impact of POS marketing on tobacco-related health behaviors, suggesting both sufficient evidence for policy intervention and the need for more prospective studies.[36,37] Both a National Cancer Institute monograph and the Surgeon General report indicate the importance of POS marketing.[31,38]

More specifically, tobacco marketing at the POS likely contributes to the normalization of tobacco products,[39] is associated with smoking initiation among youth,[40,41] is associated with brand preference among youth,[42] can prompt impulse purchases by smokers,[43,44] and serves as a primary communications channel for industry marketing efforts to patrons of retail stores, including children.[45] Such communications are designed promote positive views of tobacco use and are often targeted to youth and people attempting to quit.[46-48] Being near to a store is associated with decreased likelihood of quitting[49,50] and with current smoking.[41,51,52]

Disparities in Tobacco Retailer Density

The first report of a disparity in tobacco retailer density found greater density of tobacco retailers in lower socio-economic status (SES) and higher African American census tracts by quartile in a single New York county.[53] Further research identified similar disparities in census tracts within an Iowa county.[54] In the same Iowa county researchers found the opposite result when using geographically weighted regression (GWR),[‡] which is typically used in an exploratory fashion, finding unexpected negative associations between density and percent African American.[55] Among all 99 Iowa counties, however, at the county level of analysis, tobacco retailers were disproportionately present in areas with,

[‡] Geographically weighted regression (GWR) allows the parameter estimates from the regression model to vary over space, e.g., predictors of child poverty in one part of the country may be different than in another.

unexpectedly, higher incomes and, as expected, with higher percentages of racial/ethnic minorities.[56,57] These differences in Iowa suggest the challenge of interpreting results from larger area units such as counties, which do not approximate neighborhoods, using a single county and using regression approaches that may be best suited to exploratory work.

Five studies examine tobacco retailer density in New Jersey using increasingly sophisticated analytic techniques. Fakunle and colleagues (2010) analyzed census tracts in two New Jersey counties and found differences in retailer density by quartile of median household income and racial/ethnic demographics in the expected direction.[58] A statewide cluster analysis (i.e., a K-means cluster analysis) of tract characteristics found high retailer density in conjunction with higher percentages of African American and Hispanic residents and lower median income.[59] Geographically weighted regression techniques yielded similar findings only after transformation to achieve normality of residuals.[60] Last, spatial regression[§] approaches used at the census-tract level with statewide data found greater percentage Hispanic, lower median income, and greater percentage African American were predictors of greater tobacco retailer density.[61]

In New York, the density of retailers around New York City schools was not found to be related to race, ethnicity, or income in multivariable regression.[62] A statewide analysis in New York using spatial regression at the census-tract level, however, found greater tobacco retailer density for lower SES and higher proportion African American areas.[63]

Fewer studies examine these findings in other areas of the United States. In randomly

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[§] That is, a regression model in which spatial autocorrelation or the "geographic influence of being near" is explicitly included in the model, thereby accounting for the problem of non-independence of contiguous area units. Such models can vary in their treatment of the dependent variable's assumption of form using a spatial regression approach to ordinary least squares regression, Poisson regression, etc. Multi-level modeling addresses the same statistical problem of non-independence (i.e., area units nested within a larger area unit) but is not overtly spatial in its treatment of the influence of being near. See: Modeling spatial effects (pp. 399-400) in Cromley & McLafferty, 2012.

selected census tracts in Omaha, Nebraska, the percent of African American and percent of Hispanic residents were positively associated with tobacco retailer density while median income was negatively associated.[64] Nationally, Rodriguez and colleagues found tobacco retailer density to be significantly and positively related to Hispanic ethnicity, poverty, and other indicators of SES using multivariable linear regression.[65]

Globally, disparities in tobacco retailer density by deprivation indices and other measures of SES have been found in Southeast Queensland, Australia;[66] Western Australia;[67] Ontario, Canada;[68] Cologne, Germany;[69] and New Zealand.[70] However, one study from New South Wales, Australia, found no relationship between SES and retailer density[71] until smoking prevalence was entered as a control.[72]

The patterns found across New York, Iowa, New Jersey, the United States as a whole, and even globally, when analyzed at appropriate area units (i.e., definition of neighborhood), show a consistent pattern of greater tobacco retailer density being associated with higher percentages of racial/ethnic minorities and lower income. These indicate greater access to tobacco products and the marketing at tobacco retailers provide cues to purchase tobacco products.[43,73-75] The origin of these differences likely comes from two sources. First, the tobacco industry targets its marketing by neighborhood characteristics.[76] Second, there are differences in store types where lower income and more diverse neighborhoods have smaller retailers and fewer chain retailers,[77,78] likely due in part to historic underinvestment (e.g., redlining) of African American communities.

Disparities in POS Tobacco Marketing

The evidence of greater amounts of marketing per store and different types of marketing in neighborhoods with more racial/ethnic diversity and lower-income

neighborhoods is more complex than the evidence of disparities in tobacco retailer density. Lee, Henriksen, Rose, Moreland-Russell, and Ribisl (under review) conducted a systematic review of tobacco marketing disparities that identified 43 papers across the four P's of marketing:[79] Price, Promotion, Product, and Placement. Although methodological quality and measures varied widely, several key findings suggest that disparities in marketing are present with more marketing in African American neighborhoods and there is greater volume of menthol marketing in African American neighborhoods. Additionally, several studies suggest differences in price: Menthol is found to be cheaper in neighborhoods with more African American residents.[80]

Most studies identified were conducted in and around a single city. Among the papers with the strongest methodologies come findings from Minneapolis/St. Paul, Minnesota;[81,82] Oklahoma County, Oklahoma;[83] and, Omaha, Nebraska.[84] In the Minneapolist/St. Paul metropolitan statistical area (MSA), Toomey and colleagues examined premium, menthol, and discount cigarettes marketed by the same company and showed differences in pricing based on store and neighborhood characteristics. They found wide variation in price and higher prices in neighborhoods with fewer white residents, except for the menthol brand.[82] That is, cigarette prices other than menthol prices are positively associated with higher percentage non-white neighborhood demographics after controlling for the manufacturer and store type. Menthol, however, was relatively more affordable in neighborhoods with more non-white residents. In St. Paul, Minnesota, Widome and colleagues found more ads in more African American neighborhoods and more menthol ads in African American and poorer neighborhoods.[81] In Omaha, Nebraska, Siahpush and colleagues found every $10,000 increase in median income was associated with a 14% decrease in the number of marketing

materials; however, they found little evidence of racial/ethnic disparities in marketing.[84] In Oklahoma County, Oklahoma, John and colleagues found more tobacco marketing at stores in neighborhoods with lower income and more minority[**] population.[83] These patterns from single cities show overall trends toward more marketing in neighborhoods with lower income and with more African American residents.

Several state- or province-wide studies confirm and extend these findings. Cohen and colleagues examined stores in 20 Ontario cities, finding more tobacco promotion in lower income areas after controlling for store type in a multi-level model.[85] In California high school neighborhoods, Henriksen and colleagues found that as the percentage of African American students increased, the odds of a Newport promotion increased, the proportion of menthol advertising increased, and the cost of Newport cigarettes decreased; the same relationship was not found for the leading non-menthol brand, Marlboro.[80] In Victoria, Australia, school neighborhoods, McCarthy and colleagues[86] found that price discounts below the recommended retail price were disproportionally present in lower-income areas. Overall, these findings echo a previous systematic review of billboard and magazine marketing in black neighborhoods,[††] which found higher amounts of marketing per person than in white neighborhoods.[87] In sum, the presence of tobacco retailers and tobacco marketing at the POS is not randomly distributed throughout the population. Although these studies present tantalizing evidence of neighborhood differences in tobacco marketing, which are already supported by differences in industry targeting of demographic groups,[76] no

[**] A number of studies use the term "minority" generally referring to non-white, Hispanic identification in the U.S. Census, although some studies do not define their use of the term minority. I use the term minority to be consistent with the study being described when a more descriptive term is not available. I recognize that the term "minority" is somewhat problematic in the United States, because this term does not and increasingly will not reflect that a majority of the population in many places is non-white and Hispanic.

[††] Primack and colleagues (date) conducted a meta-analysis of "black" versus "white" media markets, including neighborhoods, but did not define the cut off of "black" versus "white."

literature has examined neighborhood tobacco retailer marketing in relation to same-sex couples. The next section presents a conceptual overview of how tobacco retailer density and marketing can drive disparities. I then make the case that the spatial patterning of tobacco retailer density and marketing may overlap with the patterning of same-sex couples' neighborhood selection.

Getting Into One's Lungs: Applying Frameworks and Theories of Disparity

Conceptual Overview

How does the density of tobacco retailers and the marketing of tobacco products get under one's skin or, perhaps more aptly, into one's lungs? Moreover, how might this contribute to population health disparities? I contextualize this research within a social ecological framework[88] to detail how environmental factors such as tobacco industry marketing can influence health behaviors. To expand this to the creation and reproduction of health disparities, I use a framework of neighborhood health disparities developed by Bernard and colleagues.[89] Yet these two frameworks only provide us with an understanding of how tobacco marketing matters and why its presence can influence health disparities. Additional consideration is required to conceptualize and guide understanding of the formation of same-sex dense neighborhoods, the migration of same-sex couples to those neighborhoods, and the characteristics of the spatial patterning thereof that might influence the relationship with the presence, types, and characteristics of tobacco retailers.

A recent systematic review shows that the literature measuring retail tobacco marketing is largely atheoretical with only a few mentions of broader theories and frameworks such as structural violence, diffusion of innovations, and community empowerment.[90] One exception is Canadian research on neighborhood health disparities that

has used domains of the Bernard framework[89] to empirically examine neighborhood smoking disparities.[91] Described in detail in the next section, this framework[89] helps organize this project and provides the underpinnings of understanding the phenomena under study.

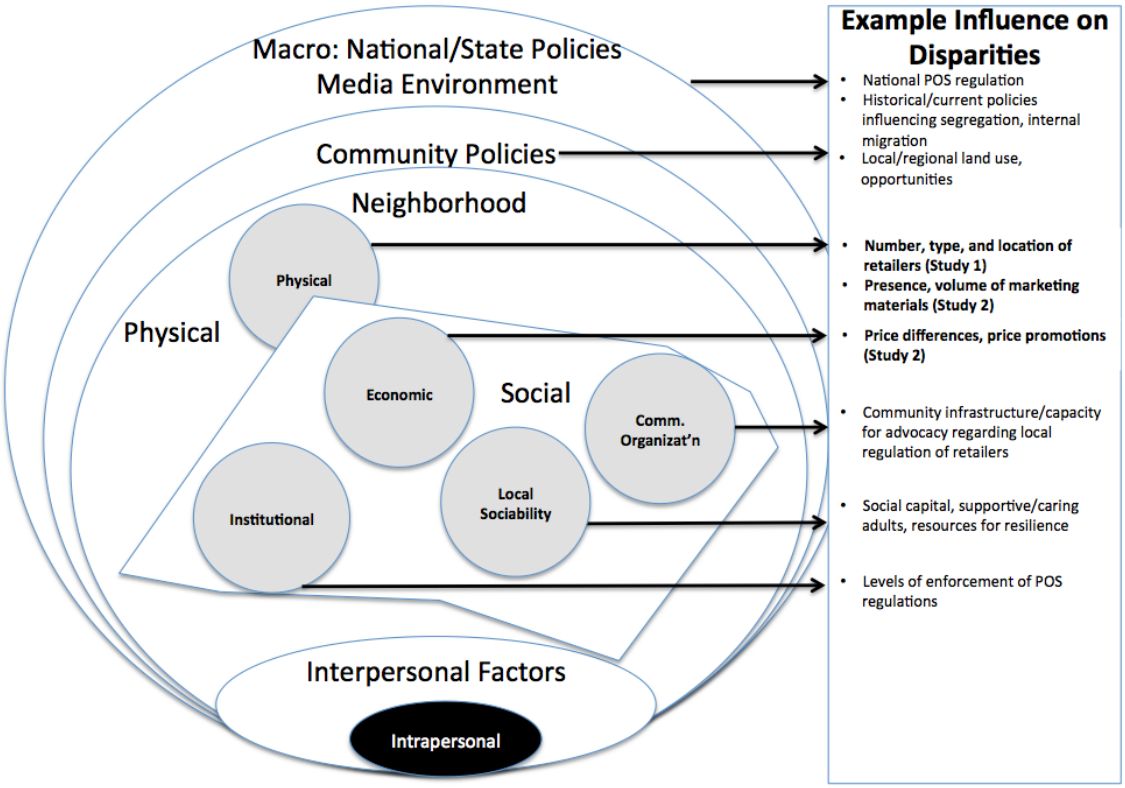
Although research on gay and lesbian space and place, or the "geography of sexualities," was historically neglected,[92] work in the 1980s and beyond in cultural geography, economics, and demography has provided a rich set of research on the formation and maintenance of gay and lesbian neighborhoods as well as on internal migration patterns. I use this body of research to develop an empirically driven understanding of the formation of denser areas of same-sex couples and differences therein by gender that inform this dissertation research.

Applicability of the Bernard Framework of Neighborhood Health Disparities

I use a theoretical framework of neighborhood health disparities developed by Bernard and colleagues.[89] Derived from theories of structuration[93] and reciprocity, Bernard and colleagues attempted to develop a framework that balanced individual agency and the social and physical structures of society in creating and reproducing health disparities at the neighborhood level. This framework allows for the role of historical processes that influenced the types of retailers present in a given neighborhood and for the substantial role of the tobacco industry in influencing the pricing and marketing of its products in retailers.[2] This framework specifically posits that health disparities are the result of the *availability* of and *access* to health-related resources. Both availability and access are subject to proximity, prices, rights, and informal reciprocity. Taken together, these are conceptualized into five domains of influence on availability and access of health-promoting resources: (1) physical, (2) local sociability, (3) institutional, (4) community organization, and (5) economic. Unlike

the social ecological framework where domains of influence are essentially scaled up from micro- to macro-level influences, the domains of influence in the Bernard framework operate together within a single level: the neighborhood. Figure 1 shows an overarching framework, specific to the creation and reproduction of neighborhood disparities in tobacco retailer density and marketing volume that draws from Bernard et al.,[89] Bronfenbrenner,[88] and Sallis et al.[94]

Figure 1. Conceptual framework for creation and reproduction of neighborhood disparities related to tobacco retailer density and marketing based on Bernard et al.[89]



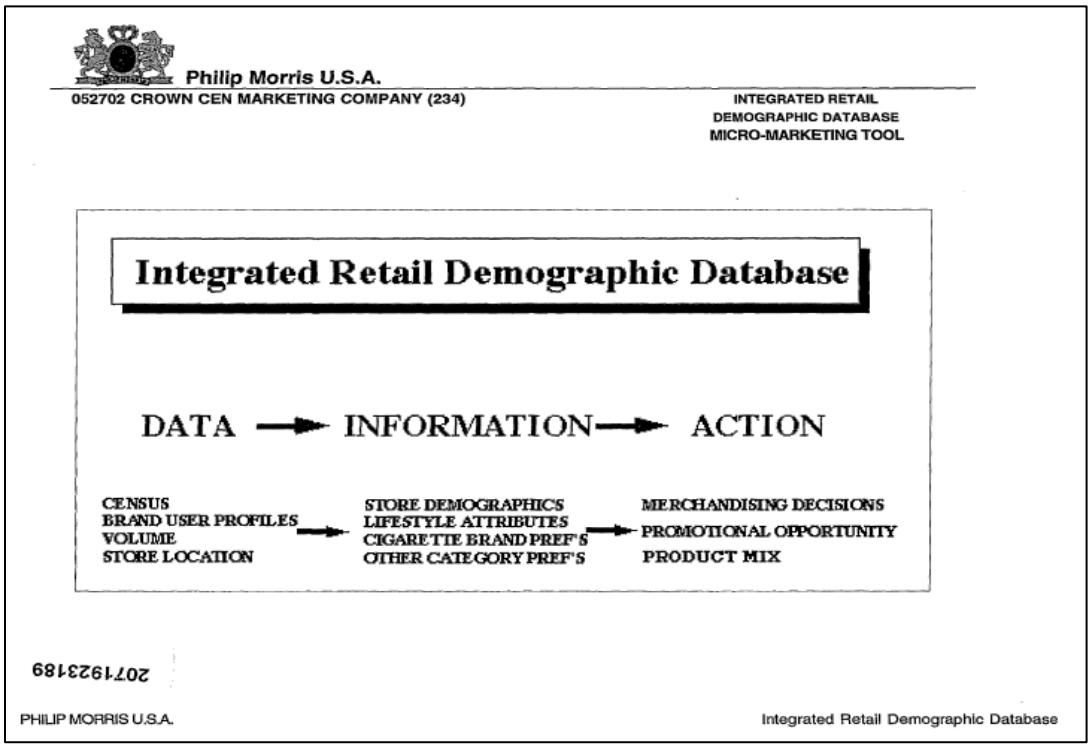
The Bernard framework's five domains of influence have been empirically examined in relation to neighborhood disparities in youth smoking.[91] These within-neighborhood

characteristics suggest components of the social and physical environment that contribute to the creation or reduction of health disparities. Specific examples from the Bernard framework's domains include the *physical domain*, whereby the presence of tobacco retailers, availability of specific tobacco products, and the presence of tobacco marketing contribute. The *economic domain* suggests the importance of neighborhood tobacco pricing and price promotions as well as minimum price floor policies. The *institutional domain* includes the enforcement of existing regulations on tobacco marketing as well as the governmental role in community investment (and thus the resources available and types of retailers) through banking policies. The *community organization* domain notes the importance of local organization and empowerment to promote tobacco-related policies. *Local sociability* suggests the importance of resiliency against tobacco addiction and the sharing of resources among community members. While I focus on the physical and economic domains of the Bernard framework in this dissertation, the others provide additional context for understanding potential intervention points in tobacco retailer density and marketing disparities. Although this framework is not specific to LGB people, it provides a basis for understanding the relationship between neighborhoods and health disparities. Together, the domains of influence are useful in conceptualizing how neighborhood tobacco retailers and POS marketing can influence health *and* how there is potential for policy intervention at the neighborhood level.

Any discussion of these domains of influence would be remiss without a discussion of the role of the tobacco industry's influence. The tobacco industry's influence manifests at the neighborhood level in multiple ways. First, the Bernard framework is situated within a broader social ecological framework where the tobacco industry has swayed macro-level

state and federal policies, changed social norms to promote the acceptance of tobacco use, and saturated media environments with tobacco imagery.[95] Thus, the four social domains of institutions, economics, local sociability, and community organizations have been influenced by lobbying, legal victories,[2] corporate social responsibility campaigns,[96,97] and "philanthropy" to community organizations.[98] The tobacco industry has been convicted[3] of racketeering that subverted scientific findings and misled both the public and elected officials. Second, the tobacco industry plays a direct role in geodemographic marketing segmentation, thus carefully altering the physical presence of marketing materials and price promotions based on neighborhood characteristics to maximize sales. Figure 2 shows an example of this from a Philip Morris client presentation showing the use of neighborhood information to inform marketing strategies.

Figure 2. Slide from Philip Morris USA Integrated Retail Demographic Database presentation.[99]



In summary, the tobacco industry and various macro-level forces influence neighborhoods and their retailers. At the same time, there is also social influence on same-sex couples' neighborhood selection, toward which I now turn attention.

"Get Thee to a City": Internal Migration, Gay and Lesbian Enclaves, and Residential Patterning

Movement to a city is something of a common theme in the historical and popular imagination about the "natural" trajectory of LGB lives.[30,100] At first approach, gay and lesbian neighborhoods bring to mind San Francisco's Castro; Washington, D.C.'s DuPont Circle; New York City's Park Slope, Greenwich Village, and Chelsea; Paris's Le Marais; and Tokyo's Shinjuku Ni-chōme. Geographers have long tracked the development of LGB neighborhoods,[101] even diagramming the national distribution of gay bars.[102] Cultural geographers have catalogued the development of these neighborhoods across time in multiple cities,[103-105] noting neighborhood differences by gender in both the development of neighborhoods and their role in LGB life[106] and examining the role of LGB space on identity formation.[107,108] Researchers have identified the role of gay men and lesbians in gentrification (i.e., reinvestment and renovation in neighborhoods that increases housing values and displaces existing residents when tax values rise quickly) and proposed stage-based models of neighborhood change (e.g., gay men move into red light districts with gay bars, housing renovations draw a broader population, and housing prices rise).[109] Economists suggest that gay men, with fewer children and thus more resources, are drawn to cities with cultural amenities to a greater degree than opposite-sex couples.[110] These approaches inform understanding of classic gay enclaves, but LGB people are also influenced by some of the same social forces that influence other people's movement. Emerging research examines decision-making regarding internal migration and its relation to sexual orientation.[111,112] That

is, an understanding of the geography of gay and lesbian neighborhoods and, more specifically, of overall LGB patterns of neighborhood selection must consider that these broad patterns of movement to a city are not universal and LGB people opt to live in the suburbs and the in rural areas well beyond the urban enclaves. In the next section, I discuss regional patterns of migration for LGB people and what we know about neighborhood selection.

Neighborhood, as cultural geographers and community psychologists remind us, has a meaning that is not entirely about physical space but also about a sense of place, shared history, and social connectivity.[113] This sense of place and its role in LGB identity, housing selection, and activity space is also an important contributor to the spatial patterning of LGB lives. Given the research question driving the subsequent chapters—that same-sex dense neighborhoods may have more tobacco retailers and a greater volume of tobacco marketing—understanding the formation of neighborhoods can help posit mechanisms behind identified disparities.

Establishment and Reproduction of Gay and Lesbian Enclaves

Early work on gay and lesbian neighborhoods noted two driving forces: territorialization, or the communities' political efforts to develop physical space for LGB people, and marginalization or stigma.[114] In broad strokes, these two forces have interacted over time with gender and sexual politics that have shifted LGB rights discourses from assimilation (1960s) to sexual liberation (1970s), to representation as a quasi-ethnic minority group (late 1970s–1980s), through the AIDS epidemic (1980s), and into political movements for equality and increasing assimilationist tendencies (1990s onward).[104]

Research based in economics on the establishment of urban gay neighborhoods identified four stages of neighborhood development: 1) *pre-conditions* consisting of urban decline in red light districts; 2) *emergence* of clustering of gay bars and initial renovations in neighborhoods; 3) *expansion and diversification* of additional gay businesses, increasing housing availability, and growing density of gay households; and, 4) *integration* of the neighborhood into both gay and straight commerce with growing trendiness, construction of new apartment buildings, and suburban outflow of some early residents.[109] Others have proposed a fifth stage of decline[115] and offered empirical support for the gentrification of gay neighborhoods.[116] Of course, although such a linear heuristic of neighborhood change is compelling, the dynamic social processes that alter neighborhoods are not so orderly and the future of gay and lesbian neighborhoods remains unknown.[117] Real estate prices suggest a more complex pattern of influence on housing prices: using cross-sectional real estate sales data from Ohio, researchers found that the addition of a same-sex couple per 1,000 households was associated with increased housing values in progressive neighborhoods and lowered housing values in conservative neighborhoods.[118]

Although cities and their LGB neighborhoods have long captured [relatively] popular imagination, historians have investigated the presence of gay lives in places and spaces in rural areas[119] and some work has explicitly examined gay life in the suburbs[120] and rural areas.[121-123] The formation and reproduction of the most visible urban neighborhoods interacts with in-migration to cities and out-migration to suburban areas.[109] Thus, scholarly attention has increasingly turned to patterns of migration and residential selection and away from the most visible gay neighborhoods into examinations of rural, suburban, and population trends. Researchers also note that migration can be temporary and can play an

important part of one's sexual identity development, even if one returns to their community of origin.[108,111] Indeed, gentrification, access to other housing opportunities due to social acceptance, and legal recognitions are likely responsible for an ongoing changes to the spatial patterning of LGB populations. Thus, I next review the literature regarding internal migration of LGB people and the spatial patterns thereof.

Role of Internal Migration in Same-Sex Couple Density

In studies across multiple cities and in both rural areas and urban areas, gay and lesbian neighborhood selection is shown to be impacted by knowing someone in the neighborhood (i.e., social connections),[124,125] the reputation of the neighborhood for being gay-"friendly,"[122,125,126] and by the perception of an open-minded space.[121] It is clear that housing patterns are not random; same-sex couples cluster in space resulting in national, regional, and local concentration.[29,127] These are in addition to general trends toward amenities such as better weather, more jobs, and lower crime rates.[128] It is unclear to what extent discriminatory policies play a role in housing selection, even though growing evidence suggests that wage penalties for gay men are present in states with more discriminatory policies[129] and hiring discrimination is present to a greater extent in those same states.[130] Because the burgeoning demographic literature on the movement and density of same-sex couples offers some conflicting findings, I present a brief review of the extant literature ordered by the size of the geographic unit used for analyses.

Black and colleagues provided the first empirical investigation of the spatial pattern of same-sex male couples using the 1990 Census and indices of amenities and quality of life in metropolitan statistical areas (MSAs) of ≥ 700,000 population.[110] This analysis conducted at the MSA level showed higher concentrations of gay men in areas with more cultural

amenities and better climate and that the cultural amenities were more correlated with same-sex couples than social values about the morality of homosexuality.[110] Similar analyses by Walther and Poston found that at the MSA level better weather and lower crime rates were better predictors of same-sex couple indices than the political environment. Nonetheless, same-sex couples were more likely to be in MSAs that had fewer Republican voters.[128] A more recent update of this research found same-sex couples more likely to be in places with low unemployment, higher temperatures, less conservatism, less discrimination, and larger size.[131] Cooke and Rapino used the 2000 Census at the Bureau of Economic Analysis Area-level, which divides the contiguous United States into 177 areas. They found that for same-sex female couples, only movement toward less densely populated areas and the presence of other same-sex female couples were significant predictors of net migration, explaining 9% of the variance. For male same-sex couples approximately 17% of the variance in net migration could be explained by movement to less densely populated areas of the country as well as to areas scoring higher on an amenities index.[28] These constitute patterns of migration at the regional level. I turn next to the zip code level, which better approximates neighborhoods within regions.

Gates and Ost published a 2004 book *The Gay and Lesbian Atlas*, which used 2000 Census data. At the zip code level they found: (1) Same-sex couples are more likely to live in urban areas than heterosexual couples; this is even more so for male same-sex couples than female same-sex couples; (2) same-sex couples are more likely to live in areas with greater non-white, foreign-born, and non-English speaking populations than heterosexual couples; (3) same-sex couples are more likely to live in neighborhoods with lower median household income than married heterosexual couples; (4) same-sex male and female couples are more

likely to live in neighborhoods with older housing than married couples, however, female same-sex couples and unmarried heterosexual partners have similar housing age; (5) same-sex couples are more likely to live in areas with higher crime rates than heterosexual couples; and (6) same-sex male couples are more likely to live in areas with fewer owner-occupied homes than same-sex female or opposite sex couples.[29]

Hayslett and Kane used spatial regression to investigate same-sex couple density and neighborhood characteristics at the census tract level (n=226) in Columbus, Ohio.[132] They found same-sex male couples were associated with neighborhood characteristics of amenities, diversity, and openness while same-sex female couples were only associated with the presence of nearby density of same-sex couples. Spring examined same-sex couples in Census 2000 and Census 2010 using metrics of residential segregation in census tracts within the 100 census places (i.e., cities) with the highest population.[133] Although same-sex couple segregation generally declined, there were still substantial levels of segregation within the 100 places at similar levels to economic/class segregation. Same-sex couple segregation was less extreme than racial/ethnic segregation. Other findings included greater segregation in areas of greater population, greater segregation in the South, and, for females, greater segregation in areas with higher median home prices.[133]

Together these studies show patterning of same-sex couples in cities and regions with greater amenities and provide a clear indication that same-sex couples, though represented across the country, are not randomly distributed. Moreover, at smaller geographic areas, same-sex couples are also patterned in ways that are unique by gender and are associated with key determinants of tobacco retailer density and marketing such as socio-economic status and racial/ethnic neighborhood composition.

The following two chapters explore the relationships between tobacco retailer density, tobacco retailers' marketing, and the concentration of same-sex couples in neighborhoods. First, driven by the literature that same-sex couples are more likely to live in more diverse, more low-income neighborhoods, which are associated with tobacco retailer density, I examine patterns of tobacco retailer density in 97 U.S. counties, predicting density from census tract same-sex couple rates. I use a spatial regression approach to address spatial autocorrelation. Second, I examine if the marketing at tobacco retailers is associated with tract same-sex couple rates using multi-level models. Last, I conclude with limitations and implications of this research.

CHAPTER 2: IS THERE A RELATIONSHIP BETWEEN THE CONCENTRATION OF SAME-SEX COUPLES AND TOBACCO RETAILER DENSITY?[‡‡]

Introduction

The lesbian, gay, and bisexual (LGB) population is routinely found to have a large, persistent disparity in tobacco use.[10] In the 2012–2013 U.S. Adult Tobacco Survey, the prevalence of any tobacco use among LGB adults was 36% compared to 24% for heterosexual adults.[134] Explanations for LGB tobacco use disparities typically focus on discrimination, structural stigma, and resulting stress.[15] Media influence is another prominent explanation: LGB populations report high exposure[24,135] and receptivity[136] to targeted tobacco industry marketing.[23] Tobacco use is also normative in LGB print[20] and entertainment[137] media. Other environmental influences have received too little attention, including the retail environment and concentration of stores that sell tobacco products ("tobacco retailers") in neighborhoods. Emerging evidence shows that LGB people have unique patterns of migration and neighborhood selection.[29,132,133] Yet a systematic review of the literature reveals no research examining whether tobacco retailers are more or less present in places where LGB people are more likely to live.[15]

Theories of neighborhood health disparities applied to tobacco retailer density suggest that tobacco retailers represent a physical presence that can hinder health by promoting ready access to tobacco products. Additionally these physical locations provide a channel for tobacco industry marketing and decrease search costs for tobacco products.[89,91] Tobacco

[‡‡] In press at *Nicotine & Tobacco Research* with authors, Joseph G. L. Lee, William K. Pan, Lisa Henriksen, Adam O. Goldstein, and Kurt M. Ribisl.

retailers provide ubiquitous cues to smoke.[37,43,44,138] Proximity to tobacco retailers is associated with decreased success in tobacco use cessation,[49,139] although this may be true only in lower socioeconomic status neighborhoods.[73] Tobacco retailer density has been associated with smoking behaviors[51,140,141] and with youth initiation;[52] however, some findings are mixed.[49,141,142]

There are both regional and local patterns of same-sex couple migration and neighborhood selection in the United States.[29] (We use the term same-sex couple to discuss migration and other aspects of research using census data, because individual sexual orientation is not ascertained in the U.S. Census. In discussing broader literature regarding sexual orientation identity, we use LGB.) Indeed, similar levels of neighborhood segregation exist for same-sex couple households as for household income, although fewer than exist for race.[133] Same-sex couples, like other couples, tend to migrate toward regions with better jobs, more temperate weather, lower crime, and more cultural amenities.[28,110] Yet the political environment also matters for same-sex couples, with greater concentrations of same-sex couples in less conservative places[128,131] and in regions with higher concentrations of other same-sex couples.[28] Within these regions, however, neighborhood selection can be influenced by several factors: Qualitative research finds strong evidence of the importance of other same-sex couples in neighborhood selection.[125,126] These patterns of neighborhood selection differ somewhat by sex, with greater concentrations of same-sex male couples into fewer, more dense neighborhoods than for female same-sex couples.[132] Same-sex couples, and male couples in particular, were more likely than opposite-sex couples to live in urban area zip codes, and in more racially/ethnically diverse zip codes with lower median household income.[29]

Existing evidence suggests racial minority and lower income neighborhoods have a disproportionately higher density of tobacco retailers. The first report of a disparity in tobacco retailer density found greater density of tobacco retailers in lower socioeconomic status (SES) and higher proportion African American census tracts by quartile in a single New York county.[53] Similar findings have been identified in Iowa;[54] New Jersey with added disparities for tracts with more Hispanic residents;[58-61] New York state;[63] for poverty and Hispanic residents in Chicago, Illinois;[143] and for Hispanic residents and lower income in Omaha, Nebraska.[64] In one national study, tobacco retailer density was related to Hispanic ethnicity, poverty, and other indicators of lower SES.[65]

In this national study, we sought to identify if same-sex couples live in areas with higher tobacco retailer density and to assess if the association is independent from other neighborhood characteristics.

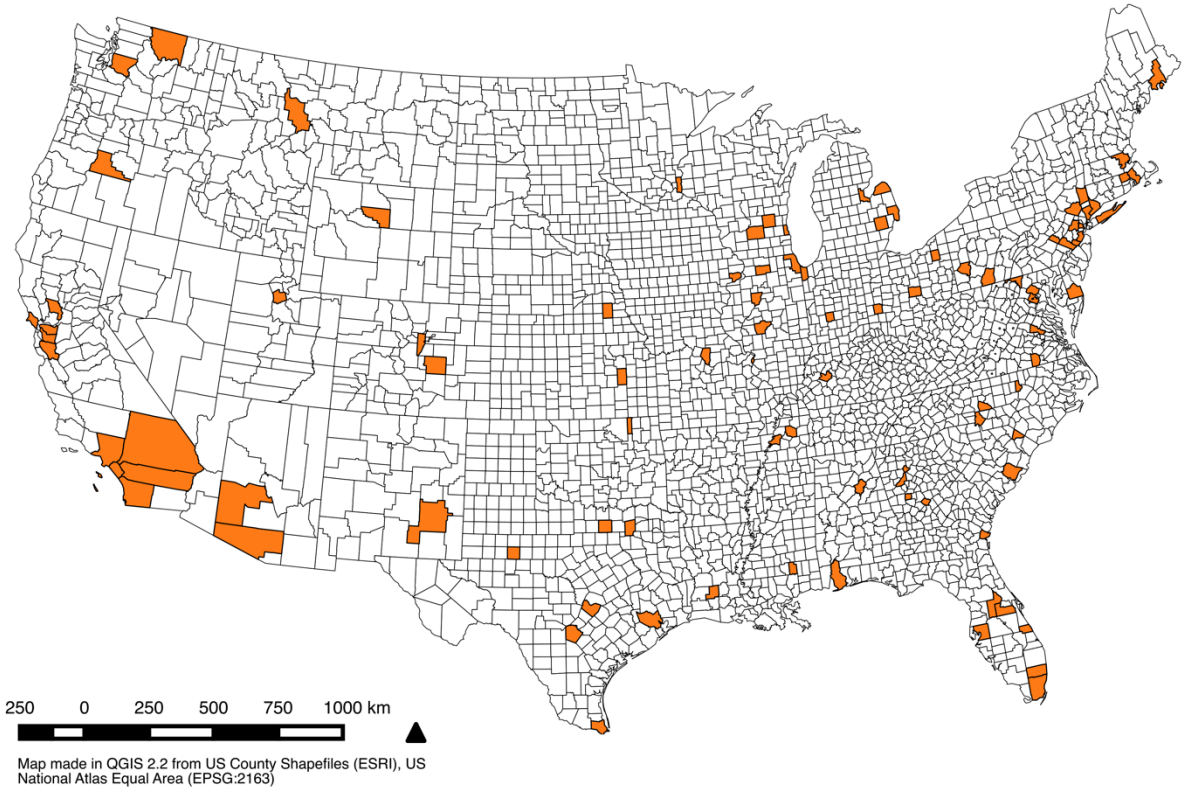
Methods

Data Sources: Tobacco Retailers

This is a secondary analysis of data from Advancing Science and Policy in the Retail Environment (ASPiRE), funded by the National Cancer Institute's State and Community Tobacco Control Research Initiative. ASPiRE is a consortium of the Center for Public Health Systems Science (CPHSS) at Washington University in St. Louis, MO; the Stanford Prevention Research Center; and the University of North Carolina Gillings School of Global Public Health in Chapel Hill. The selection of counties for a nationally representative sample of U.S. tobacco retailers was based on all counties in the contiguous 48 states. The sample of counties was selected using a probability proportionate to size method developed by

Chromy.[144] This resulted in 97 unique counties (Figure 1) in which 26% of the U.S. population (79 million people) resides.[145]

Figure 3. Counties included in sampling frame, n=97.



Retailer address and phone data were purchased in 2012 from two sources: North American Industry Classification System (NAICS) Association and ReferenceUSA. We requested lists of stores with primary or secondary classification as one of the following: supermarkets and other grocery (except convenience) stores; convenience stores; tobacco stores; gasoline stations with convenience stores; warehouse clubs and supercenters; news dealers and newsstands; beer, wine, and liquor stores; pharmacies and drug stores; discount department stores; and other gasoline stations.

Data cleaning removed stores without addresses, removed punctuation and spaces, removed suite numbers, replaced PO boxes, and removed non-street address (e.g., airport) stores. The cleaning process eliminated discount department stores other than Walmart, separate stores within Walmarts (e.g., Walmart Bakery), retained only the top 50 pharmacy chains, and removed stores known to not sell tobacco (e.g., ABC stores, Aldi, Trader Joe's, Whole Foods). This was conducted separately for NAICS Association and ReferenceUSA lists. Lists were then merged by zip code and address and de-duplicated.

A national review of food stores found that commercial lists like those used in this study are a viable data source for large-scale studies[146] and the use of these commercial databases has been validated using ground truthing in a state without tobacco retail licensing.[147] Previous research has also validated the use of commercial lists to measure tobacco retailer density, finding that commercial lists did not show disproportionate under- or over-reporting of state-licensed tobacco retailers by area demographics in Washington.[65]

Data Sources: Same-Sex Couples

Data on same-sex couples came from the 2010 U.S. Census, which included a question on relationship to the owner or renter of the household ("How is this person related to Person 1?"). By aggregating responses of "Husband or wife" and "Unmarried partner" and comparing to the sex of each person, same-sex couples were computed by the Census Bureau as a subcategory of unmarried partner households, where "an adult who is unrelated to the householder, but shares living quarters and has a close personal relationship with the householder" is present.[148] Census 2010 includes same-sex couples as unmarried partners even when they are legally married and live in states with provisions for same-sex marriage or other legal recognition. An important questionnaire design issue has been identified in

Census 2010 that caused misclassification of sex in door-to-door data collection by census workers, thereby causing some estimates of same-sex couples to exceed the total possible number.[149,150] To correct for this error, we applied a state-level error-rate correction developed and recommended by Gates.[151]

Data Sources: Census Tract Characteristics

Census tract demographic variables on race/ethnicity and total population were available from Census 2010.[152] We used the Census Bureau's American Community Survey (ACS), 5-Year Estimates, 2008–2012, for income.[153] ACS data were unavailable for eight census tracts.

Measures

Following earlier research,[53,59,61,63,64] we conducted all analyses at the census tract level. Census tracts represent the best available area unit to reflect neighborhood processes for our purposes, having been designed to define homogenous community areas[154] and provide a large enough population to also analyze small subgroups (i.e., same-sex couples). Measure definitions are reported in Table 1 by their role as dependent variable, independent variables, and explanatory variables. Percentages were divided by ten (e.g., 12% = 1.2) for scaling purposes.

Table 1. Key Measures and Definitions

Variable	Item Details
Dependent Variable	
Tobacco Retailer Density	Total number of tobacco retailers in a census tract divided by total population and multiplied by 1,000
Block 1: Independent Variable	
Same-Sex Couple Households, Female, per 1,000 Coupled Households	Number of female householders with female partner divided by total married and unmarried coupled households and multiplied by 1,000
Same-Sex Couple Households, Male, per 1,000 Coupled Households	Number of male householders with male partner divided by total married and unmarried coupled households and multiplied by 1,000

Block 2: Explanatory Variables	
Percentage African-American Population in 10-point increments	Percentage of the total population reporting Black or African-American race alone or in combination with another race divided by ten
Percentage Hispanic Ethnicity in 10-point increments	Percentage of the total population reporting Hispanic or Latino origin divided by ten
Median Annual Household Income, Adjusted to 2012 USD	Median household income in the past 12 months, in 2011 inflation-adjusted dollars divided by 1,000
Block 3: Explanatory Variables	
Presence of Interstate Highway	Dichotomous (0 = No, 1 = Yes)
Rurality	County-level ordinal U.S. Department of Agriculture Urban-Rural Continuum Codes (range 1 - 9, from most to least urban)

Tobacco retailer density was computed as the number of tobacco retailers divided by 1,000 population in a given census tract. Because of non-normality in the distribution of tobacco retailer density (skew: 7.9, p=0.02; kurtosis: 139.3, p=0.04), we tested various transformations with an offset of 0.3 to see which transformation's Pearson correlation with same-sex couple rates best approximated a non-parametric correlation coefficient between the female and male same-sex couple household rates with tobacco retailer density, respectively, $r_{s(n=17,675)}$ = 0.09 (p<0.001) and 0.14 (p<0.001). Of these, a square-root transformation provided the best option (skew: 1.8, p=0.02; kurtosis: 9.5, p=0.04). We then ran analyses using both transformed and untransformed dependent variables. Because patterns of significance and direction were not sensitive to the transformation, we used Loomis and colleagues' method—we left our dependent variable untransformed so as to facilitate interpretation.[63]

There are multiple ways to calculate the density of same-sex couples, and they are very highly correlated.[128] We choose to follow an approach used by Walther et al.[131] that calculates a same-sex couple rate per 1,000 coupled households, shown for male couples:

$$\left(\frac{\#\ Male\ Same-Sex\ Couple\ Households}{\#\ of\ Same-Sex\ Couple\ Households + \#\ Opposite-Sex\ Unmarried\ Couple\ Households + \#\ Married\ Couple\ Households}\right) * 1000$$

Data from an earlier study[155] showed that particularly in suburban and rural areas retailers clustered at exits along interstate highways. Thus we created a dichotomous measure of presence of an interstate highway within a tract.[156] We used the U.S. Department of Agriculture's (USDA) 2013 Rural-Urban Continuum Codes for county urbanicity.[157] Data management was conducted in SPSS v. 22 (IBM, Chicago, Illinois) and QGIS v. 2.2 (www.qgis.org). Data analysis was conducted with GeoDa v. 1.6.0 (Arizona State University, Tempe, Arizona).

Analysis Strategy

Because some census tracts are not residential or have very few people, rates of demographic characteristics can be unstable. We thus excluded census tracts with fewer than 250 households (n=266 tracts) and retained 17,675 tracts (or 98.5% of the original sample). We then excluded eight tracts for which no economic data were available. All model results are reported using n=17,667 tracts.

Given gendered differences in spatial patterns of same-sex couple migration, we stratified all analyses by sex of same-sex couple. When statistically modeling phenomena with a spatial component, key tenets of linear regression are violated by non-independence of observations based on shared characteristics due to their proximity.[158] We identified spatial clustering of the dependent variable (Moran's $I = 0.10$, $p = 0.001$). Indeed, ordinary least squares regression residuals showed significant spatial clustering (Female: Moran's $I = 0.08$, $p = 0.001$; Male: Moran's $I = 0.07$, $p = 0.001$). Therefore, we used spatial regression models to account for spatial dependence in our data. We examined models with multiple contiguity weights matrices, selecting a second-order queen weights matrix. Two common approaches to spatial dependence include spatial lag and spatial error models. Spatial lag models address

the influence of the dependent variable in one location on nearby locations. Spatial error models address the influence of omitted independent variables over space. Past tobacco retailer density analyses have used a spatial lag approach.[61,63] Lagrange Multiplier Tests indicated the spatial error model was more appropriate for our data. We set all critical values at $\alpha=0.05$ and used two-tailed tests. Finally, we graphically displayed results using a dot and 95% confident interval plot, using Jenks natural breaks in the data.[159]

Modeling Approach

We selected variables for model building based on the existing literature of tobacco retailer density and same-sex couple demography discussed previously. We approached modeling in three blocks, stratifying by sex. First, we entered the same-sex couple household rates, defined as same-sex coupled households per 1,000 coupled households. We then added tract-level characteristics for income and racial/ethnic composition. Last, we added variables for the presence of interstates and rurality, as indicated by USDA Rural-Urban Continuum Codes (see Table 1). We compared models using changes in R^2 and likelihood ratio tests. Last, we conducted sensitivity analyses for edge effects (i.e., a boundary problem in spatial analysis), where the lack of data on neighboring units at the borders of the area under study can influence results.[160]

Because there were no human subjects, the UNC Office of Human Research Ethics exempted this research from further review (#13-2602).

Results

Same-Sex Couples and Tobacco Retailer Density

At the census-tract level, the average density was 1.27 tobacco retailers per 1,000 population (range 0 to 50.96, sd=1.55, median=0.96). The average rate of same-sex

households per 1,000 coupled households was 6.66 for same-sex female couples (range 0 to 68.74, sd=5.96, median=5.21) and 10.07 for same-sex male couples (range 0 to 562.35, sd=23.77, median=3.26).

Results from spatial regression show that higher rates of both female and male same-sex couples were associated with a higher density of tobacco retailers (Table 2). However, the magnitude of this association was small: For each additional same-sex household per 1,000 households, the number of tobacco retailers per 1,000 people increased by 1/100. For both sexes, the first model explained only 6% of variance. Figure 2 illustrates the bivariate relationship in natural breaks of same-sex couple rates.

Table 2. Same-Sex Couple Household Rate Predicting Tobacco Retailer Density

(Same-sex coupled households per 1,000 coupled households and tobacco retailer density per 1,000 population in census tracts (*n*=17,667), 97 counties, U.S.A., respectively, stratified by sex of couple.)

		Female			**Male**		
Model	**Variable**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
1	Constant	**1.18**	0.03	<0.001	**1.17**	0.02	<0.001
	Same-sex couple rate	**0.01**	<0.01	<0.001	**0.01**	<0.01	<0.001
	Lag coefficient, Lambda	**0.44**	0.02	<0.001	**0.40**	0.02	<0.001
	Overall model	R^2 = 0.06; AIC = 64849			R^2 = 0.06; AIC = 64714		
2	Constant	**1.83**	0.06	<0.001	**1.71**	0.05	<0.001
	Same-sex couple rate	<0.01	<0.01	0.19	**0.01**	<0.01	<0.001
	% Black race (10 points)	<0.01	0.01	0.82	0.01	0.01	0.35
	% Hispanic ethnicity (10 points)	**-0.04**	0.01	<0.001	**-0.03**	0.01	<0.001
	Median household income (1000s)	**-0.01**	<0.01	<0.001	**-0.01**	<0.01	<0.001
	Lag coefficient, Lambda	**0.43**	0.02	<0.001	**0.39**	0.02	<0.001
	Overall model	R^2 = 0.07; AIC = 64613			R^2 = 0.08; AIC = 64448		
3	Constant	**1.73**	0.08	<0.001	**1.57**	0.07	<0.001
	Same-sex couple rate	<0.01	<0.01	0.15	**0.01**	<0.01	<0.001
	% Black race (10s)	<0.01	0.01	0.83	0.01	0.01	0.30
	% Hispanic ethnicity (10s)	**-0.04**	0.01	<0.001	**-0.03**	0.01	<0.001
	Median household income (1000s)	**-0.01**	<0.01	<0.001	**-0.01**	<0.01	<0.001

Presence of interstate highway	**0.26**	0.03	<0.001	**0.27**	0.03	<0.001
Rurality level	0.01	0.04	0.70	0.04	0.03	0.22
Lag coefficient, Lambda	**0.43**	0.02	<0.001	**0.38**	0.02	<0.001
Overall model	R^2 = 0.08; AIC = 64483			R^2 = 0.08; AIC = 64348		

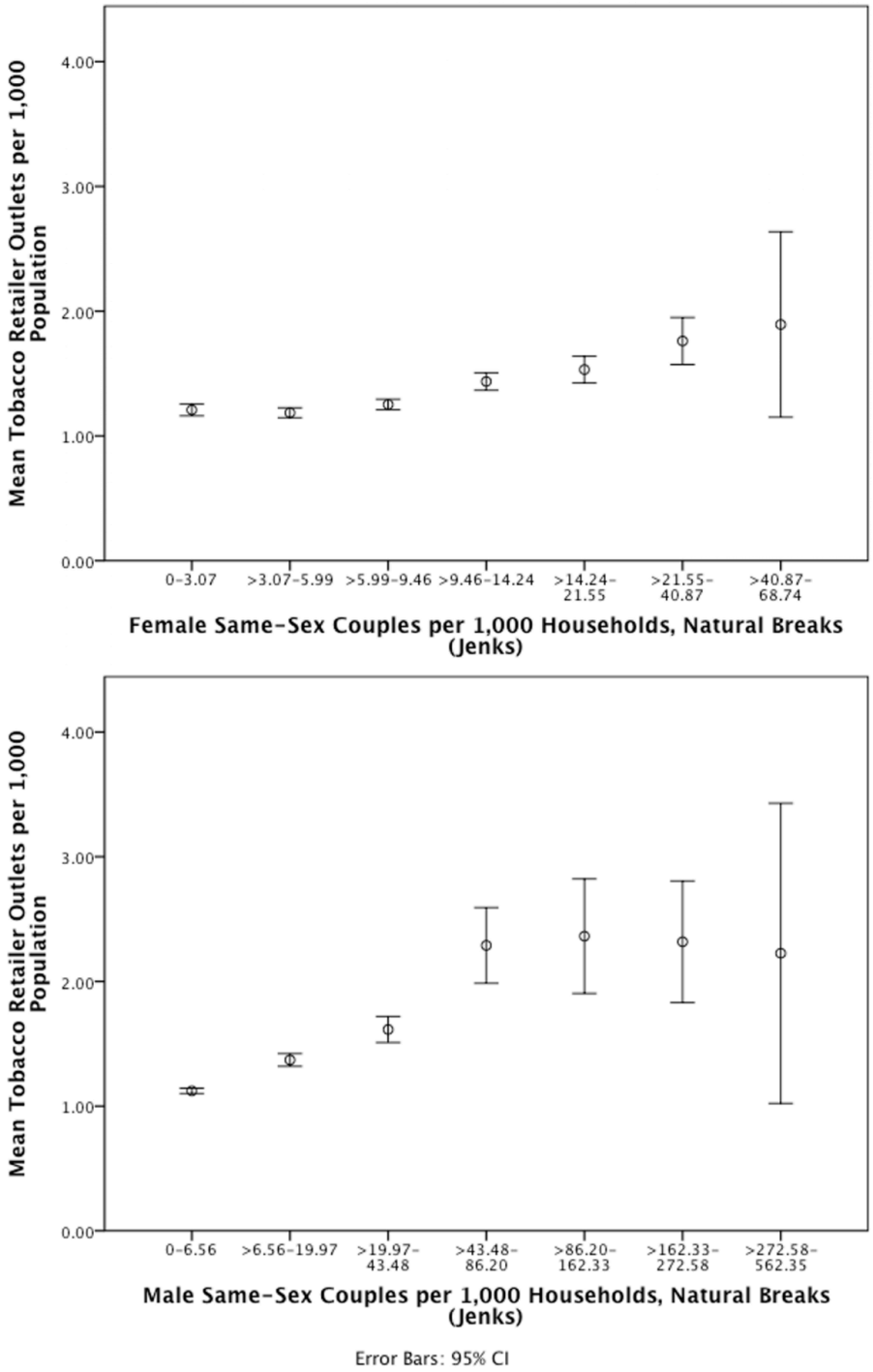
Note: Using a row-standardized second-order (including lower orders) queen weights matrix and a spatial error model. AIC = Akaike information criterion, SE = standard error

We examined whether including area-level demographic characteristics of race, ethnicity, and income explained the bivariate association in Model 1. For female same-sex couples, the addition of other neighborhood indicators explained the relationship between same-sex couple households and tobacco retailer density. For male same-sex couples, however, a significant positive association of same-sex households and tobacco retailer density was independent of other neighborhood demographics.

A third block of variables looked at whether physical area–level characteristics would offer additional explanation of this association. Thus, in this third model, we included variables for the presence of an interstate and rurality level. These did not fully explain the relationship between male same-sex couples and tobacco retailer density but did offer significant improvements in both models.

The addition of each block of variables significantly improved model fit based on likelihood ratio tests, $p<0.001$. Nonetheless, our final models explained only a modest amount of variance (8%) in the tobacco retailer density.

Figure 4. Same-sex couples per 1,000 partnered households classified by natural breaks (Jenks) and mean number of tobacco retailers per 1,000 population, census tracts (*n*=17,667), 97 counties, U.S.A., in 2010 and 2012, respectively, by sex of couples.



Sensitivity Analysis

To assess the sensitivity of our findings to edge effects, which can influence results in spatial analysis,[160] we re-ran all analyses in a subset of 15,085 tracts after removing all census tracts at the edges of counties. Our findings were sensitive to the removal of edge tracts. For female same-sex couples excluding edge tracts, there was a negative association with tobacco retailer density, which is in the opposite direction of our main findings. Estimates became more pronounced: -0.05 in Model 1 and -0.07 in Models 2 and 3. Significance was maintained between female same-sex couples and tobacco retailer density in each model ($p<0.01$). For men, estimates were similar for each model (0.01), but control for tract demographics and physical characteristics resulted in a marginally significant relationship between male same-sex couple rate and tobacco retailer density in Models 2 ($p=0.07$) and 3 ($p=0.08$). Thus, our findings for female same-sex couples show substantive differences when edge tracts are removed while the removal of edge tracts has less influence on our findings for male same-sex couples.

Further examination revealed quantitative differences in edge vs. non-edge tracts, all $p<0.01$: Edge tracts have fewer African American residents (M=11% vs. 15%), fewer Hispanic residents (M=15% vs. 29%), higher median income ($74,379 vs. $63,489), lower population density per square mile (M=4,737 vs. 8,895), and a lower same-sex couple household rate than non-edge tracts (M=6.05 vs. 6.75 female and 8.64 vs. 10.53 male couples per 1,000 coupled households). These findings appear to be consistent with historical patterns of residential segregation in urban areas.[161] These sensitivity analyses indicate that we cannot rule out the possibility of edge effects, but differences from the main model may be driven by

patterns of residential segregation. Future research using areas with fewer edges (e.g., an entire state instead of a sample of non-contiguous counties) is indicated.

Discussion

Principal Findings

Same-sex couples tend to live in neighborhoods where tobacco retailer density is greater, and for male same-sex couples this association persists even after adjustments for neighborhood income, race/ethnicity, and other correlates of higher retailer density. An increase of 100 same-sex couple households in the rate of same-sex households was associated with an additional tobacco retailer for every 1,000 residents in census tracts. Although the association between the density of same-sex households and tobacco retailers was relatively small, such findings matter to our understanding of population-level influences on health.[162] This study is the first to suggest a role for neighborhoods in understanding the etiology of LGB tobacco-related health disparities.

That the relationship between same-sex couples and tobacco retailer density can be explained by area demographics for female same-sex couples but not for male same-sex couples suggests differences by sex in the mechanisms by which same-sex couple households come to be associated with tobacco retailer density. Two processes may be involved in this. First, retailer density can be explained by theories of organizational ecology,[163] which consider available resources to promote the founding, evolution, and closing of retail locations. Neighborhood resources for retailers may be influenced by historical underinvestment in more urban, more African American neighborhoods.[164] With fewer large and chain stores, more smaller corner stores may be present.[77,78] Second, neighborhood selection choices of same-sex couples may be related to selection into neighborhoods that,

for other reasons, have more tobacco retailer density. Mechanisms could include differences in childrearing (less for male couples)[165] and interest in school quality; in perceived safety of neighborhoods, which may differ by gender,[166] although some studies find no differences for lesbian women and gay men;[167] and in income (lower for women).[168] There is evidence that LGB people are subject to wage and hiring discrimination, the latter of which may differ by state.[129,130,169] Same-sex couples are not as wealthy as the popular imagination holds.[170] Lesbian couples are also affected by gender-based inequity in pay compared to heterosexual couples and gay male couples.[168]

Early research on gay neighborhoods described a process of territorialization, rooted in masculine behavior and need to create gay [male] space.[114] Others describe a process by which gay male neighborhoods were created out of red light districts.[109,115] In qualitative research, these patterns of neighborhood formation do not parallel the formation of lesbian neighborhoods.[106,124-126] Alternatively, declining residential segregation for same-sex couples[133] and rural and suburban neighborhood selection[108,120,123] as well as the feasibility of returning to communities of origin with growing social acceptance[111] could be different by gender and result differences in our models. Regardless of the different mechanisms, our findings show both the rate of male and female same-sex couples are associated with greater tobacco retailer density.

In sensitivity analyses to assess edge effects, our results differ, particularly for female same-sex couple models. However, because the counties included in our study are more urban than the typical county, edge tracts appear to be qualitatively different than core tracts. Thus we cannot rule out the possibility of edge effects. For many included counties, a central

city occupies the center of the tract and many edge tracts are larger and suburban in nature. Future research should explore this more fully.

Strengths and Weaknesses of the Study

There are several strengths and limitations to this research. We selected an area unit we viewed to be most conceptually appropriate for neighborhoods and selected variables for model building a priori based on the existing literature. The statistical approach explicitly modeled spatial dependence. We note two important limitations: First, census data only provide information on same-sex couples; were data on individual sexual orientation available they might provide different results. Although the census undercounts some racial/ethnic minorities,[171] census data represent a high-quality data source. Second, there is no national licensing of tobacco retailers. Although we used a unique, high-quality list of tobacco retailers that has been validated in similar studies,[65,147] there is an unknown amount of error in identifying current tobacco retailers. Additionally, we did not have information on retailer type.

Future research should examine (1) activity space as an area unit[172] because we did not have data on individual households, (2) the potential role of edge effects because we were unable to rule them out, (3) the role of tobacco retailer policy interventions on density for neighborhoods with more same-sex couples, and (4) changes in gay and lesbian neighborhoods[133,173] in relation to tobacco retailer density.

Conclusion

This is the first study to examine tobacco retailer density in relation to same-sex couples, thus providing new information to our understanding of LGB disparities in tobacco use. Much of the literature on tobacco dependence disparities for LGB populations is based

on a minority stress model.[15] Our work suggests a small role for an environmental factor that may also contribute to disparities, differences in neighborhood tobacco retailer density. The positive relationship between tobacco retailer density and same-sex couples at the tract level suggests that this may play a part in population-level disparities in tobacco use for LGB adults. The extent and quantification of that role requires further research. Given the lack of tobacco control interventions that reduce disparities,[174] identifying pro-equity interventions is an important area of future research. Policy interventions[175-177] to limit the density of tobacco retailers should be assessed for their impact on LGB tobacco use disparities.

CHAPTER 3: RELATIONSHIP BETWEEN RETAILERS' POINT-OF-SALE TOBACCO MARKETING AND RATE OF SAME-SEX COUPLES IN CENSUS TRACTS

Introduction

Lesbian, gay, and bisexual (LGB) people are at much higher risk of tobacco use than their straight counterparts.[10] In addition to more than 50% higher smoking prevalence than for straight people,[134] LGB people are more likely to smoke menthol brands, flavored little cigars, filtered little cigars, and use e-cigarettes than heterosexual people.[134,178-180] Data for transgender populations are scarce,[12] although similar disparities likely exist.[181] The reasons for these disparities are only partially known, and research has focused primarily on the role of discrimination, stigma, and stress.[15] Researchers have also suggested that the role of LGB bars as safe community spaces may promote tobacco use,[17,18] that the media environment may contribute as tobacco use is normative in the LGB print press and in LGBT-themed movies,[19-21] and that tobacco industry marketing targeted directly at LGB communities contributes to disparities.[23,24,136]

In one of the tobacco industry's plans to market to gay men titled Project Sub-Culture Urban Market (SCUM), RJ Reynolds Tobacco Co. planned to make its products and their marketing ubiquitous in a neighborhood considered to be a gay enclave, San Francisco's Castro.[23,27] Project SCUM called for better "in store presence," better "store front presence," and "consistent POS[point-of-sale]/PDI placements," with an objective to "[p]enetrate fragmented/nontraditional outlets to increase Camel's Distribution and presence."[27] Thus, in

one of the clearest examples of tobacco industry targeted marketing to LGB people, Reynolds sought to make its marketing ubiquitous in tobacco retailers in a gay neighborhood.

In studies of the etiology of LGB health disparities in tobacco,[15] neighborhood-level marketing to LGB people has been largely ignored although some research has examined political and social environments at the county level and school level in relation to LGB youth smoking.[182] Yet there is emerging demographic evidence that internal migration of LGB people within the United States results in the concentration of same-sex couples[§§] in certain types of neighborhoods, in regional cities, and in places where there are already more same-sex couples.[28,29,133] These patterns are more complex than the common view of migration of LGB people to major cities,[30] potentially reveal decision-making regarding migration that is informed by sexual orientation identity,[111,121] and indicate that LGB people have, as a population, unique spatial patterning.[28,29,132,133] If LGB people live in places where there is disproportionate exposure to tobacco industry marketing, exposure to this marketing could partially explain the presence of large disparities in tobacco use for LGB populations compared to heterosexual populations because such marketing can stymie quit attempts. Indeed, demographic research suggests that same-sex couples often live in lower income and more diverse neighborhoods,[29] especially male same-sex couples.[132] Tobacco industry marketing is frequently found at greater volume at retailers in poorer and less white neighborhoods.[76,83,87,183,184] Neighborhoods with more black residents have more menthol marketing,[80,81,185] lower menthol prices,[80] and more little cigar marketing.[186] E-cigarettes are more available in higher-income neighborhoods and neighborhoods with more white residents.[187] Thus, same-sex couples are, as a population, more likely to live in a more

[§§] We use the terminology "same-sex couples" to describe patterns available from the U.S. Census, which does not report on individual sexual orientation. When discussing the literature or conceptual issues, we use LGB.

racially/ethnically diverse neighborhood with lower income; these neighborhoods are likely to have disproportionate tobacco market due to industry targeting of African American neighborhoods and lower-income neighborhoods.[87]

Tobacco marketing at the POS is part of a broader marketing effort that is causally related to smoking behaviors.[31,32] Both a National Cancer Institute monograph and the Surgeon General report highlight the importance of POS marketing to tobacco prevention and control.[31,38] The tobacco industry spends the majority (85%) of its reported marketing dollars at the POS in the United States.[33,34] Two systematic reviews have synthesized the evidence of the impact of POS marketing on tobacco-related health behaviors, suggesting sufficient evidence for policy intervention.[37,188] Because tobacco use starts during adolescence,[31] POS tobacco marketing is relevant to our understanding of LGB tobacco use disparities through its role in stymieing quit attempts. Greater volume of tobacco marketing at retailers in neighborhoods with more same-sex couples could delay quit attempts or make them more likely to fail.[37,43,74,75,139,188,189]

We aimed to examine the association between census tracts' rate of same-sex couple households and tobacco retailers' marketing. Because this is the first study to explore the rate of same-sex couples in neighborhoods in relation to retailers' POS marketing, our hypotheses are driven by two competing approaches. First, same-sex couples tend to live in more diverse neighborhoods,[29] which are the same neighborhoods that are more likely to be targeted by the tobacco industry.[81,83,87] These neighborhoods have smaller, non-chain stores with more marketing.[77,78,190] Second, same-sex couples have been associated with neighborhood gentrification[115,116] and rising home prices,[118] which are associated with less POS tobacco marketing.[81,85] We proposed eight hypotheses based on the first approach, given the weight

of demographic evidence[29] but recognizing that this study is the first to investigate this relationship.

Given the LGB tobacco disparities that exist (higher smoking prevalence, higher menthol use, and higher use of flavored little cigars) we hypothesized store marketing characteristics that would contribute to those disparities in hypotheses 1–7. We then hypothesized the likelihood of stores' sale of e-cigarettes based on evidence that same-sex couples live in more diverse neighborhoods.[187] The rate of same-sex couple households in census tracts is:

$H_{1–2}$: Positively associated with the presence of (H_1) promotional offers and (H_2) Newport-specific (i.e., menthol) promotional offers.

H_3: Not associated with the advertised price of Marlboro Red cigarettes at tobacco retailers.

H_4: Negatively associated with the price of Newport-brand mentholated cigarettes at tobacco retailers.

$H_{5–6}$: Positively associated with numbers of (H_5) total marketing materials and (H_6) total number of exterior marketing materials.

$H_{7–8}$: Positively associated with (H_7) the likelihood of the sale of flavored cigars and (H_8) negatively associated with the likelihood of the sale of e-cigarettes.

Methods

Selection of Counties

This study is part of a nationally representative study of point-of-sale (POS) tobacco marketing and the methodology is described elsewhere.[187] Briefly, we randomly selected 100

counties with replacement and with probability proportionate to population size using a Chromy[144] technique in SAS 9.2 with minimal replacement. This resulted in 100 counties (97 unique) where approximately one-quarter of the U.S. population lives.[145]

Tobacco Retailer Sampling Frame

For the 97 counties, retailer address and phone data were purchased from two sources in 2012: North American Industry Classification System (NAICS) Association and ReferenceUSA. We requested lists of stores with primary and/or secondary classification as one of the following: supermarkets and other grocery (except convenience) stores; convenience stores; tobacco stores; gasoline stations with convenience stores; warehouse clubs and supercenters; news dealers and newsstands; beer, wine, and liquor stores; pharmacies and drug stores; discount department stores; and other gasoline stations. Codes were selected for store types most likely to sell tobacco.

Data cleaning was conducted using a cleaning protocol that removed stores with no addresses, removed punctuation and spaces, removed suite numbers, replaced PO boxes, and removed non-street address (e.g., airport stores). The cleaning process included eliminating discount department stores other than Walmart, removing separate stores within Walmarts (e.g., Walmart Bakery), retaining only the top 50 pharmacy chains, and removing stores known to not sell tobacco (e.g., state-owned liquor stores, Aldi, Trader Joe's, Whole Foods). This was conducted separately for NAICS Association and ReferenceUSA lists. Lists were then merged by zip code and address and manually de-duplicated.

As part of data cleaning for in-person data collection regarding marketing at the point-of-sale, up to 55 randomly selected stores per county from the cleaned sampling frame of tobacco retailers were initially verified by telephone with up to three callbacks using a

standardized phone script and computer-assisted dialing. Telephone verification indicated that a majority of retailers in each county (M=56%, SD=9%) included in the merged lists could be confirmed by telephone as tobacco retailers. For each selection of a county, up to 24 phone-verified stores were selected for in-person observation.

POS Marketing Audit

Thirteen data collectors participated in a five-hour, in-person training with practice at local stores. Data collectors then visited each store and conducted an audit of tobacco products and marketing materials from June through October 2012 using an iPad. We assigned 2,346 stores to be visited. Of these 2,236 were eligible and data were fully collected at 97% of them. This resulted in 2,231 store audits, of which 67 only assessed the store exterior due to refusal for interior data collection (n=55) or temporary closure/construction (n=12). Non-response was more likely to be in alcohol (OR = 3.06, 95% CI: 1.78–5.25) or tobacco stores (OR = 4.79, 95% CI: 2.29–9.57) than a typical store and in neighborhoods (tracts) with more black residents in 10-percentage point increments (OR=1.12, 95%CI: 1.01–1.24). We assessed reliability of marketing audits by assigning eight auditors to repeat audits at 166 stores; we calculated inter-rater reliability using Krippendorff's alpha.[191] Audits were often over a week apart; some variability is expected due to changes in the store environment. When stratified by time, audits with a short retest interval had higher reliability than those with longer intervals (data not shown). Thus, lower reliability may partially reflect expected rotation of store marketing and promotions. Table 1 shows definitions of marketing materials used and reliability.

Table 3. Dependent Variables by Domain of Marketing and Inter-Rater Reliability

Marketing Type	Response Options	Krippendorff's α
Price		
Advertised Price, Marlboro Reds	$XX.XX	0.71
Advertised price, Newport Green (mentholated)	$XX.XX	0.86
Price promotions, interior or exterior	Yes, No	0.42
Price promotion for Newport Green (mentholated), interior or exterior	Yes, No	0.45
Promotion		
Total marketing materials	Count	0.63
Total exterior marketing materials	Count	0.70
Product		
Flavored cigars (regular or little) sold	Yes, No	0.63
E-cigarettes sold	Yes, No	0.59

Note: Price promotion included a multi-pack discount, a special (i.e., discounted) price, or both.

Demographic Data

Data on the concentration of same-sex couples come from the 2010 U.S. Census, which included a question on relationship to the owner or renter of the household ("How is this person related to Person 1?"). By aggregating responses of "Husband or wife" and "Unmarried partner" and comparing to the sex of each person, same-sex couples are computed by the Census Bureau as a subcategory of unmarried partner households, where "an adult who is unrelated to the householder, but shares living quarters and has a close personal relationship with the householder" is present.[148] Census 2010 includes same-sex couples as unmarried partners even when they are legally married and live in states with provisions for same-sex marriage or other legal recognition. An important questionnaire design error has been identified in Census 2010 that caused incorrect reporting of sex in door-to-door data collection by census workers, thereby causing estimates of same-sex couples to exceed the total possible number.[149,150] To correct for this error, we applied an error-rate correction developed by Gates.[151]

We calculated a same-sex couple rate used by Walther et al.[131] as shown for male same-sex couple households:

$$\left(\frac{\#\ Male\ Same\ Sex\ Couple\ Households}{\#\ of\ Same\ Sex\ Couple\ Households + \#\ Opposite\ Sex\ Unmarried\ Couple\ Households + \#\ Married\ Couple\ Households}\right) * 1000$$

Census tract demographics come from Census 2010,[152] except for median household income, which is from the American Community Survey, 5-Year Estimates, 2008–2012.[192] For scaling purposes, percentages were divided by 10 (e.g., 12% = 1.2). Rurality was defined by the U.S. Department of Agriculture's (USDA) 2013 Urban Rural Continuum Codes.[157]

Table 4. Independent Variables

Variable	Details
County level	
Rurality	U.S. Department of Agriculture Urban Rural Continuum Codes, 1 - 9 (in increasing rurality)
Census-Tract Level	
Same-Sex Couple Households, Female, per 1,000 Coupled Households	Number of female householders with female partner divided by total married and unmarried coupled households and multiplied by 1,000
Same-Sex Couple Households, Male, per 1,000 Coupled Households	Number of male householders with male partner divided by total married and unmarried coupled households and multiplied by 1,000
Percentage African-American Population	Percentage of the total population reporting Black or African-American race alone or in combination with another race, in 10s
Percentage Hispanic Ethnicity	Percentage of the total population reporting Hispanic or Latino origin, in 10s
Median Annual Household Income, Adjusted to 2012 USD	Median household income in the past 12 months, in 2012 inflation-adjusted dollars, in $10,000s
Store Level	
Store type	Supermarkets (n=399) Convenience stores (n=258) Convenience stores with gas (n=929) Tobacco Stores (n=93) Alcohol stores (n=224) Drug stores (n=236) Other (n=90, including Warehouse Clubs, Newsstands, Discount Department Stores, "Other" Gas Stations, and Other Store Types)

Analysis

Selection of Area Unit

Following earlier research,[84,85,185,193,194] we selected to conduct all analyses at the census tract level. Additionally, the Census originally developed tracts starting in the early 1900s using local committees to define small relatively stable geographic units that approximated local communities.[154] We determined that census tracts represented the best available geographic level to reflect neighborhood processes and provide a large enough population to also analyze small subgroups (i.e., same-sex couples).

Statistical Approach

Because our data on store audits were for stores located in census tracts within counties, they violate the independence assumption of standard regression procedures. We used a multi-level modeling approach to account for the nested nature of our data. We conducted all preliminary data management in SPSS 22 (IBM, Chicago, Illinois) and used HLM 7.01 (Scientific Software International, Skokie, Illinois) to test study hypotheses. Because the sample of counties was drawn with replacement and with probability proportionate to size, we used sampling weights that accounted for county selection and non-response. For advertised price, we used linear models; for counts of marketing, we used generalized linear models with a Poisson distribution; and for dichotomous outcomes we used a binary distribution. For linear models we used full maximum likelihood estimation and for non-linear models we used 9-point adaptive quadrature estimation.

We use different strategies for advertised cigarette prices than for other forms of marketing. Because prices are subject to state and county tax variation, we report a three-level model with random intercepts at the tract and county levels for price variables.

However, for other forms of marketing, to facilitate convergence and report consistent models, we report a two-level model with random intercepts at the tract level. Tracts have higher intra-class correlations than counties for these variables. Three-level models (see Appendices) showed no substantive differences from two-level models but exhibited convergence problems.[***]

Based on the previous demography literature, we selected a priori a modeling strategy, building sex-stratified models for each dependent variable. First, we assessed the association of same-sex couple rates with each of the marketing variables. Second, we included other neighborhood demographic characteristics including racial/ethnic composition, median income, and county rurality. Third, we added retailer store type using weighted-effect coding.

We did not adjust our analyses for multiple comparisons, following Rothman[195] and Poole.[196] Because this is exploratory research, we set critical values to $\alpha = 0.05$ and used two-tailed tests. The UNC Office of Human Research Ethics exempted the parent study from further review (#12-0765).

Results

We first present results from unadjusted models to assess for the hypotheses. We then discuss the role of covariates in Models 2 and 3.

Price

We could not reject the null of hypotheses 1 (greater presence of promotional offers) and 2 (greater presence of Newport-specific promotional offers) (Tables 5–6) among either

[***] Because this secondary data analysis used a dataset sampled at the county level, weights were only available at the store *or* store and county level. Thus, we did not have weights available for the census tract level. The pattern of results did not differ substantively with weights, without weights, or with control for county population. Nor did it differ substantively between two- and three-level models.

female or male same-sex couples. There was, as expected, no significant relationship between same-sex couples and Marlboro cigarettes' advertised prices (H_3, Table 7). For male same-sex couples and Newport (mentholated) cigarette prices, there was a significant positive association: For every additional male same-sex couple per 1,000 coupled households, Newport prices increased by a fraction of a cent ($0.002). That is, for 100 additional same-sex male couples per 1,000 couples, prices would be expected to increase by $0.20. This was in the opposite direction of our hypothesis (H_4). Thus, hypothesis 3 was supported for no differences in Marlboro cigarettes, and our findings are in the opposite direction of hypothesis 4 regarding a small but significant association with higher Newport prices.

Number of Advertisements

For both male and female same-sex couples, the likelihoods of an additional advertisement at retailers were negatively associated with each additional same-sex couple. This was in the opposite direction of our hypothesis. The count of exterior ads was not associated with the same-sex couple rate. Thus we could not reject the null of hypotheses 5 (total ads) or 6 (total exterior ads).

Product Availability

Neither flavored cigars nor e-cigarette sales were associated with the same-sex couple rates, thus we could not reject the null of hypotheses 7–8.

Role of Store Type, Neighborhood Characteristics, and County Rurality

After control for tract-level demographics, the three significant associations did not lose their significance, nor did the addition of control for store type cause the associations to lose their significance (Tables 5–7). However, in the third model, the likelihood of sale of

flavored cigars was significantly associated with the male same-sex couple rate, OR 0.99 (95% CI: 0.99–1.00).

Table 5. Two-Level Weighted Models Associating Female Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random Tract Intercepts

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing ERR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)
Model 1 (Base)						
L1: Stores	*n*=2164	*n*=2159	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**3.63 (2.93-4.50)**	**0.56 (0.46-0.68)**	**20.55 (19.11-22.10)**	0.97 (0.83-1.13)	**5.94 (4.39-8.03)**	**0.52 (0.44-0.61)**
L2: Tracts	*n*=1655	*n*=1652	*n*=1655	*n*=1696	*n*=1654	*n*=1650
Same-Sex Couple Rate	1.00 (0.98-1.02)	1.01 (0.99-1.03)	**0.99 (0.98-1.00)**	1.00 (0.99-1.02)	1.01 (0.98-1.03)	0.99 (0.97-1.01)
Model 2 (Base + Neighborhood Characteristics)						
L1: Stores	*n*=2164	*n*=2159	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**5.93 (3.01-11.72)**	1.02 (0.58-1.80)	**38.24 (30.61-47.76)**	**2.96 (1.89-4.63)**	**12.06 (6.25-23.26)**	0.92 (0.57-1.47)
L2: Tracts	*n*=1655	*n*=1652	*n*=1655	*n*=1696	*n*=1654	*n*=1650
Same-Sex Couple Rate	0.99 (0.96-1.01)	0.98 (0.96-1.01)	**0.99 (0.98-1.00)**	0.99 (0.97-1.01)	0.99 (0.97-1.01)	0.99 (0.97-1.01)
% Black (10s)	1.06 (0.97-1.15)	**1.25 (1.16-1.35)**	**0.96 (0.94-0.99)**	1.03 (0.97-1.08)	**1.13 (1.03-1.24)**	**0.88 (0.82-0.94)**
% Hispanic (10s)	**0.88 (0.83-0.94)**	**0.92 (0.86-0.97)**	**0.91 (0.89-0.93)**	**0.90 (0.86-0.95)**	0.97 (0.91-1.03)	**0.92 (0.87-0.97)**
Median Income (10ks)	0.99 (0.93-1.05)	0.96 (0.91-1.01)	**0.94 (0.92-0.96)**	**0.85 (0.82-0.89)**	**0.89 (0.84-0.94)**	1.00 (0.96-1.05)
Rurality Code	0.95 (0.85-1.05)	**0.84 (0.76-0.93)**	1.01 (0.97-1.06)	1.02 (0.94-1.11)	0.96 (0.88-1.06)	**0.87 (0.80-0.94)**
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)						
L1: Stores	*n*=2164	*n*=2159	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**6.06 (3.01-11.91)**	0.87 (0.48-1.56)	**31.52 (26.17-37.96)**	**1.49 (1.01-2.21)**	**16.50 (7.44-36.57)**	0.72 (0.44-1.20)
Supermarkets	*(weighted-effect coding reference group - see note below)*					

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing ERR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)
Convenience	0.77 (0.55-1.07)	**1.57 (1.14-2.16)**	**1.13 (1.07-1.18)**	**2.44 (2.10-2.83)**	0.95 (0.64-1.41)	0.90 (0.67-1.20)
Convenience with gas	**2.59 (2.10-3.19)**	**1.64 (1.41-1.91)**	**1.56 (1.53-1.59)**	**2.83 (2.58-3.10)**	**2.51 (1.97-3.21)**	**1.42 (1.25-1.62)**
Tobacco	1.14 (0.61-2.14)	1.55 (0.89-2.72)	**3.17 (3.00-3.34)**	**7.52 (6.34-8.92)**	**7.47 (1.79-31.25)**	**9.60 (5.30-17.38)**
Alcohol	**0.20 (0.14-0.30)**	**0.40 (0.27-0.60)**	**0.54 (0.51-0.58)**	0.84 (0.70-1.01)	**0.15 (0.10-0.24)**	**0.21 (0.13-0.33)**
Drug	**2.17 (1.40-3.35)**	**2.17 (1.55-3.03)**	**0.58 (0.55-0.62)**	**0.02 (0.01-0.04)**	**1.78 (1.10-2.88)**	**3.49 (2.57-4.74)**
Other	**0.19 (0.11-0.33)**	**0.17 (0.08-0.36)**	**0.65 (0.60-0.70)**	**1.90 (1.57-2.30)**	**0.30 (0.17-0.55)**	**1.95 (1.23-3.11)**
L2: Tracts	*n*=1655	*n*=1652	*n*=1655	*n*=1696	*n*=1654	*n*=1650
Same-Sex Couple Rate	1.00 (0.97-1.02)	0.99 (0.96-1.01)	**0.99 (0.98-1.00)**	1.00 (0.98-1.01)	0.99 (0.97-1.02)	1.00 (0.98-1.02)
% Black (10s)	1.08 (1.00-1.17)	**1.28 (1.18-1.38)**	0.98 (0.96-1.00)	**1.06 (1.02-1.11)**	**1.18 (1.07-1.31)**	**0.89 (0.83-0.95)**
% Hispanic (10s)	**0.89 (0.84-0.95)**	**0.93 (0.87-0.99)**	**0.93 (0.91-0.94)**	**0.93 (0.90-0.97)**	1.00 (0.93-1.08)	**0.93 (0.88-0.98)**
Median Income (10,000s)	1.02 (0.96-1.08)	0.97 (0.92-1.03)	**0.96 (0.95-0.98)**	**0.91 (0.88-0.95)**	**0.90 (0.84-0.96)**	1.01 (0.97-1.07)
Rurality Code	0.91 (0.82-1.01)	**0.83 (0.75-0.92)**	**0.98 (0.95-1.02)**	0.96 (0.90-1.03)	0.92 (0.83-1.03)	**0.86 (0.80-0.94)**
ICC	0.15	0.15	0.51	0.74	0.08	0.07

Note: Significance at the $p < 0.05$ level is indicated by bolded text. Store type is coded with weighted-effect coding and should be interpreted as the odds of the outcome variable against the typical tobacco retailer. OR = odds ratio; CI = confidence interval; ERR = event rate ratio; ICC = intra-class correlation; † = Hierarchical generalized linear model (binary); ‡ = Hierarchical generalized linear model (Poisson). ICC calculated as $ICC = \frac{\tau_{00}}{\tau_{00}+\frac{\pi^2}{3}}$ and should be interpreted as the ICC for a hypothetical latent continuous variable underlying the binary variable. Intercepts are reported as exponentiated and represent odds at value of zero. Price promotions model 2 was estimated with 7 adaptive quadrature points after 9 points would not converge. Weights were applied at L1.

Table 6. Two-Level Weighted Models Associating Male Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random Tract Intercepts

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing ERR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)
Model 1 (Base)						
L1: Stores	*n*=2164	*n*=2164	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**3.58 (2.98-4.31)**	**0.60 (0.52-0.69)**	**19.89 (18.87-20.97)**	1.04 (0.92-1.17)	**6.43 (4.86-8.50)**	**0.52 (0.47-0.57)**
L2: Tracts	*n*=1655	*n*=1655	*n*=1655	*n*=1696	*n*=1654	*n*=1650
Same-Sex Couple Rate	1.00 (0.99-1.00)	1.00 (0.99-1.01)	**1.00 (0.99-1.00)**	0.99 (0.99-1.00)	1.00 (0.99-1.00)	1.00 (1.00-1.01)
Model 2 (Base + Neighborhood Characteristics)						
L1: Stores	*n*=2164	*n*=2164	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**4.02 (2.59-6.23)**	0.96 (0.56-1.63)	**35.89 (29.10-44.25)**	**6.29 (4.22-9.38)**	**11.86 (6.32-22.23)**	0.86 (0.55-1.34)
L2: Tracts	*n*=1655	*n*=1655	*n*=1655	*n*=1696	*n*=1654	*n*=1650
Same-Sex Couple Rate	1.00 (0.99-1.00)	0.99 (0.99-1.00)	**1.00 (0.99-1.00)**	**0.99 (0.99-1.00)**	0.99 (0.99-1.00)	1.00 (1.00-1.01)
% Black (10s)	1.05 (0.99-1.12)	**1.24 (1.15-1.34)**	**0.96 (0.93-0.99)**	1.03 (0.97-1.08)	**1.13 (1.03-1.24)**	**0.87 (0.82-0.93)**
% Hispanic (10s)	**0.90 (0.86-0.95)**	**0.92 (0.86-0.98)**	**0.91 (0.89-0.93)**	**0.90 (0.86-0.95)**	0.97 (0.91-1.03)	**0.92 (0.87-0.97)**
Median Income (10000s)	1.00 (0.95-1.04)	0.96 (0.91-1.01)	**0.94 (0.92-0.96)**	**0.85 (0.82-0.89)**	**0.89 (0.84-0.94)**	1.00 (0.96-1.05)
Rurality Code	0.96 (0.89-1.03)	**0.84 (0.76-0.93)**	1.01 (0.97-1.05)	1.01 (0.94-1.10)	0.96 (0.87-1.05)	**0.87 (0.80-0.94)**
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)						
L1: Stores	*n*=2164	*n*=2164	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**6.09 (3.21-11.57)**	0.84 (0.48-1.46)	**29.93 (25.11-36.67)**	**1.53 (1.05-2.22)**	**17.24 (8.02-37.03)**	0.71 (0.44-1.15)
Supermarkets	*(weighted-effect coding reference group - see note below)*					
Convenience	0.77 (0.55-1.07)	**1.56 (1.14-2.15)**	**1.12 (1.07-1.18)**	**2.44 (2.10-2.83)**	0.95 (0.64-1.41)	0.90 (0.67-1.20)
Convenience with gas	**2.58 (2.09-3.18)**	**1.63 (1.40-1.90)**	**1.56 (1.63-1.59)**	**7.51 (6.33-8.91)**	**2.47 (1.94-3.16)**	**1.42 (1.25-1.62)**
Tobacco	1.14 (0.61-2.14)	1.55 (0.89-2.71)	**3.17 (3.00-3.34)**	**2.82 (2.57-3.10)**	**7.43 (1.79-30.84)**	**9.59 (5.30-17.35)**

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing ERR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)
Alcohol	**0.20 (0.14-0.30)**	**0.40 (0.27-0.60)**	**0.54 (0.51-0.58)**	0.84 (0.70-1.00)	**0.15 (0.10-0.24)**	**0.21 (0.13-0.33)**
Drug	**2.19 (1.42-3.40)**	**2.24 (1.60-3.14)**	**0.59 (0.56-0.62)**	**0.02 (0.01-0.04)**	**1.88 (1.15-3.06)**	**3.52 (2.59-4.80)**
Other	**0.19 (0.11-0.33)**	**0.17 (0.08-0.37)**	**0.65 (0.60-0.70)**	**1.90 (1.57-2.30)**	**0.31 (0.17-0.56)**	**1.96 (1.23-3.13)**
L2: Tracts	*n*=1655	*n*=1655	*n*=1655	*n*=1696	*n*=1654	*n*=1650
Same-Sex Couple Rate	1.00 (0.99-1.00)	0.99 (0.99-1.00)	**1.00 (1.00-1.00)**	1.00 (0.99-1.00)	**0.99 (0.99-1.00)**	1.00 (0.99-1.00)
% Black (10s)	1.08 (1.00-1.17)	**1.28 (1.18-1.38)**	**0.98 (0.95-1.00)**	**1.06 (1.02-1.11)**	**1.19 (1.07-1.31)**	**0.89 (0.83-0.95)**
% Hispanic (10s)	**0.89 (0.84-0.95)**	**0.93 (0.87-0.99)**	**0.93 (0.91-0.94)**	**0.93 (0.90-0.97)**	1.00 (0.93-1.07)	**0.93 (0.88-0.98)**
Median Income (10,000s)	1.02 (0.96-1.08)	0.97 (0.92-1.03)	**0.97 (0.95-0.98)**	**0.91 (0.88-0.95)**	**0.90 (0.84-0.96)**	1.01 (0.97-1.07)
Rurality Code	0.91 (0.82-1.00)	**0.82 (0.75-0.91)**	0.98 (0.95-1.02)	0.96 (0.90-1.02)	0.91 (0.82-1.02)	**0.86 (0.79-0.94)**
ICC	0.15	0.15	0.51	0.74	0.08	0.07

Note: Significance at the $p < 0.05$ level is indicated by bolded text. Store type is coded with weighted-effect coding and should be interpreted as the odds of the outcome variable against the typical tobacco retailer. OR = odds ratio; CI = confidence interval; ERR = event rate ratio; ICC = intra-class correlation; † = Hierarchical generalized linear model (binary); ‡ = Hierarchical generalized linear model (Poisson). ICC calculated as $ICC = \frac{\tau_{00}}{\tau_{00}+\frac{\pi^2}{3}}$ and should be interpreted as the ICC for a hypothetical latent continuous variable underlying the binary variable. Intercepts are reported as exponentiated and represent odds at value of zero. Weights were applied at L1.

Table 7. Three-Level Weighted Models Associating Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random County and Tract Intercepts (97 counties, U.S.A.)

	Female		Male	
	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)
Model 1 (Base)				
L1: Stores	*n*=2040	*n*=1852	*n*=2040	*n*=1852
Intercept	**$6.33 (0.17)**	**$6.44 (0.14)**	**$6.33 (0.17)**	**$6.44 (0.14)**
L2: Tracts	*n*=1610	*n*=1547	*n*=1610	*n*=1547
Same-Sex Couple Rate	<$0.01 (<0.01)	<$0.01 (<0.01)	<$0.01 (<0.01)	**<$0.01 (<0.01)**
L3: Counties	*n*=97	*n*=97	*n*=97	*n*=97
Model 2 (Base + Neighborhood Characteristics)				
L1: Stores	*n*=2040	*n*=1852	*n*=2010	*n*=1852
Intercept	**$6.75 (0.30)**	**$6.60 (0.28)**	**$6.72 (0.28)**	**$6.60 (0.25)**
L2: Tracts	*n*=1610	*n*=1547	*n*=1610	*n*=1547
Same-Sex Couple Rate	<$0.01 (<0.01)	**$0.01 (<0.01)**	<$0.01 (<0.01)	**<$0.01 (<0.01)**
% Black (10s)	$-0.01 (0.01)	**$-0.04 (0.01)**	<$0.01 (0.01)	**$-0.03 (0.01)**
% Hispanic (10s)	$-0.01 (0.02)	<$0.01 (0.02)	$-0.01 (0.02)	$0.01 (0.02)
Median Income (10000s)	$-0.01 (0.01)	$0.02 (0.01)	$-0.01 (0.01)	$0.02 (0.01)
L3: Counties	*n*=97	*n*=97	*n*=97	*n*=97
Rurality Code	$-0.15 (0.08)	$-0.11 (0.07)	**$-0.16 (0.07)**	$-0.11 (0.07)
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)				
L1: Stores	*n*=2040	*n*=1852	*n*=2040	*n*=1852
Intercept	**$6.75 (0.30)**	**$6.63 (0.27)**	**$6.70 (0.27)**	**$6.61 (0.24)**
Supermarkets	*- (weighted-effect coding reference group - see note below)*			
Convenience	<$0.01 (0.03)	**$-0.12 (0.04)**	<$0.01 (0.03)	**$-0.12 (0.03)**
Convenience with gas	**$-0.04 (0.02)**	**$-0.09 (0.02)**	**$-0.04 (0.02)**	**$-0.09 (0.02)**
Tobacco	**$-0.25 (0.11)**	**$-0.25 (0.08)**	**$-0.25 (0.11)**	**$-0.25 (0.08)**
Alcohol	**$0.22 (0.05)**	**$0.19 (0.05)**	**$0.21 (0.05)**	**$0.19 (0.05)**
Drug	**$-0.35 (0.04)**	**$-0.21 (0.04)**	**$-0.37 (0.04)**	**$-0.23 (0.05)**
Other	**$0.32 (0.07)**	**$0.43 (0.08)**	**$0.33 (0.07)**	**$0.44 (0.08)**

	Female		Male	
	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)
L2: Tracts	*n*=1610	*n*=1547	*n*=1610	*n*=1610
Same-Sex Couple Rate	<$0.01 (<0.01)	**$0.01 (<0.01)**	**<$0.01 (<0.01)**	**<$0.01 (<0.01)**
% Black (10s)	$-0.01 (0.01)	**$-0.04 (0.01)**	<$0.01 (0.01)	**$-0.03 (0.01)**
% Hispanic (10s)	$-0.02 (0.02)	<$0.01 (0.01)	$-0.01 (0.01)	<$0.01 (0.01)
Median Income (10000s)	$-0.01 (0.01)	$0.02 (0.01)	<$0.01 (0.01)	$0.02 (0.01)
L3: Counties	*n*=97	*n*=97	*n*=97	*n*=97
Rurality Code	$-0.15 (0.08)	$-0.11 (0.08)	**$-0.16 (0.07)**	$0.10 (0.07)

Note: Significance at the $p < 0.05$ level is indicated by bolded text and is reported with robust standard errors. SE=standard error. Intercept is calculated with explanatory variables set at zero. Weight applied at L1.

Discussion

Overall, we found few significant relationships between the rate of same-sex couples in census tracts and eight measures of tobacco marketing in tobacco retailers within those tracts. Nonetheless, our study did find small but significant relationships in unexpected directions, including higher Newport prices for same-sex male couples and fewer ads for both male and female same-sex couples. Although these finding should be replicated in other data sources, it provides no evidence that the origin of LGBT tobacco disparities lies in store-level differences in POS tobacco marketing. Nonetheless, our analysis does not take into account differences in retailer density and thus cannot determine if the total volume of marketing *in neighborhoods* is associated with same-sex couple rates. In Chapter 2, we found a small but significant positive association between same-sex couple rates and tobacco retailer density, with markedly higher density among the neighborhoods with the highest rates of same-sex couples. Greater density could indicate greater neighborhood-level tobacco marketing even in the absence of store-level differences in tobacco marketing.

That we did not find disproportionate amounts of marketing in stores in neighborhoods with more same-sex couples suggests our approach, which focused on same-sex couples' greater likelihood of being in a more diverse and lower-income neighborhood, may have been incorrect. However, in our data, as expected, same-sex couple rates at the tract level were positively associated with the proportion of tract residents reporting black race ($r_{s(n=1696)}$=0.29, p<0.01; $r_{s(n=1696)}$=0.32, p<0.01) or Hispanic/Latino ethnicity ($r_{s(n=1696)}$=0.11, p<0.01; $r_{s(n=1696)}$=0.17, p<0.01) and negatively associated with median household income ($r_{s(n=1696)}$=-0.18, p<0.01; $r_{s(n=1696)}$=-0.15, p<0.01), percentage of housing units that are owner-occupied ($r_{s(n=1696)}$=-0.36, p<0.01; $r_{s(n=1696)}$=-0.42, p<0.01), and county

rurality ($r_{s(n=1696)}$=-0.10, p<0.01; $r_{s(n=1696)}$=0.17, p<0.01), respectively, for female and male same-sex couples. It may be that neighborhoods with higher same-sex couple rates are qualitatively different from those otherwise being targeted by the tobacco industry for their racial/ethnic diversity and lower income. Or, alternatively, processes of neighborhood change including gentrification may have attenuated the relationships between neighborhood demographics and tobacco industry targeting that have previously been documented[87] by changing the composition of neighborhood stores and advertising. It is also possible that growing acceptance of same-sex couples has led to increasing integration of same-sex couples into a broader array of neighborhoods than in previous years. There is some evidence to support this; segregation indices for same-sex couples have declined between the 2000 and 2010 census.[133]

As for specific products and types of marketing, flavored cigars are disproportionately used by LGB people[179] as are little filtered cigars,[180] and we expected to see a neighborhood-level association with the presence of flavored cigars (regular or little) in tobacco retailers. Not finding this association, we suggest further investigation using other more comprehensive measures of little cigar sales and examination of the potential for flavored little cigars use to be influenced by LGB identity-related preferences to enhance our understanding of neighborhood-level influence of the retail marketing environment.

Fallin et al. report that LGB smokers were more likely to use menthol than their heterosexual peers in the National Adult Tobacco Survey.[178] The reasons for this discrepancy are unclear. We note that document research about LGB targeting by the tobacco industry has not reported specific targeting of mentholated products.[23,24,135] Menthol is also disproportionately used by black and African American smokers;[197] researchers have

consistently suggested that this is due to heavy targeting by the tobacco industry[76,197] and linked declines in menthol in Australia to declining marketing.[198] Because we did not find differences in retail marketing of menthol products, other avenues to explain this disparity should be explored. Physiological differences in sensory experience of menthol, which have been suggested by some researchers,[199] seem unlikely to explain differences for LGB people. However, menthol use is associated with being health conscious and a desire to quit,[200] and we believe future research should examine the role of these as potential reasons for LGB menthol disparities, given gendered and cultural differences in menthol preferences.[200]

Last, our research focuses on the neighborhood level of the social-ecological framework and the potential role of POS tobacco marketing therein on LGB tobacco disparities. Further research is needed on other sources of influence on these disparities, such as policies increasing the per-unit cost of tobacco products, other forms of tobacco marketing (e.g., print media, corporate sponsorship), media effects, and differential effects of tobacco use cessation interventions.

Limitations

There are important limitations to this study. First, the census may underestimate same-sex households and only captures information on same-sex couples. Individual LGB people are more likely to live in more urban areas than same-sex couples.[201] Individual sexual orientation data, which is not available in the census, would have strengthened our study, which is not generalizable to LGB individuals.

Second, reliability on some audit measures was low to moderate; we believe this is due to an up to six-week gap between audits. This may reflect expected changes in product promotions (and reliability was negatively related to the length of time between audits); audit

questions such as ours generally show good reliability.[202] But lower reliability makes it harder to detect a true effect. Given our largely null findings, this is a cause for concern.

Third, because of the national scope of this study, it was not financially viable to visit retailers who were not known to be tobacco retailers. Our phone verification protocol may have biased our study against the inclusion of smaller, independent retailers who may be in higher minority and lower income neighborhoods.[77,78] Indeed, at the county level, there are differences in phone verification rates by the proportion of county population reporting African American race ($r_{s(n=97)} = -0.21$, $p = 0.04$), Hispanic ethnicity ($r_{s(n=97)} = -0.37$, $p < 0.001$), and same-sex couple households ($r_{s(n=97)} = -0.28$, $p = 0.01$). Phone verification rates do not differ significantly by median county household income ($r_{s(n=97)} = -0.14$, $p = 0.19$).

Fourth, this study, because of its sampling strategy, was conducted in largely urban counties. Geographers have noted that assessing differences within higher density LGB areas reduces our ability to see differences across the country.[127] That is, by focusing in urban areas, where there are overall higher concentrations to same-sex couples,[29] we may have attenuated our ability to detect differences.

Fifth, we had two limitations from our measures of product marketing. Mentholated products were limited to advertised price of a leading mentholated cigarette brand and the presence of price promotions for that same brand. Future research should examine same-sex couple rates in relation to the volume of marketing for mentholated products. Our measure of flavored cigars was not specific to little cigars and included regular cigars.

Nonetheless, this is one of the largest national audit studies to date, and past systematic reviews[202] have identified no other studies assessing retail tobacco marketing in relation to LGB people or same-sex couples.

Conclusion

In a 2013 systematic review, Blosnich and colleagues noted that the minority stress model is the most frequently used conceptual approach to explaining the origin of LGB tobacco disparities.[15] We attempted to extend this line of research to include spatial patterning of same-sex couples; however, our findings suggest that tobacco industry marketing at the store level is not disproportionately greater in neighborhoods with more same-sex couples. This is not to say existing market is not meaningful; even without disproportionate exposure, tobacco industry marketing may have a greater impact on LGB people than heterosexual people possibly due to LGB community appreciation for being recognized.[136,203,204] Further research is needed to assess density in relation to marketing because greater density could cause total ads per neighborhood to be higher even with no store-level differences. Chapter 2 shows evidence of greater tobacco retailer density in census tracts with higher rates of same-sex couples. Although we hope others will replicate this study, it suggests that the store-level physical marketing environment may play a limited or role or no role in the origin of LGB tobacco disparities, use of mentholated products, use of flavored little cigars, and use of e-cigarettes.

CHAPTER 4: BUILDING OUR UNDERSTANDING OF TOBACCO-RELATED DISPARITIES AMONG LESBIAN, GAY, BISEXUAL, AND TRANSGENDER PEOPLE

Although the evidence of disproportionate prevalence of tobacco use among LGBT populations is robust,[205] our understanding of the origins of tobacco use disparities for LGBT people are limited.[15] Most research has focused on a minority stress model framework, suggesting coping with added stress from discrimination and other difference-related stressors.[15] Other researchers have noted the possibility of the media environment as well as exposure to tobacco-genic spaces such as bars and clubs.[17,136] No research has focused on the potential of neighborhood-level influence on this disparity. Tobacco marketing in the United States is predominantly communicated through retailers at the point of sale (POS), with major cigarette and smokeless tobacco manufacturers spending approximately 85% of their marketing expenditures in this venue.[33,34] In this dissertation, I sought to expand our knowledge of social-ecological influences on LGB smoking by examining the neighborhood environment. I drew on a neighborhood health disparities framework developed by Bernard and colleagues and based in structuration and reciprocity theories[89] to inform the research questions and hypotheses. I then examined these using data on and from retailers in a nationally representative sample of 97 U.S. counties. In the next section, I first discuss the general pattern of results, how results align with the rationale for my hypotheses, how results relate to the theoretical framework, and results' meaning for our understanding of the origins of these disparities. I then give an overview of limitations, areas for future research, and finally implications for public health policy.

As for the general pattern of results, we examined the density of tobacco retailers (Chapter 2) and the characteristics of tobacco retailers' marketing (Chapter 3) in relation to census tracts' rate of same-sex couple households. We found a positive association between tobacco retailer density and both male and female same-sex couple rates per 1,000 coupled households. Although the models found small effect sizes for the density relationship, I note that small effect sizes can make large differences to population health.[162] When I examined if tobacco retailers' *marketing* characteristics were associated with same-sex couple rates, I found few associations and the associations I found were small and in the opposite direction of our hypotheses. For several types of tobacco marketing, we identified no significant store-level differences by census tract same-sex couple rate. However, if store-level marketing shows no or limited differences but there is greater density of tobacco retailers, then the *total* number of tobacco marketing materials in a given neighborhood may be higher for neighborhoods with more same-sex couples. That is, even with the absence of store-level differences there still may be neighborhood-level differences in the volume of tobacco marketing. Although the data used here were not designed to directly address this issue, it is an important issue for future research.

The hypotheses were driven by demographic data showing same-sex couple rates are correlated with more diverse and lower neighborhood income.[29] These are characteristics of neighborhoods associated with disproportionate tobacco industry marketing.[81,83,85] Indeed, the neighborhoods in these studies show similar patterns of racial/ethnic diversity and lower income being associated with same-sex couple rates. The hypotheses were largely supported regarding density but were not supported regarding store-level marketing. Regarding density, I hypothesized that the relationship could be explained in part by other neighborhood

demographic characteristics. Although this held for female same-sex couples, the relationship maintained significance for male same-sex couples. Regarding marketing characteristics of tobacco retailers, none of our hypotheses were supported except for one suggesting no difference in Marlboro prices. The non-significance of our findings suggests that the underlying rationale of our hypotheses should be reconsidered. I hypothesized greater marketing and lower mentholated prices based on overlapping demographic patterns of same-sex couples, racial/ethnic diversity, and some indicators of fewer neighborhood economic resources. Given other research that suggests decreasing neighborhood segregation of same-sex couples,[133] gentrification of traditionally gay/lesbian neighborhoods,[115,116,173] and the ability of LGB people to return to communities of origin,[111] it may be that the processes of neighborhood selection and change are, at the population level, resulting in same-sex couples living in more diverse areas. Yet at the same time, those areas may be changing in ways that attenuate tobacco industry geodemographic targeting.

Here I briefly discuss how the study results relate to our conceptual framework. Our findings suggest the importance of considering theories of neighborhood health disparities (with domains of physical, economic, institutional, community organization, and local sociability influence)[89] within a broader social ecological framework to our understanding of LGBT tobacco use disparities. Chapters 2 and 3 solely addressed the physical and economic domains, finding disproportionate density of tobacco retailers in neighborhoods with more same-sex couples (i.e., in the physical domain) and limited differences (possibly even health promoting) of higher Newport prices in neighborhoods with more same-sex couples (i.e., the economic domain). The other domains are relevant to future work on tobacco retailer marketing. For example, institutional factors could include Food and Drug Administration

enforcement of tobacco retailer regulations,[206] community organizations may intervene on tobacco retailers' behavior[207,208] and push for policy change,[209] and local sociability can describe the role of retailers in the social fabric of the community as well as the role of the community in moderating potential impacts of tobacco retailer marketing.

There are other channels by which LGB people are marketed to by the tobacco industry (and, indeed, such marketing may been more influential given the historic invisibility of LGB consumers[136,203,204]). Although the tobacco industry is best known for the Project Sub-Culture Urban Marketing (SCUM) marketing plan for gay neighborhoods, a major change in marketing strategy took place with the ACT-UP[†††] boycott of Philip Morris. ACT-UP attempted to apply pressure to then–Senator Jesse Helms, who blocked public health HIV prevention efforts, with a boycott of Philip Morris.[26] In part to combat this boycott and to prevent future such boycotts, tobacco companies engaged in efforts to support LGB communities through donations to AIDS services organizations, arts, and other organizations supported by LGB communities as well as inclusive corporate human resources policies.[23,24,26] Reynolds American, for example, competes in the Corporate Equality Index and has received a perfect score in promoting equality for its LGB workers.[25] These efforts combine with targeted print advertising[19] and the normative nature of tobacco products in the LGB print press[20] and LGBT movies, which show an average of one incident of tobacco use for every 15 minutes of run time.[137]

Although tobacco marketing targets LGB communities, it is important to contextualize this research with other forms of tobacco industry influence. The conceptual model I use, which focuses on the production of neighborhood health disparities, does not

[†††] ACT-UP = AIDS Coalition To Unleash Power, an important HIV/AIDS advocacy/protest group that targeted Senator Jesse Helms for his work to hinder public health efforts relating to HIV/AIDS.

explicitly include the tobacco industry. Yet each of the domains of influence in the model has been influenced by the tobacco industry's long and successful efforts to normalize tobacco use and undermine public policies that would challenge that use. These efforts have included being convicted of racketeering[3] and clear (often successful) attempts to obfuscate and undermine science and policy.[95] More specifically, the domains of influence I examine in the Bernard framework of neighborhood disparities are influenced by the historic lack[210] of regulation of tobacco as a consumer product and by political efforts to undermine efforts to increase prices of tobacco products. Both of these, for example, impact neighborhoods where access and availability of tobacco products, marketing and low prices are relevant to the production of neighborhood health disparities. Thus this research and its conceptual model are situated in an environment where the powerful influence of the tobacco industry goes well beyond our measures of store density, counts of marketing at retailers, and presence of products. This research, like similar research, cannot disentangle the many forms of influence of the tobacco industry's marketing and policy efforts.

Marketing segmentation and targeting is a normative business practice[211] and niche or "long-tail" approaches are increasingly recommended in public health campaigns.[212] The tobacco industry has used market segmentation based on identity, lifestyle, and image and calibrated products and marketing campaigns to draw upon these.[213] Marketing approaches have also included explicit efforts to improve corporate image and create "evidence" of corporate social responsibility by supporting organizations and causes that appeal to different target markets.[23] For LGBT communities, these have included efforts to show workplace equality, sponsorship of HIV/AIDS, and arts organizations.[24,26] Other strategies have included LGBT bar-based outreach by the tobacco industry, sponsorship of LGBT

organizations, and presence at LGBT events (e.g., pride parades).[23,98] In 2003, Smith and Malone described the tobacco industry's targeting marketing of LGBT communities as "underdeveloped" and described Philip Morris's first gay-oriented media campaign, which garnered media attention and caused corporate worries of effeminizing the Marlboro man.[135,214] Most research has described print media campaigns and corporate sponsorship strategies.

Research on tobacco industry targeted marketing has clearly documented an important spatial component to tobacco industry marketing: targeting by neighborhood demographics.[76] A less discussed form of spatial targeting, geodemographic targeting, uses demographic information in addition to data sources on lifestyle and spatial information to create consumer profiles by area.[215] Tobacco industry documents show the use of an Integrated Micro-Marketing Tool by Philip Morris, which uses a variety of consumer data sources on brand selection, magazine subscriptions, census data, and sales data.[99] From these each "retail trade area" can be targeted with specific mix of products and marketing strategies.[99] Other Philip Morris documents show use of a commercial geodemographic marketing tool, Claritas's PRIZM segmentation tool, which creates consumer profiles at the ZIP-code level.[216] PRIZM's segmentation profiles are derived from proprietary techniques, and none of the available profiles mention same-sex couples or LGBT people.[217] The only spatial evidence of tobacco industry targeting of LGBT communities comes from Project SCUM, which sought to make RJ Reynolds's products ubiquitous in gay neighborhoods in San Francisco, California. RJ Reynolds spokespeople have told journalists that the SCUM plan was never implemented.[25] Thus, there is limited evidence of how the tobacco industry operationalizes area units other than as a ZIP code in PRIZM or their own "retail trade area."

Nonetheless, no systematic examination of tobacco industry documents has examined geodemographic targeting by the tobacco industry's use of area units and specific neighborhood-level strategies used to target LGBT people.

There are a number of important strengths and limitations to this research. First, we draw upon data from the U.S. Census, which is a uniquely high quality data source with no sampling error. However, the Census had a questionnaire design error that over-counted same-sex couples in door-to-door data collection.[149] Although we corrected for this using a recommended method,[151] some error likely exists in our measure of same-sex couples. Additionally, there is likely some underestimation of same-sex couples who did not wish to disclose sexual orientation to a government worker. Non-disclosure of same-sex couple status may be patterned by geography, income, and race. Because the Census captures only same-sex couples, not LGB individuals, this research is not generalizable to individual LGB people, who may have different patterns of neighborhood selection and health behaviors.[201] Second, we use a high quality list of tobacco retailers from 97 U.S. counties; however, as there is no licensing of tobacco retailers in the U.S., there is likely some error in our count of retailers for density calculations.[147] Nonetheless, our list, created from two databases, represents one of the largest and most comprehensive lists of tobacco retailers to date. Third, our sampling of tobacco retailers for in-person marketing audit began with phone verification of retailers. This likely biased our sample toward larger and more chain retailers. Nevertheless, with over 2,200 in-person audits, these data represent one of the larger tobacco retailer audit studies. In a 2012 systematic review of studies auditing tobacco retailer marketing, the median sample size was 208 stores.[202] Fourth, with an up-to-six-week gap for inter-rater reliability calculations, a number of our marketing variables showed lower

reliability. While reliability was higher for shorter gaps and while the types of questions used on the audit generally show good reliability,[202] this is a cause for concern. Fifth, the sampling design for this study provided a nationally representative sample drawn from the lower-48 states. Given that the counties selected often had no neighbors, spatial analysis may be influenced by edge effects (i.e., missing data from outside the study boundaries).[160] Due to differences between the core and edges of counties from patterns of segregation and sprawl in the U.S., our sensitivity analyses could not confirm or rule out the presence of edge effects. Future research from a contiguous study area should examine this issue further. Sixth, our in-person audit measures of marketing characteristics were designed for a larger nationally representative study. Thus, they did not have the level of detail to fully address some of our hypotheses. For example, our measure of targeted menthol marketing did not include the count of menthol ads. Previous research has used the proportion of marketing for menthol marketing. Seventh, our study area, because of its sampling strategy focusing on higher selection of counties proportional to their size, sampled larger, more urban counties. As same-sex couples may migrate toward more urban areas, this may have limited our ability to capture the full range of differences in same-sex couple household rates. These strengths and limitations suggest that future research may be able to provide additional depth and information regarding the research questions addressed in this dissertation, which provides the first information on tobacco retailer density and marketing characteristics in relation to the spatial patterns of same-sex couples.

Our findings suggest areas for future research. First, the neighborhood environment contains more than just tobacco retailers. Future research should examine a broader set of indicators of health-promoting neighborhood resources as well as those that may hinder

health. This might include work incorporating bars and alcohol retailer density.[17,218,219] Methodologically, using activity space of LGBT people instead of area-unit aggregation of rates would greatly strengthen our understanding of exposure to these retailers. Similarly, future work should assess these relationships with LGBT individuals instead of same-sex couples, as spatial patterns are likely different.[201] Lastly, the contribution of neighborhood differences in tobacco retailer density and marketing should be quantified.

Finally, these findings have relevance for public health policy. An emerging literature suggests potential in the U.S. for regulating tobacco marketing at the POS through land use policies,[175] permitting,[176] restrictions of store window marketing,[208] limits on the time/place/manner of tobacco sales,[220,221] and minimum price policies.[209] Many evidence-based tobacco control interventions likely increase disparities even as they improve population health,[174] an effect that has been termed "the inequality paradox."[222] While efforts to increase the per-unit cost of tobacco products (e.g., excise taxes), appear to improve population health while exerting a pro-equity effect by reducing health disparities, little evidence exists about the role of POS and density policies. Only one study provides limited evidence regarding higher tobacco costs and the smoking behaviors of LGB people: a French cohort study of HIV-positive gay men found greater declines in smoking for gay men[‡‡‡] than other men in the cohort following price increases.[223] This finding suggests there may be promise in price-based policies that increase the per-unit cost of tobacco products through floor prices, taxes, or other available strategies, particularly if implemented in neighborhoods and communities with higher rates of same-sex couples. Given the large disparities that exist, pro-equity interventions are needed in general and, more specifically, for LGB populations.

[‡‡‡] Interpretation of this study is difficult as sexual orientation was assessed by transmission route of HIV, which is an imperfect measure and makes comparison groups of drug use and heterosexual transmission.

Future work should examine the role of POS tobacco marketing interventions on LGBT tobacco disparities.

Equity being an important consideration, future work should also examine the role of other evidence-based tobacco prevention and cessation interventions[224] for moderation by sexual orientation.[225] These include the role of media campaigns, interventions to increase the per-unit cost of tobacco products, and the quitline, all of which are evidence-based interventions at the population level.[224] The current, albeit limited, evidence suggests no difference in outcomes by sexual orientation for intensive, non-tailored clinical tobacco dependence treatment interventions (i.e., pharmacotherapy and counseling)[226,227] and emerging evidence suggests little to no differences in receipt of advice to quit from healthcare professionals,[228] although quitline utilization may be lower among LGBT smokers.[229] Thus, while this work suggests a potential role for neighborhood-level environmental factors in LGBT tobacco use disparities, continued attention is needed on other levels of the social-ecological framework.

There is a role for the neighborhood environment and the social ecological framework in our understanding of the origins of LGBT tobacco use disparities. The majority of work conducted on this topic has used a minority stress model[16] to understand the origins of these disparities. This work extends this understanding to include the neighborhood environment, thereby offering additional information to our understanding of tobacco disparities for LGBT populations. While the associations we identified were small, even small associations can have a meaningful impact on population health.[162] Patterns of neighborhood selection for same-sex couples likely combine with processes of minority stress to influence the origin of LGBT health disparities. It is our hope that this research provides additional neighborhood-

level context to understanding of potential origins of LGBT health disparities. It is clear that these disparities exist; the challenge for future research is to extend our understanding of their origins and develop effective interventions across the social-ecologic framework.

APPENDIX A. SAME-SEX COUPLE CORRECTION

SPSS syntax developed from Stata code provided by Dr. Kate McFarland Bruce of Wake Forest University.

```
* HERE WE IMPORT CENSUS DATA DOWNLOADED FROM SOCIAL EXPLORER.
THIS IS FROM CENSUS 2010 and uses CENSUS TABLES for urbanicity and P8
multiracial
* AND SOCIAL EXPLORER TABLES for all others

* TODO: Enter the path to the folder containing your data file!
* Replace "<Full path to data FOLDER>" with the path to the folder where the CSV file is
located.
* Leave single quotes around the paths!
* Publications and research reports employing the data must cite it appropriately. The citation
should include the following:
* www.socialexplorer.com      New York City, NY: Social Explorer 2013
* Citations should also include the URL for this report:


* HERE I USE THE GATES CORRECTION FOR DOOR-TO-DOOR QUESTIONNAIRE
DESIGN ERRORS THAT MISCLASISIFY SEX (AND THUS SAME-SEX PARTNERS)
* Concept is by Gates: DiBennardo, R., & Gates, G. J. (2013). Research Note: US Census
Same-Sex Couple Data: Adjustments to Reduce Measurement Error and Empirical
Implications.
* Population Research and Policy Review. doi:10.1007/s11113-013-9289-2
* Code is adapted from STATA code written by Dr. Kate McFarland Bruce, Elon University
* Mail in percentages are from: http://www.census.gov/cgi-bin/census2010/staterates.cgi
* Mail in percentage rates were merged from the 50 states and then disaggregated into three
files: state rates, county rates, and tract rates.

GET
 FILE='/Users/josephlee/Documents/Cabinet/Education/PhD/Dissertation/Data/Census
Adjustment/USA Mail Rates/Tract.sav'.
DATASET NAME DataSet2 WINDOW=FRONT.

* This gives 64098 tracts

EXAMINE VARIABLES=MAILPCT2010
 /PLOT BOXPLOT STEMLEAF
 /COMPARE GROUPS
 /STATISTICS DESCRIPTIVES
 /CINTERVAL 95
 /MISSING LISTWISE
 /NOTOTAL.
```

* As I've learned in piloting this for NC, these are 2010 rates for 2000 tracts, so some will be missing for the 2010 tracts that I'm using.

* This sorts both files by FIPS and puts FIPS codes into the same format.

* This is for the census data for USA.

```
GET DATA /TYPE = TXT
/FILE = '/Users/josephlee/Documents/Cabinet/Education/PhD/Dissertation/Data/Social
Explorer - Census5/R10603945_SL140.csv'
/DELCASE = LINE
/DELIMITERS = ","
/QUALIFIER = """
/ARRANGEMENT = DELIMITED
/FIRSTCASE = 2
/IMPORTCASE = ALL
/VARIABLES =
NAME A90
QName A250
FIPS A50
SUMLEV A3
GEOCOMP A2
STATE A2
COUNTY A3
COUNTYSC A2
COUSUB A5
TRACT A6
V1 F10
V2 F10
V3 F10
V4 F10
V5 F10
V6 F10
V7 F10
V8 F10
V9 F10
V10 F10
V11 F10
V12 F10
V13 F10
V14 F10
V15 F10
V16 F10
V17 F10
V18 F10
V19 F10
```

V20 F10
V21 F10
V22 F10
V23 F10
V24 F10
V25 F10
V26 F10
V27 F10
V28 F10
V29 F10
V30 F10
V31 F10
V32 F10
V33 F10
V34 F10
.

VARIABLE LABELS
NAME ‘NAME: Area Name-Legal/Statistical Area Description’
QName ‘QName: Qualifying Name’
FIPS ‘FIPS: FIPS’
SUMLEV ‘SUMLEV: Summary Level’
GEOCOMP ‘GEOCOMP: Geographic Component’
STATE ‘STATE: State (FIPS)’
COUNTY ‘COUNTY: County’
COUNTYSC ‘COUNTYSC: County Size Code’
COUSUB ‘COUSUB: County Subdivision (FIPS)’
TRACT ‘TRACT: Census Tract’
V1 ‘PCT0150001: Households’
V2 ‘PCT0150002: Households: Husband-wife households’
V3 ‘PCT0150003: Households: Husband-wife households: Male householder’
V4 ‘PCT0150004: Households: Husband-wife households: Male householder: With related children under 18 years’
V5 ‘PCT0150005: Households: Husband-wife households: Male householder: With related children under 18 years: With own children under 18 years’
V6 ‘PCT0150006: Households: Husband-wife households: Male householder: With related children under 18 years: No own children under 18 years’
V7 ‘PCT0150007: Households: Husband-wife households: Male householder: With related children under 18 years: No related children under 18 years’
V8 ‘PCT0150008: Households: Husband-wife households: Male householder: With related children under 18 years: Female householder’
V9 ‘PCT0150009: Households: Husband-wife households: Male householder: Female householder: With related children under 18 years’
V10 ‘PCT0150010: Households: Husband-wife households: Female householder: With related children under 18 years: With own children under 18 years’

V11 ‘PCT0150011: Households: Husband-wife households: Female householder: With related children under 18 years: No own children under 18 years’
V12 ‘PCT0150012: Households: Husband-wife households: Female householder: With related children under 18 years: No related children under 18 years’
V13 ‘PCT0150013: Households: Husband-wife households: Female householder: With related children under 18 years: Unmarried-partner households’
V14 ‘PCT0150014: Households: Unmarried-partner households: Male householder and male partner’
V15 ‘PCT0150015: Unmarried-partner households: Male householder and male partner: With related children under 18 years’
V16 ‘PCT0150016: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V17 ‘PCT0150017: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V18 ‘PCT0150018: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V19 ‘PCT0150019: Unmarried-partner households: Male householder and female partner’
V20 ‘PCT0150020: Unmarried-partner households: Male householder and male partner: Male householder and female partner: With related children under 18 years’
V21 ‘PCT0150021: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V22 ‘PCT0150022: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V23 ‘PCT0150023: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V24 ‘PCT0150024: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V25 ‘PCT0150025: Female Household with Female Partner with related children’
V26 ‘PCT0150026: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V27 ‘PCT0150027: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V28 ‘PCT0150028: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V29 ‘PCT0150029: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V30 ‘PCT0150030: Unmarried-partner households: Male householder and male partner: Male householder and female partner: Female householder and female partner: Female householder and male p...’
V31 ‘PCT0150031: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V32 ‘PCT0150032: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V33 ‘PCT0150033: Unmarried-partner households: Male householder and male partner: With related children under 1...’
V34 ‘PCT0150034: Households: All Other Households’

```
.

EXECUTE.
DATASET NAME DataSet1 WINDOW=FRONT.

* This gives 74002 tracts

DATASET ACTIVATE DataSet1.
recode FIPS (convert) into FIPS2.
EXECUTE.
SORT CASES BY FIPS2 (A).
EXECUTE.

* This is for the mail-in tracts dataset.

DATASET ACTIVATE DataSet2.
rename variables (GEOID = FIPS2).
SORT CASES BY FIPS2 (A).
EXECUTE.

* This combines the two datasets

DATASET ACTIVATE DataSet1.
MATCH FILES /FILE=*
 /FILE='DataSet2'
 /IN source01
 /BY FIPS2.
EXECUTE.

* Now I open the county mail-in percentages data into a new file.

GET
 FILE='/Users/josephlee/Documents/Cabinet/Education/PhD/Dissertation/Data/Census
Adjustment/USA Mail Rates/County.sav'.
DATASET NAME DataSet3 WINDOW=FRONT.
rename variables (MAILPCT2010 = MAILRATECNTY2010).

* First, though, we must concatenate state and county in DataSet1 to match with county FIPS
in DataSet 3
* Now I drop cases that are empty of census data based on their having missing data for
housholds in the census tract.

DATASET ACTIVATE DataSet1.
USE ALL.
SELECT IF (SYSMIS(V1) ~= 1).
EXECUTE.
```

```
* This leaves me with the same number (which is good since we dropped census 2000 tracts).

DATASET ACTIVATE DataSet1.
recode STATE (convert) into STATEN.
execute.
recode COUNTY (convert) into COUNTYN.
execute.

* This makes a five digit number for the state and county FIPS code

COMPUTE COUNTYFULL = STATEN *1000 + COUNTYN.
execute.

* I reformat this new variables to eliminate decimals

FORMATS COUNTYFULL(F5.0)
/STATEN(F2.0).

* Now I drop the unnecessary state and county variables that I created.

delete variables COUNTYN source01.

* Now I merge the county mail-in rates (DataSet3) with the census tract rates (DataSet1).
* First, I make the variable name match in the county mail-in rates dataset

DATASET ACTIVATE DataSet3.
rename variables (GEOID = COUNTYFULL).
SORT CASES BY COUNTYFULL (A).

DATASET ACTIVATE DataSet1.
SORT CASES BY COUNTYFULL (A).

MATCH FILES /FILE=*
 /TABLE='DataSet3'
 /BY COUNTYFULL.
EXECUTE.

* Each census tract now also has a county rate.

* Lets rename the tract rate to make it clear that it is different from the county rate.
rename variables (MAILPCT2010 = MAILRATETRCT2010).

* There are 24 counties missing a mail-in rate. They appear to be places with extreme
circumstances where the census visited all residents. Thus, I set the mail-rate to zero.
```

```
DO IF (SYSMIS(MAILRATECNTY2010)).
RECODE MAILRATECNTY2010 (SYSMIS=0).
END IF.
EXECUTE.

* Now I select cases missing their census tract mail-in percentage and replace it with the
county percentage.
* If tract mail in rate is missing the county is placed into the new mailin variable.
* If tract mail in rate is not missing the tract mail in rate is placed into the new mailin
variable.

DO IF (SYSMIS(MAILRATETRCT2010)=1).
RECODE MAILRATECNTY2010 (0 thru 1=Copy) INTO mailin.
END IF.
VARIABLE LABELS mailin 'mailin rate'.
EXECUTE.

DO IF (SYSMIS(MAILRATETRCT2010)~=1).
RECODE MAILRATETRCT2010 (0 thru 1=Copy) INTO mailin.
END IF.
EXECUTE.



* Now we can clean up by dropping some extra variables.
delete variables mailratecnty2010 mailratetrct2010.

DATASET CLOSE dataset3.
DATASET CLOSE dataset2.

*There are still 74002 tracts, all with a mail-in percentage in DataSet1. That's good.

* Now I will import and add in the preferred estimates of same sex couples from Gary Gates
* A link within this: http://williamsinstitute.law.ucla.edu/wp-content/uploads/Census2010-
Snapshot-Adjustment-Procedures.pdf

GET DATA /TYPE=XLSX
 /FILE='/Users/josephlee/Documents/Cabinet/Education/PhD/Dissertation/Data/Census
Adjustment/NC Test/PreferredRatesUSA.xlsx'
 /SHEET=name 'Sheet1'
 /CELLRANGE=full
 /READNAMES=on
 /ASSUMEDSTRWIDTH=32767.
EXECUTE.
DATASET NAME DataSet4 WINDOW=FRONT.
DELETE VARIABLES v6.
```

```
* I rename the state FIPS code to match with DataSet1

rename variables (PREFStateFIPS = STATEN).

FORMATS STATEN(F2.0).

* I remove extra empty cases picked up from Excel.
DATASET ACTIVATE DataSet4.
USE ALL.
SELECT IF (SYSMIS(STATEN) ~= 1).
EXECUTE.
SORT CASES BY STATEN (A).

DATASET ACTIVATE DataSet1.
SORT CASES BY STATEN (A).
MATCH FILES /FILE=*
 /TABLE='DataSet4'
 /BY STATEN.
EXECUTE.
DATASET CLOSE DataSet4.

* Let's get rid of PR in the dataset

FILTER OFF.
USE ALL.
SELECT IF (STATEN ~= 72).
EXECUTE.

* Now we have 73057 tracts.

* Now we have census tracts as cases with a mail-in rate as well as the state preferred rates
and the unadjusted tract counts.

* Following Kate's code here in Stata:
* gen oldmfhh=mfhhmarr+mfhhpartner = PCT0150003 (married male householder) +
PCT0150019 (unmarried partner households male householder and female partner)
* gen oldfmhh=fmhhmarr+fmhhpartner = PCT0150008 (married female householder) +
PCT0150029 (unmarried partner households female householder and male partner)

COMPUTE oldmfhh = V3 + V19.
COMPUTE oldfmhh = V8 + V29.

VARIABLE LABELS oldmfhh 'Unadjusted Count M-F Households'
/ oldfmhh 'Unadjusted Count F-M Households'.
```

```
COMPUTE oldffhh = V24.
COMPUTE oldmmhh = V14.

VARIABLE LABELS oldffhh 'Unadjusted Count of F-F Households'
/ oldmmhh 'Unadjusted Count M-M Households'.

COMPUTE error = (.003*mailin) + (.01*(1-mailin)).
EXECUTE.
* Error rate among different sex couples in a given level of geography (g)
* errorg = (0.003 * Mailinpctg) + (0.01 * (1-Mailinpctg))

EXAMINE VARIABLES=error
 /PLOT BOXPLOT STEMLEAF
 /COMPARE GROUPS
 /STATISTICS DESCRIPTIVES
 /CINTERVAL 95
 /MISSING LISTWISE
 /NOTOTAL.
* Error is small and pretty normally distributed

* Here we compute errors to apply based on female and male straight households.

COMPUTE mmhherr = oldmmhh - (error*oldmfhh).
* Official tabulation of same-sex male couples reduced by the error rate applied to the
official tabulation of comparable different-sex couples with a male householder
* SSMtg = SSMg - (errorg * (DSMARMg+DSUMPMg))

COMPUTE ffhherr = oldffhh - (error*oldfmhh).
* Official tabulation of same-sex female couples reduced by the error rate applied to the
official tabulation of comparable different-sex couples with a female householder
* SSFtg = SSFg - (errorg * (DSMARFg+DSUMPFg))

CORRELATIONS
 /VARIABLES=mmhherr oldmmhh
 /PRINT=TWOTAIL NOSIG
 /MISSING=PAIRWISE.

GRAPH
 /SCATTERPLOT(BIVAR)=oldmmhh WITH mmhherr
 /MISSING=LISTWISE.

* Must remember to deal with ones that have gone negative. But otherwise appears to be
decreasing each estimate slightly. :-)

* To get rid of corrections that made the total go negative.
DO IF (mmhherr < 0).
```

```
RECODE mmhherr (ELSE=0).
END IF.
EXECUTE.

GRAPH
 /SCATTERPLOT(BIVAR)=oldmmhh WITH mmhherr
 /MISSING=LISTWISE.

* Male: That fixed the negative problem.
* R^2 = 0.81, so for each household, on average, in the unadjusted 0.81 households is
predicted in the adjusted. That seems about right.
* Repeat for female

DO IF (ffhherr < 0).
RECODE ffhherr (ELSE=0).
END IF.
EXECUTE.

GRAPH
 /SCATTERPLOT(BIVAR)=oldffhh WITH ffhherr
 /MISSING=LISTWISE.

VARIABLE LABELS mmhherr 'Adjusted Count for M-M Households'
/ ffhherr 'Adjusted Count for F-F Households'.

* We allocate the same-sex couples to the geographical unit based on unit's proportion of the
entire state's summed adjusted number.

AGGREGATE
/break = STATEN
/statemmhherr = SUM(mmhherr)
/stateffhherr= SUM(ffhherr).

COMPUTE pctmmhherr = mmhherr / statemmhherr.
EXECUTE.
COMPUTE pctffhherr = ffhherr / stateffhherr.
EXECUTE.

VARIABLE LABELS pctmmhherr 'Percent M-M Households in Tracts'
/pctffhherr 'Percent F-F Households in Tracts'.

RENAME VARIABLES (PREFmalehoushold = prefmmhh).
RENAME VARIABLES (PREFfemalehoushold = preffhh).

COMPUTE ffhh = pctffhherr * preffhh.
EXECUTE.
```

```
COMPUTE mmhh = pctmmhherr * prefmmhh.
EXECUTE.

VARIABLE LABELS ffhh 'F-F Households (Adjusted)'
/mmhh 'M-M Households (Adjusted)'.

* We now add in the old same-sex couples who were "fake" back into their straight group.

COMPUTE mfhh = oldmfhh + (oldmmhh-mmhh).
EXECUTE.
COMPUTE fmhh = oldfmhh + (oldffhh-ffhh).
EXECUTE.
COMPUTE difmmhh = oldmmhh-mmhh.
EXECUTE.
COMPUTE diffhh = oldffhh-ffhh.
EXECUTE.

VARIABLE LABELS mfhh 'M-F Households (Adjusted)'
/ fmhh 'F-M Households (Adjusted)'.

COMPUTE sshh = ffhh + mmhh.
EXECUTE.
COMPUTE dshh = mfhh + fmhh.
EXECUTE.

VARIABLE LABELS sshh 'Same-Sex Couple Households (Adjusted)'
/ dshh 'Different Sex Couple Households (Adjusted)'.

* Let's see if we add up the totals of adjusted SS households to the state level, do we get the
preferred estimate?
* Answer: Yes!

AGGREGATE
/break = STATEN
/statetotalcheck = SUM(sshh).

* Is our preferred estimate lower than the original estimate? Yes!

COMPUTE oldsshh=oldffhh + oldmmhh.
EXECUTE.

AGGREGATE
/break = STATEN
/stateoldtotalcheck = SUM(oldsshh).
```

```
* Now, why are there missing data for 614 census tracts? Let me first remove AK and HI,
which I don't have mail rates for.
* Have to change format of STATE variable first. This should be corrected now that mail-in
is zero for 24 counties responsible for these tracts in lower 48 states.

RECODE sshh (SYSMIS=1) (ELSE=0) INTO missing.
EXECUTE.
RECODE STATE (2=1) (15=1) (ELSE=0) INTO non48.
VARIABLE LABELS non48 'Non-Contiguous States'.
EXECUTE.

CROSSTABS
 /TABLES=non48 BY missing
 /FORMAT=AVALUE TABLES
 /CELLS=COUNT
 /COUNT ROUND CELL.

* This suggests that there are 96 tracts missing a same-sex couple rate that are not in the two
excluded states.

* So, let's add those two up to find the ones where there's a problem

COMPUTE missingnon48=missing + non48.
EXECUTE.
RECODE missingnon48 (2=0).
EXECUTE.
SORT CASES BY missingnon48(D).

*/
```

The 96 tracts are missing because there is no mail-in rate at the county level for 24 counties

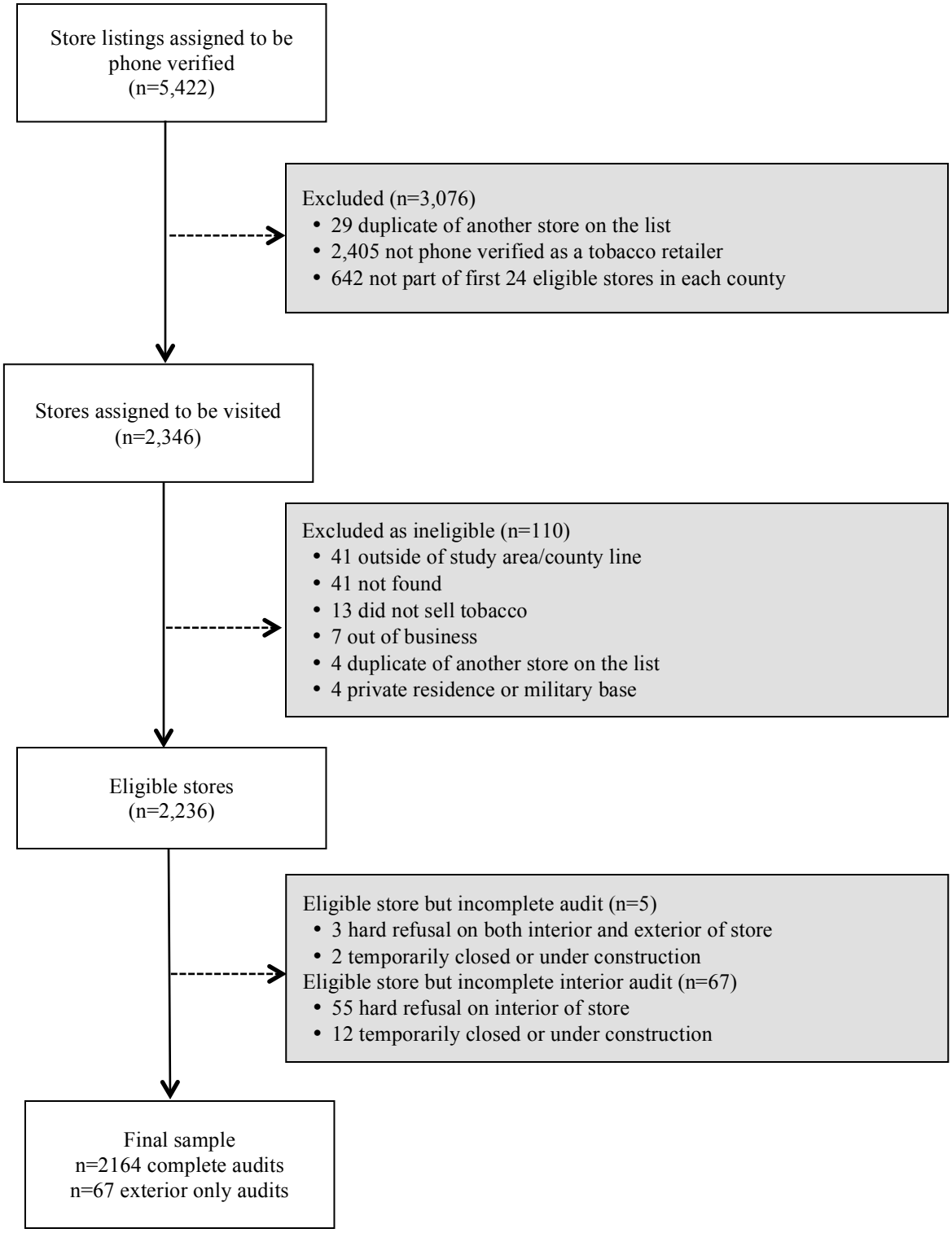
Dukes County	Massachusetts	25007
Nantucket County	Massachusetts	25019
Mahnomen County	Minnesota	27087
Thurston County	Nebraska	31173
Hamilton County	New York	36041
Sioux County	North Dakota	38085
Bennett County	South Dakota	46007
Corson County	South Dakota	46031
Dewey County	South Dakota	46041
Shannon County	South Dakota	46113
Todd County	South Dakota	46121
Ziebach County	South Dakota	46137
Ashland County	Wisconsin	55003
Bayfield County	Wisconsin	55007
Burnett County	Wisconsin	55013
Florence County	Wisconsin	55037

Forest County	Wisconsin	55041
Iron County	Wisconsin	55051
Menominee County	Wisconsin	55078
Oneida County	Wisconsin	55085
Price County	Wisconsin	55099
Sawyer County	Wisconsin	55113
Vilas County	Wisconsin	55125
Washburn County	Wisconsin	55129

/*

* These are supposed to be missing because they had no mailings.

APPENDIX B. FLOW DIAGRAM OF STORE AUDITS



APPENDIX C. ASSESSMENT OF STORE TYPE DIFFERENCES IN AUDIT REFUSAL

Purpose: Non-response (i.e., refusals and temporary store closure) may be patterned in ways that bias the estimates in a survey. I examined unadjusted predictors of non-response to see what store and tract level characteristics predicted non-response.

Non-response (N=67) including refusals (n=55) and stores being temporarily closed (n=12), could be predicted by store type characteristic and by some neighborhood characteristics.

Table 8. Unadjusted Odds of Non-Response by Neighborhood and Store-Type Characteristics (n=2,231)

Characteristic (Census Tract)	**Odds Ratio (95% Confidence Interval)**
Female Same-Sex Couple Rate	1.02 (0.98-1.05)
Male Same-Sex Couple Rate	1.00 (0.99-1.01)
Percent Black Residents in 10s	**1.12** (1.01-1.24)
Percent Hispanic Residents in 10s	1.06 (0.96-1.17)
Median Household Income in $1,000s	0.99 (0.98-1.00)
Store Type (Weighted-Effect Coded)	
Convenience	1.44 (0.75-2.76)
Convenience with Gas	0.79 (0.55-1.11)
Supermarket	*- Reference Category (see note below)*
Tobacco	**4.79** (2.39-9.57)
Alcohol	**3.06** (1.78-5.25)
Drug	0.34 (0.10-1.21)
Other	1.34 (0.43-4.19)

Note: Weighted-effect coding used for store type. Odds ratios should be interpreted in reference to a typical store.

Conclusion: Non-response was more likely for stores in census tracts with more African-American residents and at alcohol- and tobacco-specific retailers than at a typical retailer. Nonetheless, overall non-response was low.

APPENDIX D. SENSITIVITY ANALYSES OF RETAILER TOBACCO MARKETING CHARACTERISTICS

Purpose: The purpose of this appendix is to illustrate sensitivity analyses carried out to examine if the implementation of sampling weights and two- versus three-level models would change patterns of results.

Table 9. Three-Level Models Associating Female Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random County and Tract Intercepts (Control for County Population)

	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Price Promotion, any† OR (95% CI)	Price Promotion, Newport OR† (95% CI)	Marketing ERR‡ (95% CI)	Ext. Marketing ERR‡ (95% CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95% CI)§
Model 1 (Base)								
L1: Stores	n=2102	*n*=2000	*n*=2164	*n*=2159			*n*=2162	*n*=2157
Intercept (95% CI)	**$6.09 (0.17)**	**$6.38 (0.16)**	**3.85 (2.96-5.00)**	**0.64 (0.49-0.83)**			**5.43 (4.07-7.23)**	**0.55 (0.45-0.67)**
L2: Tracts								
Same-Sex Couple Rate	<$0.01 (<0.01)	<0.01 (<0.01)	1.00 (0.96-1.03)	1.01 (0.99-1.02)			1.01 (0.99 - 1.03)	0.99 (0.97 - 1.01)
L3: Counties								
County Population	0.02 (0.01)	0.02 (0.01)	**0.99 (0.97-1.00)**	1.00 (0.99-1.01)			0.99 (0.98-1.00)	-
Model 2 (Base + Neighborhood Characteristics)								
L1: Stores	*n*=2102	*n*=2000	*n*=2164	*n*=2159			*n*=2162	*n*=2157
Intercept (95% CI)	**$6.42 (0.29)**	**$6.51 (0.28)**	**3.50 (1.81-6.77)**	0.85 (0.44-1.64)			**8.46 (3.95-18.13)**	0.88 (0.54-1.43)
L2: Tracts								
Same-Sex Couple Rate	<$0.01 (<0.01)	**$0.01 (<0.01)**	0.99 (0.97-1.01)	0.99 (0.97-1.01)	Do not converge	Do not converge	1.00 (0.98-1.01)	1.00 (0.98-1.02)
% Black (10s)	$-0.01 (0.01)	**$-0.04 (0.01)**	**1.09 (1.01-1.18)**	**1.21 (1.13-1.30)**			**1.13 (1.03-1.24)**	**0.89 (0.84-0.94)**
% Hispanic (10s)	$-0.01 (0.01)	$-0.01 (0.01)	0.96 (0.90-1.01)	0.99 (0.93-1.06)			0.96 (0.90-1.03)	**0.92 (0.87-0.96)**

	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Price Promotion, any† OR (95% CI)	Price Promotion, Newport OR† (95% CI)	Marketing ERR‡ (95% CI)	Ext. Marketing ERR‡ (95% CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95% CI)§
Median Income (1000s)	<$0.01 (<0.01)	<$0.01 (<0.01)	1.00 (1.00-1.01)	1.00 (0.99-1.00)			**0.99 (0.99-1.00)**	1.00 (1.00-1.01)
L3: Counties								
County Population	0.01 (0.01)	0.01 (0.01)	**0.99 (0.98-1.00)**	0.99 (0.98-1.00)			0.99 (0.98-1.01)	-
Rurality Code	-0.10 (0.09)	$-0.07 (0.08)	0.95 (0.84-1.08)	**0.85 (0.74-0.99)**			0.98 (0.83-1.17)	**0.89 (0.82-0.96)**
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)								
L1: Stores	*n*=2101	*n*=1999	*n*=2163	*n*=2158			*n*=2161	*n*=2156
Intercept (95% CI)	**$6.43 (0.28)**	**$6.54 (0.27)**	**3.89 (1.92-7.91)**	0.73 (0.38-1.40)			**11.03 (4.84-25.16)**	0.72 (0.44-1.17)
Supermarkets	*- (weighted-effect coding reference group - see note below)*							
Convenience	$0.01 (0.03)	**$-0.13 (0.04)**	0.79 (0.59-1.06)	1.32 (1.00-1.76)			1.11 (0.73-1.69)	0.91 (0.67-1.23)
Convenience with gas	**$-0.04 (0.01)**	**$-0.10 (0.02)**	**2.26 (1.89-2.71)**	**1.59 (1.38-1.83)**			**2.17 (1.75-2.70)**	**1.38 (1.22-1.58)**
Tobacco	**$-0.25 (0.06)**	**$-0.37 (0.07)**	1.08 (0.63-1.84)	1.55 (0.96-2.51)			**6.90 (1.86-25.53)**	**7.85 (4.50-13.68)**
Alcohol	**$0.21 (0.04)**	**$0.18 (0.04)**	**0.28 (0.20-0.38)**	**0.44 (0.32-0.62)**			**0.20 (0.13-0.31)**	**0.24 (0.15-0.41)**
Drug	**$-0.35 (0.03)**	**$-0.21 (0.04)**	**1.89 (1.13-3.14)**	**1.93 (1.32-2.82)**			1.63 (0.83-3.19)	**3.04 (2.19-4.22)**
Other	**$0.29 (0.06)**	**$0.45 (0.07å)**	**0.24 (0.15-0.37)**	**0.20 (0.11-0.40)**			**0.31 (0.19-0.49)**	**1.88 (1.18-2.99)**
L2: Tracts								
Same-Sex Couple Rate	<$0.01 (<0.01)	**$0.01 (<0.01)**	1.00 (0.98-1.02)	0.99 (0.97-1.01)			1.00 (0.97-1.02)	1.00 (0.98-1.02)
% Black (10s)	$-0.01 (0.01)	**-$0.04 (0.01)**	**1.11 (1.02-1.20)**	**1.24 (1.15-1.33)**			**1.18 (1.08-1.29)**	**0.90 (0.85-0.95)**
% Hispanic	$-0.01 (0.01)	$-0.01 (0.01)	0.96 (0.90-	1.01 (0.94-			0.99 (0.92-1.06)	**0.93 (0.88-**

	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Price Promotion, any† OR (95% CI)	Price Promotion, Newport OR† (95% CI)	Marketing ERR‡ (95% CI)	Ext. Marketing ERR‡ (95% CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95% CI)§
(10s)			1.03)	1.08)				**0.98)**
Median Income (1000s)	<$0.01 (<0.01)	$0.00 (<0.01)	1.00 (1.00-1.01)	1.00 ((0.99-1.00)			**0.99 (0.99-1.00)**	1.00 (1.00-1.01)
L3: Counties								
County Population	$0.01 (0.01)	$0.01 (0.01)	0.99 (0.98-1.00	0.99 (0.98-1.00)			1.00 (0.98-1.01)	-
Rurality Code	$-0.10 (0.09)	$-0.07 (0.08)	0.92 (0.81-1.05)	**0.84 (0.72-0.98)**			0.95 (0.79-1.15)	0.88 (0.82-0.95)

Note: Significance at the $p < 0.05$ level is indicated by bolded text. County population is in 100,000s. OR = odds ratio; CI = confidence interval; ERR = event rate ratio; * = Hierarchical linear model; † = Hierarchical generalized linear model (binary), reported as OR; ‡ = Hierarchical generalized linear model (count); § = three-level hierarchical models with random county and tract intercepts could not compute estimates for county population in block 3 (nor could this variable be computed in two level models), thus these models for e-cigarettes do not include the county population control variable. Intercepts are exponentiated at the mean value of the variable. This table was created in SAS 9.3 using PQL estimation with sandwich correction ("EMPIRICAL") for count and dichotomous outcomes.

Table 10. Three-Level Models Associating Male Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random County and Tract Intercepts (Control for County Population)

	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing ERR‡ (95%CI)	Exterior Marketing ERR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)§
Model 1 (Base)								
L1: Stores	*n*=2104	*n*=2000	*n*=2164	*n*=2159			*n*=2162	*n*=2157
Intercept (95% CI)	**6.10 (0.17)**	**6.38 (0.16)**	**3.63 (3.00-4.38)**	**0.67 (0.53-0.85)**			**5.85 (4.56-7.52)**	**0.52 (0.45-0.60)**
L2: Tracts								
Same-Sex Couple Rate	<0.01 (<0.01)	**<0.01 (<0.01)**	1.00 (1.00-1.00)	1.00 (0.99-1.00)			1.00 (0.99-1.00)	1.00 (0.99-1.01)
L3: Counties								
County Population	0.01 (0.01)	0.02 (0.01)	**0.99 (0.98-1.00)**	1.00 (0.99-1.01)			0.99 (0.98-1.00)	-
Model 2 (Base + Neighborhood Characteristics)								
L1: Stores	*n*=2104	*n*=2000	*n*=2164	*n*=2159			*n*=2162	*n*=2157
Intercept (95% CI)	**6.41 (0.29)**	**6.51 (0.27)**	**3.32 (1.80-6.10)**	0.84 (0.45-1.54)			**8.65 (4.20-17.82)**	0.86 (0.55-1.35)
L2: Tracts								
Same-Sex Couple Rate	<0.01 (<0.01)	**<0.01 (<0.01)**	0.99 (0.99-1.00)	**1.00 (0.99-1.00)**	Do not converge	Do not converge	1.00 (0.99-1.00)	1.00 (0.99-1.01)
% Black (10s)	-<0.01 (0.01)	**-0.03 (0.01)**	**1.09 (1.00-1.18)**	**1.20 (1.13-1.29)**			**1.13 (1.03-1.24)**	**0.89 (0.83-0.94)**
% Hispanic (10s)	-0.01 (0.01)	-<0.01 (0.01)	0.96 (0.91-1.01)	0.99 (0.93-1.29)			0.96 (0.90-1.03)	**0.92 (0.88-0.96)**
Median Income (1000s)	-<0.01 (<0.01)	<0.01 (<0.01)	1.00 (1.00-1.01)	1.00 (0.99-1.00)			**0.99 (0.99-1.00)**	1.00 (1.00-1.01)
L3: Counties								
County Population	0.01 (0.01)	**0.01 (0.01)**	**0.99 (0.98-1.00)**	0.99 (0.99-1.00)			1.00 (0.98-1.01)	-
Rurality Code	-0.10 (0.09)	-0.07 (0.08)	0.95 (0.85-1.08)	**0.85 (0.74-0.99)**			0.98 (0.82-1.16)	**0.89 (0.82-0.96)**

	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing ERR‡ (95%CI)	Exterior Marketing ERR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)§
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)								
L1: Stores	*n*=2103	*n*=1999	*n*=2163	*n*=2158			*n*=2161	*n*=2156
Intercept (95% CI)	**6.41 (0.28)**	**6.53 (0.27)**	**3.89 (2.01-7.51)**	0.75 (0.40-1.38)			**11.85 (5.41-25.98)**	0.73 (0.46-1.16)
Supermarkets	*- (weighted-effect coding reference group - see note below)*							
Convenience	0.01 (0.03)	**-0.13 (0.04)**	0.79 (0.59-1.06)	**1.33 (1.00-1.76)**			1.11 (0.73-1.69)	0.91 (0.68-1.23)
Convenience with gas	**-0.04 (0.01)**	**-0.10 (0.02)**	**2.26 (1.89-2.70)**	**1.58 (1.37-1.83)**			**2.16 (1.74-2.68)**	**1.38 (1.21-1.57)**
Tobacco	**-0.24 (0.06)**	**-0.37 (0.07)**	1.08 (0.63-1.84)	1.54 (0.95-2.51)			**6.86 (1.85-25.45)**	**7.84 (4.50-13.67)**
Alcohol	**0.21 (0.04)**	**0.18 (0.04)**	**0.28 (0.20-0.38)**	**0.44 (0.31-0.62)**			**0.20 (0.13-0.31)**	**0.25 (0.15-0.41)**
Drug	**-0.36 (0.03)**	**-0.22 (0.04)**	**1.90 (1.13-3.18)**	**1.97 (1.34-2.90)**			1.69 (0.86-3.30)	**3.07 (2.23-4.23)**
Other	**0.29 (0.06)**	**0.44 (0.07)**	**0.24 (0.15-0.37)**	**0.20 (0.11-0.39)**			**0.31 (0.20-0.49)**	**1.87 (1.18-3.00)**
L2: Tracts								
Same-Sex Couple Rate	**<0.01 (<0.01)**	**<0.01 (<0.01)**	1.00 (0.99-1.00)	**0.99 (0.99-1.00)**			1.00 (0.99-1.00)	1.00 (0.99-1.00)
% Black (10s)	-0.01 (0.01)	**-0.04 (0.01)**	**1.10 (1.02-1.20)**	**1.24 (1.15-1.33)**			**1.18 (1.08-1.28)**	**0.90 (0.85-0.95)**
% Hispanic (10s)	-0.01 (0.01)	-0.01 (0.01)	0.96 (0.90-1.02)	1.01 (0.94-1.08)			0.98 (0.91-1.05)	**0.93 (0.88-0.98)**
Median Income (1000s)	-<0.01 (<0.01)	<0.01 (<0.01)	1.00 (1.00-1.01)	1.00 (0.99-1.00)			**0.99 (0.99-1.00)**	1.00 (1.00-1.01)
L3: Counties								

	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing ERR‡ (95%CI)	Exterior Marketing ERR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)§
County Population	0.01 (0.01)	0.01 (0.01)	0.99 (0.98-1.00)	0.99 (0.99-1.00)			1.00 (0.98-1.01)	-
Rurality Code	-0.10 (0.09)	-0.07 (0.08)	0.92 (0.81-1.05)	**0.84 (0.72-0.98)**			0.94 (0.79-1.13)	**0.88 (0.82-0.95)**

Note: Significance at the $p < 0.05$ level is indicated by bolded text. County population is in 100,000s. OR = odds ratio; CI = confidence interval; ERR = event rate ratio; * = Hierarchical linear model; † = Hierarchical generalized linear model (binary); ‡ = Hierarchical generalized linear model (count); § = three-level hierarchical models with random county and tract intercepts could not compute estimates for county population in block 3 (nor could this variable be computed in two level models), thus these models for e-cigarettes do not include the county population control variable. Intercepts are exponentiated at the mean value of the variable. This table was created in SAS 9.3 using PQL estimation with sandwich correction ("EMPIRICAL") for count and dichotomous outcomes.

Table 11. Two-Level Models Associating Female Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random Tract Intercepts (Control for County Population in Lieu of Survey Weights)

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing IRR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)§
Model 1 (Base)						
L1: Stores	*n*=2164	*n*=2159	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**3.50 (3.00-4.10)**	**0.68 (0.59-0.79)**	**33.09 (31.08-35.23)**	**3.42 (3.00-3.91)**	**4.60 (3.84-5.51)**	**0.56 (0.48-0.65)**
L2: Tracts						
Same-Sex Couple Rate	1.00 (0.98-1.02)	1.01 (0.99-1.02)	**0.99 (0.98-1.00)**	1.00 (0.99-1.01)	1.01 (0.99-1.03)	0.99 (0.97-1.01)
County Population	**0.99 (0.99-1.00)**	**0.99 (0.99-1.00)**	**0.99 (0.99-0.99)**	**0.99 (0.99-1.00)**	1.00 (0.99-1.00)	-
Model 2 (Base + Neighborhood Characteristics)						
L1: Stores	*n*=2164	*n*=2159	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**4.34 (2.64-7.15)**	1.05 (0.68-1.63)	**49.81 (41.32-60.05)**	**6.01 (4.12-8.78)**	**9.19 (5.36-15.76)**	0.93 (0.60-1.43)
L2: Tracts						
Same-Sex Couple Rate	0.99 (0.97-1.01)	0.99 (0.97-1.01)	**0.99 (0.98-1.00)**	0.99 (0.98-1.01)	0.99 (0.97-1.01)	0.99 (0.97-1.01)
% Black (10s)	1.06 (0.99-1.13)	**1.19 (1.12-1.26)**	**0.97 (0.95-1)**	1.03 (0.98-1.08)	**1.13 (1.02-1.24)**	**0.89 (0.84-0.94)**
% Hispanic (10s)	**0.93 (0.88-0.97)**	0.95 (0.90-1.00)	**0.95 (0.93-0.97)**	**0.92 (0.88-0.96)**	0.98 (0.92-1.04)	**0.93 (0.88-0.97)**
Median Income (1000s)	1.00 (1.00-1.01)	1.00 (0.99-1.00)	**1.00 (0.99-1.00)**	**0.99 (0.99-1.00)**	**0.99 (0.99-0.99)**	1.00 (1.00-1.00)
County Population	**0.99 (0.99-1.00)**	0.99 (0.99-1.00)	**0.99 (0.99-1.00)**	1.00 (1.00-1.01)	1.00 (0.99-1.01)	-
Rurality Code	0.94 (0.87-1.01)	**0.86 (0.80-0.93)**	0.98 (0.95-1.01)	0.99 (0.93-1.05)	0.96 (0.87-1.06)	**0.88 (0.82-0.95)**
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)						
L1: Stores	*n*=2163	*n*=2158	*n*=2163	*n*=2229	*n*=2161	*n*=2156
Intercept (95% CI)	**4.43 (2.57-7.64)**	0.91 (0.58-1.44)	**38.65 (32.8-45.54)**	**2.50 (1.72-3.63)**	**11.16 (6.10-20.43)**	0.74 (0.46-1.18)
Supermarkets	*(weighted-effect coding reference group - see note below)*					
Convenience	0.81 (0.61-1.06)	**1.46 (1.14-1.87)**	**1.1 (1.00-1.21)**	**1.88 (1.54-2.30)**	0.20 (0.65-1.31)	0.91 (0.71-1.17)

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing IRR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)§
Convenience with gas	**2.18 (1.89-2.52)**	**1.47 (1.31-1.64)**	**1.51 (1.45-1.57)**	**2.94 (2.64-3.28)**	**2.23 (1.86-2.68)**	**1.39 (1.23-1.56)**
Tobacco	1.08 (0.65-1.79)	1.43 (0.92-2.232)	**2.9 (2.46-3.42)**	**7.52 (5.47-10.34)**	**6.26 (1.60-24.46)**	**7.80 (4.69-12.99)**
Alcohol	**0.27 (0.21-0.36)**	**0.51 (0.38-0.68)**	**0.57 (0.51-0.64)**	0.83 (0.66-1.06)	**0.20 (0.15-0.27)**	**0.24 (0.16-0.36)**
Drug	**1.92 (1.30-2.83)**	**1.86 (1.43-2.43)**	**0.62 (0.56-0.68)**	**0.03 (0.02-0.05)**	**1.64 (1.08-2.49)**	**3.11 (2.39-4.04)**
Other	**0.25 (0.16-0.38)**	**0.21 (0.11-0.39)**	**0.65 (0.55-0.77)**	0.69 (0.47-1.03)	**0.36 (0.22-0.57)**	**1.87 (1.23-2.85)**
L2: Tracts						
Same-Sex Couple Rate	1.00 (0.98-1.02)	0.99 (0.97-1.01)	**0.99 (0.99-1.00)**	1.00 (0.99-1.02)	1.00 (0.97-1.02)	1.00 (0.98-1.02)
% Black (10s)	**1.07 (1.00-1.15)**	**1.21 (1.14-1.29)**	0.99 (0.97-1.01)	**1.08 (1.03-1.13)**	**1.16 (1.05-1.28)**	**0.90 (0.84-0.95)**
% Hispanic (10s)	**0.93 (0.88-0.98)**	0.96 (0.91-1.01)	**0.96 (0.94-0.98)**	**0.95 (0.91-0.99)**	1.00 (0.93-1.06)	**0.94 (0.89-0.98)**
Median Income (1000s)	1.00 (1.00-1.01)	1.00 (0.99-1.00)	**1.00 (1.00-1.00)**	**0.99 (0.99-1.00)**	**0.99 (0.99-1.00)**	1.00 (1.00-1.01)
County Population	0.99 (0.99-1.00)	1.00 (0.99-1.00)	**0.99 (0.99-1.00)**	1.00 (0.99-1.00)	1.00 (0.99-1.01)	-
Rurality Code	**0.91 (0.84-0.99)**	**0.85 (0.79-0.92)**	**0.96 (0.94-0.99)**	**0.94 (0.88-0.99)**	0.94 (0.84-1.04)	**0.88 (0.81-0.95)**
ICC	0.15	0.15	0.51	0.74	0.08	0.07

Note: Significance at the $p < 0.05$ level is indicated by bolded text. County population is in 100,000s. Store type is coded with weighted-effect coding and should be interpreted as the odds of the outcome variable against the typical tobacco retailer. OR = odds ratio; CI = confidence interval; ICC = intra-class correlation; † = Hierarchical generalized linear model (binary); ‡ = Hierarchical generalized linear model (negative binomial); § = two-level hierarchical models with random county or random tract intercepts could not compute estimates for county population in block 3, thus these models for e-cigarettes do not include the county population control variable (model 1 and 2 showed no substantive differences with and without county population). ICC calculated as $ICC = \frac{\tau_{00}}{\tau_{00}+\frac{\pi^2}{3}}$ and should be interpreted as the ICC for a hypothetical latent continuous variable underlying the binary variable. Intercepts are reported as exponentiated and represent odds at mean value. This table was created in SAS 9.3 using PQL estimation with sandwich correction ("EMPIRICAL") for count and dichotomous outcomes.

Table 12. Two-Level Models Associating Male Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random Tract Intercepts (with Control for County Population in Lieu of Survey Weights)

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing IRR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)§
Model 1 (Base)						
L1: Stores	*n*=2164	*n*=2159	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**3.47 (3.07-3.92)**	**0.72 (0.64-0.81)**	**31.37 (28.73-34.24)**	**3.48 (3.13-3.86)**	**4.91 (4.28-5.63)**	**0.53 (0.48-0.58)**
L2: Tracts						
Same-Sex Couple Rate	1.00 (1.00-1.00)	1.00 (1.00-1.00)	**1.00 (0.996-1.00)**	1.00 (0.99-1.00)	1.00 (0.99-1.00)	1.00 (1.00-1.01)
County Population	**0.99 (0.99-1.00)**	1.00 (0.99-1.00)	**0.99 (0.98-0.99)**	**0.99 (0.99-1.00)**	1.00 (0.99-1.00)	-
Model 2 (Base + Neighborhood Characteristics)						
L1: Stores	*n*=2164	*n*=2159	*n*=2164	*n*=2231	*n*=2162	*n*=2157
Intercept (95% CI)	**4.10 (2.57-6.52)**	0.99 (0.66-1.51)	**47.72 (40.01-56.92)**	**6.01 (4.18-8.65)**	**9.03 (5.45-14.95)**	0.87 (0.58-1.30)
L2: Tracts						
Same-Sex Couple Rate	1.00 (0.99-1.00)	1.00 (0.99-1.00)	**1.00 (0.99-1.00)**	1.00 (0.99-1.00)	**0.99 (0.99-1.00)**	1.00 (1.00-1.01)
% Black (10s)	1.05 (0.99-1.12)	**1.19 (1.12-1.26)**	**0.97 (0.95-1.00)**	1.03 (0.98-1.08)	**1.13 (1.03-1.24)**	**0.89 (0.84-.94)**
% Hispanic (10s)	**0.93 (0.88-0.97)**	0.95 (0.90-1.00)	**0.95 (0.93-0.97)**	**0.92 (0.88-0.96)**	0.98 (0.92-1.04)	**0.93 (0.88-0.97_**
Median Income (1000s)	1.00 (1.00-1.05)	1.00 (0.99-1.00)	**1.00 (0.99-1.00)**	**0.99 (0.99-0.99)**	**0.99 (0.99-0.99)**	1.00 (1.00-1.00)
County Population	**0.99 (0.99-1.00)**	0.99 (0.99-1.00)	**0.99 (0.99-1.00)**	1.00 (1.00-1.01)	1.00 (0.99-1.01)	-
Rurality Code	0.94 (0.87-1.01)	**0.86 (0.80-0.93)**	0.98 (0.95-1.01)	0.99 (0.93-1.05)	0.96 (0.87-1.06)	**0.89 (0.93-0.95)**
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)						
L1: Stores	*n*=2163	*n*=2158	*n*=2163	*n*=2229	*n*=2161	*n*=2156
Intercept (95% CI)	**4.45 (2.67-7.41)**	0.89 (0.57-1.37)	**37.01 (31.72-43.19)**	**2.59 (1.81-3.69)**	**11.67 (6.64-20.49)**	0.73 (0.47-1.14)
Supermarkets	*(weighted-effect coding reference group - see note below)*					
Convenience	0.81 (0.61-1.06)	**1.46 (1.14-1.87)**	1.09 (1.00-1.20)	**1.90 (1.55-2.32)**	0.92 (0.65-1.31)	0.91 (0.70-1.17)
Convenience with gas	**2.18 (1.88-2.52)**	**1.46 (1.30-1.63)**	**1.51 (1.47-1.57)**	**2.93 (2.63-3.27)**	**2.21 (1.84-2.65)**	**1.39 (1.23-1.56)**
Tobacco	1.08 (0.65-1.79)	1.42 (0.91-2.22)	**2.89 (2.45-3.41)**	**7.55 (5.49-10.38)**	**6.26 (1.60-24.46)**	**7.78 (4.68-12.96)**
Alcohol	**0.27 (0.21-0.36)**	**0.50 (0.37-0.68)**	**0.57 (0.51-0.63)**	0.83 (0.66-1.05)	**0.20 (0.15-0.26)**	**0.24 (0.16-0.36)**
Drug	**1.94 (1.30-2.88)**	**1.91 (1.46-2.51)**	**0.62 (0.56-0.69)**	**0.03 (0.02-0.05)**	**1.72 (1.13-2.62)**	**3.13 (2.40-4.08)**
Other	**0.25 (0.16-0.39)**	**0.21 (0.11-0.40)**	**0.66 (0.55-0.78)**	0.70 (0.47-1.04)	**0.36 (0.23-0.58)**	**1.88 (1.23-2.86)**

	Price Promotion, any† OR (95%CI)	Price Promotion, Newport OR† (95% CI)	Marketing IRR‡ (95%CI)	Exterior Marketing IRR‡ (95%CI)	Flavored Cigars† OR (95%CI)	E-Cigarettes† OR (95%CI)§
L2: Tracts						
Same-Sex Couple Rate	1.00 (0.99-1.00)	1.00 (0.99-1.00)	**1.00 (0.996-1.00)**	1.00 (1.00-1.00)	**0.99 (0.99-1.00)**	1.00 (0.99-1.00)
% Black (10s)	**1.07 (1.00-1.15)**	**1.21 (1.14-1.29)**	0.99 (0.97-1.01)	**1.08 (1.03-1.13)**	**1.16 (1.06-1.28)**	**0.90 (0.84-0.95)**
% Hispanic (10s)	**0.93 (0.88-0.98)**	0.96 (0.91-1.01)	**0.96 (0.94-0.98)**	**0.95 (0.91-0.99)**	0.99 (0.93-1.06)	**0.94 (0.89-0.98)**
Median Income (1000s)	1.00 (1.00-1.01)	1.00 (0.99-1.00)	**1.00 (.996-1.00)**	**0.99 (0.99-1.00)**	**0.99 (0.99-1.00)**	1.00 (1.00-1.01)
County Population	1.00 (0.99-1.00)	1.00 (0.99-1.00)	**0.99 (0.99-1.00)**	1.00 (0.99-1.00)	1.00 (0.99-1.01)	-
Rurality Code	**0.91 (0.84-0.99)**	**0.85 (0.79-0.92)**	**0.96 (0.94-0.99)**	**0.93 (0.88-0.99)**	0.93 (0.84-1.03)	**0.88 (0.81-0.95)**
ICC	0.15	0.15	0.51	0.74	0.08	0.07

Note: Significance at the $p < 0.05$ level is indicated by bolded text. County population is in 100,000s. Store type is coded with weighted-effect coding and should be interpreted as the odds of the outcome variable against the typical tobacco retailer. OR = odds ratio; CI = confidence interval; ICC = intra-class correlation; † = Hierarchical generalized linear model (binary); ‡ = Hierarchical generalized linear model (negative binomial); § = two-level hierarchical models with random county or random tract intercepts could not compute estimates for county population in block 3, thus these models for e-cigarettes do not include the county population control variable (model 1 and 2 showed no substantive differences with and without county population). ICC calculated as $ICC = \frac{\tau_{00}}{\tau_{00}+\frac{\pi^2}{3}}$ and should be interpreted as the ICC for a hypothetical latent continuous variable underlying the binary variable. Intercepts are reported as exponentiated and represent odds at mean value. This table was created in SAS 9.3 using PQL estimation with sandwich correction ("EMPIRICAL") for count and dichotomous outcomes.

Table 13. Three-Level Nested Models Associating Same-Sex Couple Rate with Retailer Tobacco Marketing Characteristics, Random County and Tract Intercepts, 97 Counties, USA (Control for County Population in Lieu of Survey Weights)

	Female		Male	
	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)
Model 1 (Base)				
L1: Stores	n=2102	*n*=2000	*n*=2104	*n*=2000
Intercept (95% CI)	**$6.09 (0.17)**	**$6.38 (0.16)**	**$6.10 (0.17)**	**$6.38 (0.16)**
L2: Tracts				
Same-Sex Couple Rate	<$0.01 (<0.01)	<0.01 (<0.01)	<$0.01 (<0.01)	**<$0.01 (<0.01)**
L3: Counties				
County Population	0.02 (0.01)	0.02 (0.01)	$0.01 (0.01)	$0.02 (0.01)
Model 2 (Base + Neighborhood Characteristics)				
L1: Stores	*n*=2102	*n*=2000	*n*=2104	*n*=2000
Intercept (95% CI)	**$6.42 (0.29)**	**$6.51 (0.28)**	**$6.41 (0.29)**	**$6.51 (0.27)**
L2: Tracts				
Same-Sex Couple Rate	<$0.01 (<0.01)	**$0.01 (<0.01)**	<$0.01 (<0.01)	**<$0.01 (<0.01)**
% Black (10s)	$-0.01 (0.01)	**$-0.04 (0.01)**	<-$0.01 (0.01)	**$-0.03 (0.01)**
% Hispanic (10s)	$-0.01 (0.01)	$-0.01 (0.01)	$-0.01 (0.01)	<$-0.01 (0.01)
Median Income (1000s)	<$0.01 (<0.01)	<$0.01 (<0.01)	<$-0.01 (<0.01)	<$0.01 (<0.01)
L3: Counties				
County Population	$0.01 (0.01)	$0.01 (0.01)	$0.01 (0.01)	**$0.01 (0.01)**
Rurality Code	$-0.10 (0.09)	$-0.07 (0.08)	$-0.10 (0.09)	$-0.07 (0.08)
Model 3 (Base + Neighborhood Characteristics + Store Characteristics)				
L1: Stores	*n*=2101	*n*=1999	*n*=2103	*n*=1999
Intercept (95% CI)	**$6.43 (0.28)**	**$6.54 (0.27)**	**$6.41 (0.28)**	**$6.53 (0.27)**
Supermarkets	*- (weighted-effect coding reference group - see note below)*			
Convenience	$0.01 (0.03)	**$-0.13 (0.04)**	$0.01 (0.03)	**$-0.13 (0.04)**
Convenience with gas	**$-0.04 (0.01)**	**$-0.10 (0.02)**	**$-0.04 (0.01)**	**$-0.10 (0.02)**
Tobacco	**$-0.25 (0.06)**	**$-0.37 (0.07)**	**$-0.24 (0.06)**	**$-0.37 (0.07)**
Alcohol	**$0.21 (0.04)**	**$0.18 (0.04)**	**$0.21 (0.04)**	**$0.18 (0.04)**

	Female		Male	
	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)	Advertised Price, Marlboro* $ (SE)	Advertised Price, Newport* $ (SE)
Drug	**$-0.35 (0.03)**	**$-0.21 (0.04)**	**$-0.36 (0.03)**	**$-0.22 (0.04)**
Other	**$0.29 (0.06)**	**$0.45 (0.07)**	**$0.29 (0.06)**	**$0.44 (0.07)**
L2: Tracts				
Same-Sex Couple Rate	<$0.01 (<0.01)	**$0.01 (<0.01)**	**<$0.01 (<0.01)**	**<$0.01 (<0.01)**
% Black (10s)	$-0.01 (0.01)	**-$0.04 (0.01)**	$-0.01 (0.01)	**$-0.04 (0.01)**
% Hispanic (10s)	$-0.01 (0.01)	$-0.01 (0.01)	$-0.01 (0.01)	$-0.01 (0.01)
Median Income (1000s)	<$0.01 (<0.01)	$0.00 (<0.01)	<$-0.01 (<0.01)	<$0.01 (<0.01)
L3: Counties				
County Population	$0.01 (0.01)	$0.01 (0.01)	$0.01 (0.01)	$0.01 (0.01)
Rurality Code	$-0.10 (0.09)	$-0.07 (0.08)	-$0.10 (0.09)	$-0.07 (0.08)

Note: Significance at the $p < 0.05$ level is indicated by bolded text. County population is reported in 100,000s. SE=standard error. Created in SAS 9.3 with PROC MIXED.

Conclusions: The pattern of results is not sensitive to weighting approaches or use of a two- versus three-level model.

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