Retailing in College Towns During the Pandemic:

Spatial Location and Public Transit

Zixiong Shen

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By: Zixiong Shen

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Signed by the final examining committee:

Satyaveer S Chauhan ______ Chair

Satyaveer S Chauhan ______ Examiner

Xiaodan Pan ______ Examiner

Xiaodan Pan ______ Supervisor

Approved by Satyaveer S Chauhan ______
Chair of Department or Graduate Program Director

August 2021 Kathleen Boies ______

Dean

Abstract

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A "college town" is a unique urban landscape in America and displays different features from other urban areas. As a result, retailers located in college towns have faced different situations during the COVID-19 pandemic. In our thesis, we investigated the daily footprint data of 157 retailers in 38 identified college towns from 2018 to 2020. Our study contributes to the research on the economic consequences of college town retailers in the situation of a global pandemic. To be specific, we explore two core research questions: (1) how does the university footprint interact with spatial location and public transit in affecting the retailer footprint? And (2) what moderating effects did government containment and health index exert upon the customer footprints? Our study indicates that the university footprints, distance to university, and public transit percentage had a positive, negligible, and negative impact on store visits, respectively. Furthermore, the positive effect of university visits on store visits decreases as store-university distance increases but has little correlation with percent of public transit. Moreover, we find that the intensity of containment and health index strengthens the negative effect exerted by store-university distance upon the positive correlation between university visits and store visits. In contrast, the effects of the university visits and percent of public transit on store visits do not vary with containment and health index. This research provides essential information that can be utilized by government officials and retail managers to better respond to a global pandemic and prepare for the recovery after pandemic.

Key Words: college town, foot traffic, university-retailer distance, commuting modes, COVID-19 pandemic, spatial shopping, containment and health policies

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1. Introduction

In the past two years, the COVID-19 pandemic has caused an immense loss of life and insurmountable economic damages worldwide. No one was spared, and neither were university campuses. According to a survey by the New York Times (2020), tracking coronavirus data from 1,900 public and private universities and colleges in the United States, nearly 400,000 cases and at least 90 deaths were reported in American colleges and universities as of December of 2020. As areas of high population density and close personal contact, schools and other educational institutions across the world saw limitations and closures as part of the containment strategy. On March 6th of 2020, the University of Washington became the first major American university to close its doors, and by the end of the month, a total of 1,102 colleges and universities had followed suite (Hess, 2020).

While it is obvious that school closures were commonplace, their overall effect remains shrouded in controversy. To begin with, the closure of educational institutions can most certainly impact the local economy, especially where retailers derive a large portion of their customers from college students, staff, and visitors. To investigate the impact of the pandemic on retailers in college towns, we performed a study to analyze consumer footprints to stores during the pre-pandemic (2018-2019) and pandemic (2020) period. Specifically, we explore two core questions: (1) how does the university footprint interact with spatial location and public transit in affecting the retailer footprint? And (2) what moderating effects did government containment and health index exert upon the customer footprints?

Our main findings are as follows: Firstly, we expect the impact of university footprint on retailer footprint to be dependent on trade area characteristics such as university-store distance and city commute modes. Our results show that university footprints have a positive impact on retailer footprint, the distance to university has no significant impact of retailer footprint, and the percent of public transit has a significantly negative impact on store visits. Interestingly, the positive effect of university visits on store visits decreases as store-university distance increases, but it does not depend on percent of public transit. Second, we posit that these changes in customer footprint in college towns also depends on the external environment such as government-imposed containment and health measures. Our analysis demonstrates that the intensity of containment and health index strengthens the negative effect exerted by store-university distance on the positive relationship between university visits and store visits. In contrast, the effects of university visits and percent of public transit on store visits does not vary with intensity of containment and health index.

Our contributions span across multiple domains. First, from a theoretical perspective, we contribute to trade area and spatial shopping literature as we study how the impact of college footprint on retailer footprint interact with travelling distance and commuting modes. Second, from a practical perspective, our study provides a new addition to studies on business in college towns, which are currently both scarce and limited in variety. In particular, we study retail operations in small and midsize college towns. Third, from a methodology perspective, we utilize big data analytical techniques. We examine the daily footprint of 157 stores in 38 college towns from 2018 to 2020, providing valuable practical experience for managers and policy makers. Lastly, from a policy perspective, we study the economic consequences of government policy during the pandemic. Our findings can be valuable in aiding the post-pandemic recovery of commerce in these areas.

2. Theoretical Foundation

Figure 1 presents the theoretical model. Focusing college towns located in small and mid-sized cities (Gumprecht 2003), we explore how the interaction of university visits, retailer-university distance, and percent of public transit impact retailer footprint and how the impact varies with government containment and health index before and during the COVID-19 pandemic. In order to address our research questions, we review literature on: 1) the impact of the pandemic on educational institutions (Section 2.1), 2) college towns during the pandemic (Section 2.2), and 3) college town retailers during the pandemic (Section 2.3).

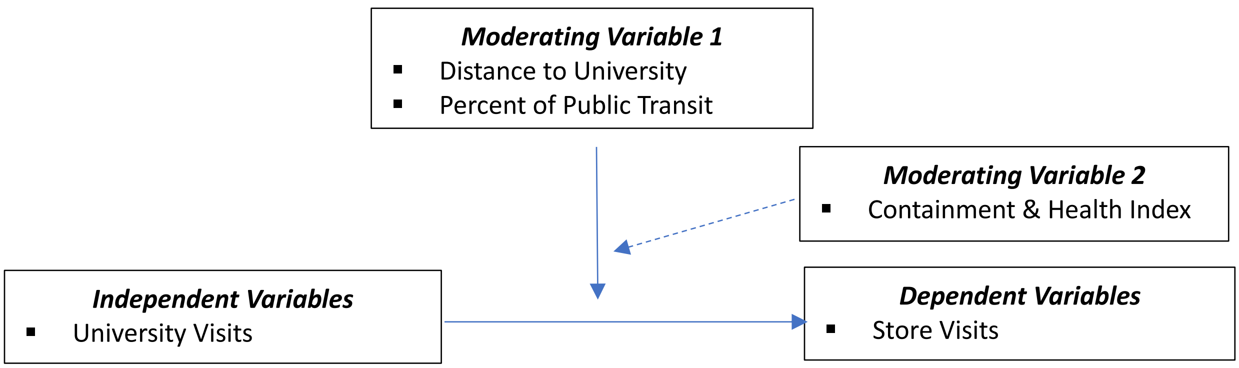

Figure 1: Theoretical Model

2.1. The impact of pandemic on educational institutions

2.1.1. Containment and health policy

On January 27th, 2020, the federal government of the United States declared a state of public health emergency in response to the COVID-19 pandemic. Since then, a multitude of containment and health policies were implemented. The containment and health policies, combining 'lockdown' restrictions and closures with health measures such as testing policy and contact tracing, shows how numerous and forceful the measures to contain the virus and protect citizen health are (Hallas et al., 2021). Specifically, containment and closure policy include school closing, workplace closing, cancellations of public events, restrictions on gathering size, closed public transport, stay at home requirements, restrictions on internal movement and restrictions on international travel. Health system policy includes public information campaigns, testing policy, contact tracing, emergency investment in healthcare and vaccine development, facial coverings, vaccination policy, and protection of the elderly (Hallas et al., 2021).

One of the main objectives of containment and health policy is to promote social distancing. According to the U.S. Centers for Disease Control and Prevention (CDC), social distancing, or "physical distancing," is the practice of maintaining a safe distance between individuals in public to reduce the risk of disease transmission, with the standard minimum distance being six feet (CDC, 2020). Anderson et al. (2020) claims that social distancing, along with other self–motivated behaviors such as early self-isolation and seeking medical advice remotely is crucial to control the spread of COVID-19. Not limited merely to the United States, social distancing has been encouraged and enforced by health authorities and governments across the world as a core aspect of reducing the impact of COVID-19 (Pedersen & Favero, 2020).

2.1.2. The consequence of school closures

With the spread of COVID-19, schools and other educational institutions worldwide saw limitations and closures as part of the disease containment strategy. According to UNESCO (2021), nearly half of the world's students were influenced by partial or full school closures by March 2021. In the United States, the total school closure duration was 56 weeks (UNESCO, 2021). In August 2020, almost all the states required general or targeted school closing at all levels, while in February 2021, only California and Illinois remained in the same school closing requirements (Hallas et al., 2021). Notably, the benefits of school closure on pandemic control are controversial. In Germany, researchers have found that neither the summer school closures, nor autumn school closures had a significant effect on the spread of COVID-19 (von Bismarck-Osten et al., 2021). In Denmark, the reopening of kindergartens and elementary schools was followed by a steady decrease in cases nationwide (Ritchie et al., 2020).

The negative influence of school closure has been widely studied. Rundle et al. (2020) pointed out that school closure has negative physical impacts, which result in the increase of obesity rate of American children. According to Education Trust (2020), lacking sufficient devices to access distancing learning is a common issue among low-income families and families of color. Kuhfeld et al. (2020) suggested that major impacts are likely to occur with students after experiencing a prolonged period of school closure. The effectiveness of virtual instruction also remains uncertain. Many public-school teachers have not been well-trained to provide high quality virtual teaching (Kuhfeld et al., 2020). In addition, the various containment measures and teaching substitution in colleges negatively influenced the students' social connections as students were unable to maintain a regular social life (Ando, 2021).

2.2. College towns during the pandemic

2.2.1. The phenomenon of college towns

The American college towns is a rather unique phenomenon with few similarities elsewhere (Almond, 2020). Defined by Gumprecht (2003), a college town, also known as a university town, indicates any city in which the character of the community is influenced by a college or a university and the cultures it creates to a large extent. Gumprecht (2003) suggested subdividing the college towns into two groups by the dominance of institutions of higher education. The first group is made up of college towns that are dominated by colleges or universities with a concentrated collegiate culture such as Ithaca, New York and Manhattan, Kansas. In the second group are college towns that are part of a major metropolitan area or state capital such as Austin, Texas and Tempe, Arizona (Gumprecht, 2003).

According to Almond (2020), the collegiate cultural phenomenon of college towns is introduced by the athletics, alumni and associations of colleges. Gumprecht (2006), in his later research, also pointed out that the characteristics of college towns are distinct other communities due to the high concentration of students and highly educated workforces. According to Gumprecht (2003), other typical characteristics of college towns include high family incomes, low unemployment rates, and a relative absence of heavy industries. Sperber (2000) studied the crime and social disorder issues of college towns and found that despite having lower serious crime rates than other urban centers, social and physical disorder, especially those incurred by alcohol is rampant and is often part of community conflicts in these areas. Woldoff & Weiss (2018) further pointed out that social problems and community conflicts are intensified with the dramatically increased university enrollments and the shortage of on-campus housing.

2.2.2. University operation during the pandemic

University closures in the United States do not mean the halt of teaching. Accurately, teaching is transferred to other channels, instead of face-to-face and in the campus. University of Washington at Seattle, as the first major university in the U.S. to close to respond to the pandemic, transferred to online teaching entirely by March 9, 2020 (Witze, 2020). On March 10, 2020, Harvard University declared that virtual teaching would start by March 23 and asked students not to return to campus after the spring break, while at the same time, Princeton University claimed that all the teaching contents would be switched to online after the spring break (Abdalla, 2020). In response to the halt of face-to-face education and switching to virtual teaching, a number of universities including Princeton University, Williams College, Spelman College, and American University, have declared discounts on tuition (Gallagher & Palmer, 2020).

After the summer vacation, universities faced the situation of whether to reopen the campus or not in the fall semester. Regarding this question, most schools in the United States planned to offer a hybrid of the options (Kaleem et al., 2020). Baylor University chose the hybrid model, which allows students to attend on campus classes as well as remain online. Among all the course sections offered by Baylor University, 39% were held face-to-face with corresponding face covering and distancing requirements, 25% were taught in hybrid and 36% were offered entirely virtually (Ryan et al., 2021). Boston University adopted a hybrid teaching mode that allowed all students, both undergraduate and graduate, to attend on campus in-person classes or online remote classes (2021).

2.3. College town retailers during the pandemic

2.3.1. Spatial shopping activities in college towns

College towns provide a unique context for studying trade area and related spatial shopping behavior. The models of trade area and spatial shopping have been developed for generations. Defined by Bennett (1995), trade area represents "*a geographical area containing the customers of a particular firm or group of firms for specific goods or services*." Gravity models have been widely used to analyze store location and trade area. The most commonly used gravity models include: 1) Reilly's Law of Retail Gravitation (1931), 2) Converse's Breaking-Point Model (1949), 3) Huff's Trade Area Attraction Model (1964), and 4) Christaller's Central Place Theory (1935). According to Rasouli & Timmermans (2013), there are three generations of spatial shopping models. The first generation assumed that shopping trips were made between residential areas and shopping centres. The second generation added variables to explain and predict shopping patterns. The latest generation view shopping activities as parts of an individual's and a household's daily life.

Travelling distance is a decisive factor in affecting the spatial shopping activities in college towns (van Leeuwen & Rietveld, 2011). Previous studies found that the effect of travelling distance on spatial shopping activities varies across demographic groups. For example, older people are more likely to shop close to their homes (Pinkerton et al., 1995; Powe & Shaw, 2004). Consumers with higher income are more capable of affording the cost of shopping outside the town (Herrmann & Beik 1968; Huff 1959, Thompson, 1971). For the not-so-mobile group, such as the elder population, households with young children and handicapped persons, local markets are the most important (Powe et al., 2009). Better travel conditions can attract consumers to travel beyond local markets (van Leeuwen & Rietveld, 2011). Residents in college towns most rely on walking, bicycle, and public transit; hence the spatial location of a retailer (i.e., distance to universities) are likely to affect the retailers' footprint in college towns.

2.3.2. Commuting modes in college towns

Residents of college towns rely less on private vehicles. According to a study regarding the commuter students in the United States, walking and biking are popular choices among the students who live on or near campus (Zhou et al., 2018). The selection of commuting modes is influenced by other factors. In research that studied the commuting modes of the University of West Australia staffs and students indicates that travel time was the most important barrier for respondents to use active transport like walking, cycling and public transit (Shannon et al., 2006). Besides travel time, price is another important factor that influence the use of public transportation. Brown et al. (2001) concluded that the implementation of a subsidized student transit pass system can increase the student ridership dramatically in the first year, from 71% to 200%.

The commuting modes chosen by residents and visitors in college towns can be significantly altered when externalities changes. The pandemic has changed the commuting pattern all over the world (Abdullah et al., 2020; Eisenmann et al., 2021; Pawar et al., 2020). A report published by the American Public Transportation Association revealed that the nation-wide public transit ridership in 2020 dropped 79% compared to that in 2019, before the start of pandemic (APTA, 2020). However, the decline of transit ridership differs between different metropolitan areas. In Washington DC, Metrorail ridership experienced a decline of 90% and the bus system experienced a 75% decline in ridership by the end of March 2020 (WMATA, 2020). In San Antonio, Texas, the ridership of the local bus agency experienced a decline of 30% by the end of March

2020 (VIA, 2020). Overall, retailers located in college towns with a high percent of public transit may see a drop in consumer footprint.

3. Research Methodology

3.1. Data Collection

We have two data sources for our research. The first data source is Placer.ai, which is a company that generated and analyzed foot traffic data. The analyzed foot traffic data can be utilized by retailers and researchers to obtain insights and make appropriate decisions. For this study, we obtained the daily footprint data of 157 retailers in 38 identified college towns, ranging from January 2018 to October 2020. We focused on two of the most popular retail chains in the U.S., which are Target and Walmart. The data from Placer.ai contained customer footprints to stores that are located in college towns, as well as other characteristics such as socio-demographic (gender, race, income, education, marital status and age), and commuting modes (drive alone, public transit, carpool, walk, bicycle and work-at-home).

Our second data source is the Variation in US State's Response to COVID-19, published by Blavatnik School of Government, University of Oxford. This working paper is developed by Laura Hallas, Thomas Hale and their team. This source provides information regarding the federal and states' response to the pandemic, as well as the embedded degree of stringency and trends of policy changes. Moreover, the process of vaccination is also introduced in this working paper. There are three policy stringency categories included in this source (stringency index, government response index and containment health index), we utilized containment and health index in this study.

3.2. Variable Definition

For our dependent variable, store visits (STORE_VISITS) measure the customer daily visits to a store. The independent variable is university visits (UNIVERSITY_VISITS). University visits (10K) is the daily number of visits to a university. For the moderating variables, distance to university (DISTANCE_TO_UNIVERSITY) measures the distance between the store location and the university centre; public transit percentage (PERCENT_PUBLIC_TRANSIT) is the percent of people who use public transit to commute in the trade area; containment and health index (CONTAINMENT_HEALTH_INDEX) measures the level of government response to the pandemic. We also control for trade area size, median income and population. Trade area size (TRADE_AREA_SIZE) is the size of trade area of a store; median income (MEDIAN_INCOME) is the median income of people who reside in the trade area of a store; population (POPULATION) is the total population of the trade area of a store.

Table 1: Variable Definition

Variables	Definitions
STORE_VISITS	Customer daily visits to a store.
UNIVERSITY_VISITS	Daily visits to a university.
CONTAINMENT_HEALTH_INDEX	Index indicating the level of government response to the pandemic.
DISTANCE_TO_UNIVERSITY	Distance from store location to university centre.
PERCENT_PUBLIC_TRANSIT	Percent of population taking public transit in the trade area of a store.
TRADE_AREA_SIZE	Size of the trade area of a store.
MEDIAN_INCOME	Median income of the trade area of a store.
POPULATION	Total population in the trade area of a store.

Table 2: Data Description

Variable	Obs	Mean	Std. dev.	Min	Max
STORE_VISITS	167,007	4493.126	2001.579	0	28154
UNIVERSITY_VISITS	167,007	2.611	2.188	0	29.574
CONTAINMENT_HEALTH_INDEX	167,007	12.278	21.393	0	74.360
DISTANCE_TO_UNIVERSITY	167,007	4.335	2.471	0.430	9.9
PERCENT_PUBLIC_TRANSIT	167,007	2628.355	4810.558	19	47984
TRADE_AREA_SIZE	167,007	52.429	29.863	8.530	169.630
MEDIAN_INCOME	167,007	4429.287	2486.348	359	16679
POPULATION	167,007	119884.500	66718.880	21753	492875

Table 3: Correlation Table

		1	2	3	4	5	6	7	8
1	STORE_VISITS	1.0000							
2	UNIVERSITY_VISITS	0.0071	1.0000						
3	CONTAINMENT_HEALTH_INDEX	-0.0652	-0.3425	1.0000					
4	DISTANCE_TO_UNIVERSITY	-0.1688	0.0795	0.0099	1.0000				
5	PERCENT_PUBLIC_TRANSIT	-0.0222	0.1213	0.0197	0.0426	1.0000			
6	TRADE_AREA_SIZE	0.1726	0.0215	-0.0468	-0.1696	-0.1340	1.0000		
7	MEDIAN_INCOME	0.0440	0.2895	-0.0042	-0.1866	0.4633	0.2935	1.0000	
8	POPULATION	-0.0181	0.2571	-0.0286	0.1766	0.6052	0.1307	0.7281	1.0000

3.3. Estimation Models

Our goal is to investigate how town characteristics, spatial location and commuting modes, influence retail footprints in college towns with respect to a changing environment such as government containment and health policy. $STORE\_VISITS_{ijkty}$ represents footprints to store i of chain j in college town k in day t of year y. η_{ijk} represents the unobserved random effects and ε_{ijkty} represents the error items.

Model 1: Direct Effect Model

$$STORE\_VISITS_{ijkty} = \alpha_0$$
$$+ \alpha_1 \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$$
$$+ \alpha_2 \cdot UNIVERSITY\_VISITS_{kty}$$
$$+ \alpha_3 \cdot DISTANCE\_TO\_UNIVERSITY_{ijk}$$
$$+ \alpha_4 \cdot PCT\_PUBLIC\_TRANSIT_{ijky}$$
$$+ \alpha_5 \cdot TRADE\_AREA\_SIZE_{ijky}$$
$$+ \alpha_6 \cdot MEDIAN\_INCOME_{ijky}$$
$$+ \alpha_7 \cdot POPULATION_{ijky}$$
$$+ \alpha_8 \cdot WEEKDAY_{ty}$$
$$+ \alpha_9 \cdot WEEK_{ty}$$
$$+ \eta_{ijk} + \varepsilon_{ijkty}$$
$$\eta_{ijk} \sim N(\mu_\eta, \sigma_\eta) \quad \varepsilon_{ijkty} \sim N(\mu_\varepsilon, \sigma_\varepsilon)$$

Model 2: Two-Way Moderating Effect Model

$STORE\_VISITS_{ijkty} = \beta_0$

$+ \beta_1 \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$

$+ \beta_2 \cdot UNIVERSITY\_VISITS_{ijkty}$

$+ \beta_3 \cdot DISTANCE\_TO\_UNIVERSITY_{ijk}$

$+ \beta_4 \cdot PCT\_PUBLIC\_TRANSIT_{ijky}$

$+ \beta_5 \cdot UNIVERSITY\_VISITS_{ijkty} \cdot DISTANCE\_TO\_UNIVERSITY_{ijk}$

$+ \beta_6 \cdot UNIVERSITY\_VISITS_{ijkty} \cdot PCT\_PUBLIC\_TRANSIT_{ijky}$

$+ \beta_7 \cdot TRADE\_AREA\_SIZE_{ijky}$

$+ \beta_8 \cdot MEDIAN\_INCOME_{ijky}$

$+ \beta_9 \cdot POPULATION_{ijky}$

$+ \beta_{10} \cdot WEEKDAY_{ty}$

$+ \beta_{11} \cdot WEEK_{ty}$

$+ \eta_{ijk} + \varepsilon_{ijkty}$

$\eta_{ijk} \sim N(\mu_\eta, \sigma_\eta) \quad \varepsilon_{ijkty} \sim N(\mu_\varepsilon, \sigma_\varepsilon)$

Model 3: Three-Way Moderating Effect Model

$STORE\_VISITS_{ijkty} = \gamma_0$

$+ \gamma_1 \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$

$+ \gamma_2 \cdot UNIVERSITY\_VISITS_{ijkty}$

$+ \gamma_3 \cdot DISTANCE\_TO\_UNIVERSITY_{ijk}$

$+ \gamma_4 \cdot PCT\_PUBLIC\_TRANSIT_{ijky}$

$+ \gamma_5 \cdot UNIVERSITY\_VISITS_{ijkty} \cdot DISTANCE\_TO\_UNIVERSITY_{ijk}$

$+ \gamma_6 \cdot UNIVERSITY\_VISITS_{ijkty} \cdot PCT\_PUBLIC\_TRANSIT_{ijky}$

$+ \gamma_7 \cdot UNIVERSITY\_VISITS_{ijkty} \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$

$+ \gamma_8 \cdot DISTANCE\_TO\_UNIVERSITY_{ijk} \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$

$+ \gamma_9 \cdot PCT\_PUBLIC\_TRANSIT_{ijky} \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$

$+ \gamma_{10} \cdot UNIVERSITY\_VISITS_{ijkty} \cdot DISTANCE\_TO\_UNIVERSITY_{ijk} \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$

$+ \gamma_{11} \cdot UNIVERSITY\_VISITS_{ijkty} \cdot PCT\_PUBLIC\_TRANSIT_{ijky} \cdot CONTAINMENT\_HEALTH\_INDEX_{kty}$

$+ \gamma_{12} \cdot TRADE\_AREA\_SIZE_{ijky}$

$+ \gamma_{13} \cdot MEDIAN\_INCOME_{ijky}$

$+ \gamma_{14} \cdot POPULATION_{ijky}$

$+ \gamma_{15} \cdot WEEKDAY_{ty}$

$+ \gamma_{16} \cdot WEEK_{ty}$

$+ \eta_{ijk} + \varepsilon_{ijkty}$

$\eta_{ijk} \sim N(\mu_\eta, \sigma_\eta) \quad \varepsilon_{ijkty} \sim N(\mu_\varepsilon, \sigma_\varepsilon)$

4. Estimation Results

In this section, we discuss our major findings. Table 4 illustrates our estimation results. In Model 1.1, we only include control variables. In Models 1.2 and 1.3, we focus on the direct effects of university visits, distance to university, percent of public transit, and containment and health index on store visits. In Model 1.4, we present the two-way moderating effects of university visits and distance to university as well as university visits and percent of public transit. Finally, in Model 1.5, we further incorporate three-way moderating effects; that is, the two-way moderating effects also depend on government containment and health index.

Table 4: Estimation Results

Store Visits	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5
UNIVERSITY_VISITS_10K		52.699*** (6.432)	**33.944***** **(7.039)**	108.981*** (17.646)	98.000*** (15.627)
DISTANCE_TO_UNIVERSITY			**-82.036** **(56.812)**	-36.081 (57.306)	-49.957 (55.148)
PERCENT_PUBLIC_TRANSIT			**-10665.065*** **(5729.360)**	-12484.633* (5936.350)	-9760.678* (5747.644)
CONTAINMENT_HEALTH_INDEX			**-3.725***** **(0.721)**	-3.892*** (0.721)	-9.828*** (2.094)
UNIVERSITY_VISITS*DISTANCE_TO_UNIVERSITY				**-17.080***** **(2.719)**	**-14.980***** **(2.751)**
UNIVERSITY_VISITS*PERCENT_PUBLIC_TRANSIT				**17.399** **(152.081)**	**-282.639*** **(135.135)**
UNIVERSITY_VISITS*CONTAINMENT_HEALTH_INDEX					8.390*** (1.142)
DISTANCE_TO_UNIVERSITY*CONTAINMENT_HEALTH_INDEX					0.757* (0.382)
PERCENT_PUBLIC_TRANSIT*CONTAINMENT_HEALTH_INDEX					-52.484* (22.161)
UNIVERSITY_VISITS*DISTANCE_TO_UNIVERSITY*CONTAINMENT_HEALTH_INDEX					**-1.198***** **(0.173)**
UNIVERSITY_VISITS * PERCENT_PUBLIC_TRANSIT*CONTAINMENT_HEALTH_INDEX					**20.167** **(14.129)**
TA_TRADE_AREA_SIZE	19.861*** (3.892)	16.359*** (3.807)	8.235* (4.478)	7.351 (4.550)	9.902* (4.369)
TA_POPULATION	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.002 (0.002)
TA_MEDIAN_HHI	0.006 (0.016)	0.001 (0.016)	-0.017 (0.018)	-0.019 (0.018)	-0.010 (0.019)
MONDAY	-758.931*** (85.157)	-794.029*** (85.089)	-781.266*** (84.906)	-779.382*** (85.039)	-783.813*** (85.278)
TUESDAY	-1011.852*** (87.921)	-1057.358*** (87.987)	-1041.168*** (87.594)	-1038.157*** (87.745)	-1042.246*** (88.082)
WEDNESDAY	-916.856*** (87.276)	-961.210*** (87.335)	-945.514*** (86.905)	-942.706*** (87.067)	-947.636*** (87.376)
THURSDAY	-752.214*** (84.526)	-800.390*** (84.476)	-783.102*** (83.986)	-779.664*** (84.167)	-783.020*** (84.522)
FRIDAY	224.039** (82.919)	177.055* (82.454)	193.986* (81.867)	194.176* (82.065)	190.548* (82.260)
SATURDAY	1305.685*** (97.585)	1259.642*** (96.901)	1276.240*** (96.654)	1273.450*** (96.802)	1276.693*** (97.129)
CONSTANT	3135.483*** (694.423)	3652.602*** (699.124)	5707.761*** (875.672)	5690.501*** (869.252)	5023.366*** (942.495)
N	167007	167007	167007	167007	167007

CHI SQUARE	3740.32	3731.45	3924.44	4154.33	4230.31

Note: The table shows estimated coefficients. Standard errors in parentheses. *p<0.1, **p<0.01, ***p<0.001

4.1. University Visits and Containment and Health Index

4.1.1. The Direct Effect of University Visits

We expect that university visits will have a significant effect on consumer footprints to stores. In Model 1.3, we include University Visits (10k) to observe the effect. In Model 1.3, the coefficient for university visits is positive and significant (33.944, p<0.001). Figure 2 illustrates the marginal effect of university visits on consumer footprints to stores using the estimation results of Model 1.3. As displayed in Figure 2, the increase in university visits results in a linear up rise in store visits. For example, as university visits increased from 0.05 (10k) to 8.55 (10k), average store visits increased from 4401.915 to 4690.436 by 288.521. *The results suggest that university visits are positively associated with consumer footprints.*

Table 5: The effects of university visits on store visits

At	University Visits	Margin	Delta-method std. err.	z	P>|z|	[95% conf. interval]	
1	0.05	4401.915	102.3298	43.02	0	4201.352	4602.478
2	8.55	4690.436	110.2265	42.55	0	4474.396	4906.476

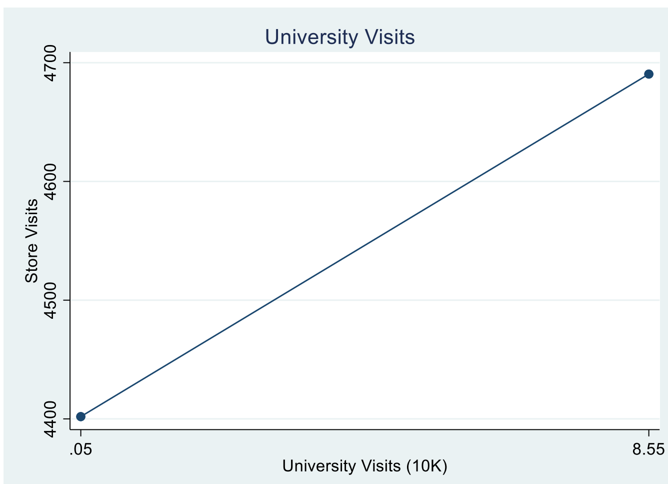

Figure 2: The effects of university visits on store visits

4.1.2. The Direct Effects of Containment and Health Index

We expect containment and health index will have significant effect on consumer footprints to stores. In Model 1.3, we include containment and health index to observe the effect. In Model 1.3, the coefficient for containment health index is negative and significant (-3.725, P<0.001). Table 6 and Figure 3 illustrates the marginal effect of containment health index on consumer footprints to stores using the estimation results of Model 1.3. As displayed in Figure 3, the increase in containment and health index results in a linear drop in store visits. For example, as containment health index increased from 0 to 60, average store visits decreased from 4534.570 to 4311.071 by 223.499 visits. *The results indicate that containment health index is negatively associated with consumer footprints.*

Table 6: The effects of containment and health index on store visits

At	Containment Health Index	Margin	Delta-Method Std. Err.	z	P>|z|	[95% conf. interval]	
1	0	4534.570	106.062	42.75	0	4326.692	4742.447
2	60	4311.071	87.906	49.04	0	4138.779	4483.362

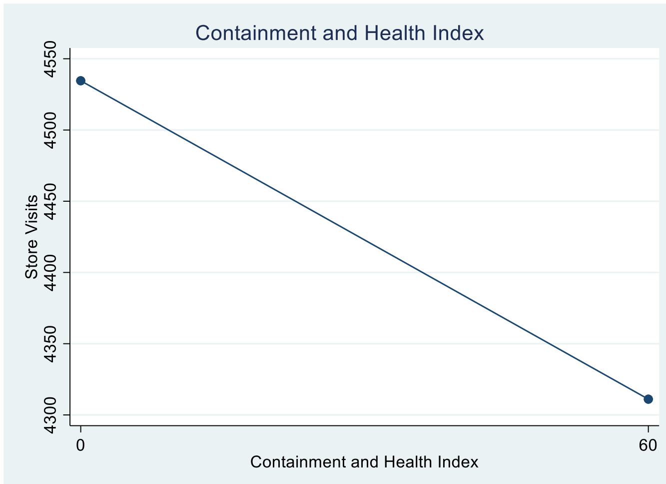

Figure 3: The effects of containment and health index on store visits

4.2. Distance to University and Containment and Health Index

4.2.1. The Direct Effects of Distance to University

Distance to university may have significant impact on consumer footprints to stores. In Model 1.3, we include distance to university to observe the effect. In Model 1.3, the coefficient for distance to university is negative but insignificant (-82.036, $p>0.1$). Table 7 and Figure 4 illustrates the marginal effect of distance to university on consumer footprints to stores using the estimation results of Model 1.3. As displayed in Figure 4, the increase in university visits results in a linear drop in store visits. For example, as distance to university increased from 0.51 to 9.71, average store visits decreased from 4802.603 to 4047.870 by 754.733. *The results indicate that distance to university is negatively associated with consumer footprints (insignificant).*

Table 7: The effects of distance to university on store visits

At	Distance to University	Margin	Delta-Method Std. Err.	z	P>|z|	[95% conf. interval]	
1	0.51	4802.603	247.632	19.39	0	4317.254	5287.952
2	9.71	4047.870	313.083	12.93	0	3434.238	4661.502

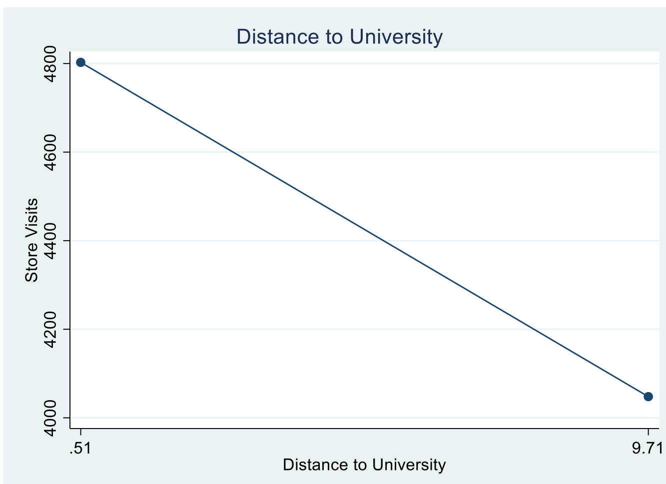

Figure 4: The effects of distance to university on store visits

4.2.2. The Moderating Effects of Distance to University

We further examine the moderating effect of store-university distance on the relationship between university visits and store visits. In Model 1.4, the coefficient for university visits is positive and significant, 108.981 ($p<0.001$), the coefficient for distance to university is -36.081 ($p>0.1$), and the coefficient for the two-way interaction term is negative and significant, -17.080 ($p<0.001$). Table 8 and Figure 5 illustrate the marginal effect of university visits and distance to university on consumer footprints to stores using the estimation results of Model 1.4. As displayed in Figure 5, when university visits equal to 0.05 (10k), as distance to university increases from 0.51 to 9.71 miles, average store visits decreased from 4540.748 to 4152.988 by 387.76; when university visits equal to 8.55 (10k), as distance to university increases from 0.51 to 9.71 miles, average store visits decreased from 6115.347 to 3405.878 by 2709.469 visits. *The results suggest that university visits* *have a positive correlation with store visits, store-university distance has no significant effects on store visits, but the positive effects of university visits decrease with distance to university.*

Table 8: The effects of university visits on store visits with respect to distance to university

At	University Visits	Distance to University	Margin	Delta-Method Std. Err.	z	P>|z|	[95% conf. interval]	
1	0.05	0.51	4540.748	237.114	19.15	0	4076.014	5005.483
2	0.05	9.71	4152.988	309.466	13.42	0	3546.445	4759.530
5	8.55	0.51	6115.347	274.657	22.27	0	5577.029	6653.665
6	8.55	9.71	3405.878	297.444	11.45	0	2822.898	3988.858

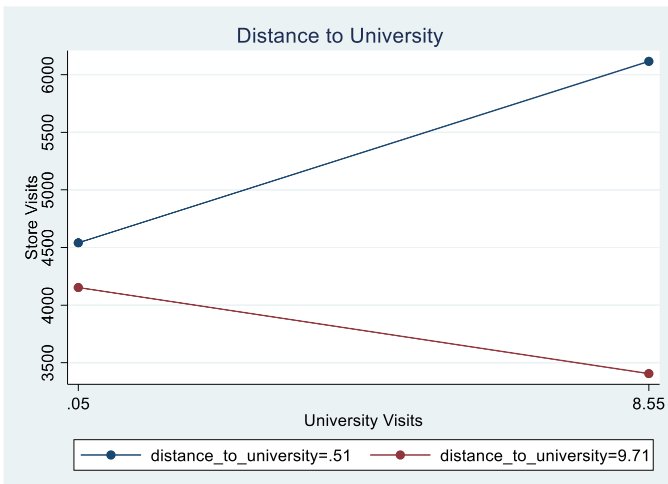

Figure 5: The effects of university visits on store visits with respect to distance to university

4.2.3. The Moderating Effects of Containment and Health Index

We expect the effect of store-university distance and university visits on store footprint vary with containment and health index. In Model 1.5, we include the three-way moderating effects of containment and health index. In Model 1.5, the coefficient for the two-way interaction term is significantly negative, (-14.980, $p<0.001$), and the coefficient for the three-way interaction term is negative and significant (-1.198, $p<0.001$). Table 9 and Figure 6 illustrates how the interaction of university visits, distance to university, and containment and health index affect store visits using the estimation results of Model 1.5. First, we consider scenarios 1-4 when containment and health index is low. In scenarios 1 and 2, when university visits are equal to 0.05 (10k) visits, as store to university distance increases from 0.51 to 9.71 miles, store visits decrease from 4676.749 to 4210.249 by 466.5; in contrast, in scenarios 3 and 4 where university visits is equal to 8.55 (10k), store visits decrease from 5356.788 to 3718.866 by 1637.922. Next, we consider scenarios 5-8 where the containment and health index are high. In scenarios 5-6, when university visits equal to 0.05 (10k) visits, as store-university distance increases from 0.51 to 9.71 miles, store visits decrease from 4020.410 to 3938.679 by 81.731, while in scenarios 7-8, when university visits equal to 8.55 (10k) visits, store visits decrease from 9044.375 to 2170.196 by 6874.179. However, the value of university visits is dynamic instead of static. The change in university visits might be influenced by university closure. The number of university visits could collapse dramatically and thereby influence the store visits. *Overall, the results suggest that store-university distance exerts a negative effect on the positive relationship between university visits and store visits, and the adverse effect further increases with intensity of containment and health response.*

Table 9: The effects of university visits and distance to university on store visits with respect to low-high containment and health index

At	Containment Health Index	University Visits (10k)	Distance To University	Margin	Delta-Method Std. Err.	z	P>|z|	[95% conf. interval]	
1	0	0.05	0.51	4676.749	241.669	19.35	0	4203.087	5150.410
2	0	0.05	9.71	4210.249	309.779	13.59	0	3603.094	4817.404
3	0	8.55	0.51	5356.788	261.616	20.48	0	4844.031	5869.545
4	0	8.55	9.71	3718.866	302.169	12.31	0	3126.626	4311.107
5	60	0.05	0.51	4020.410	238.159	16.88	0	3553.628	4487.192
6	60	0.05	9.71	3938.679	327.249	12.04	0	3297.282	4580.075
7	60	8.55	0.51	9044.375	479.403	18.87	0	8104.763	9983.987
8	60	8.55	9.71	2170.196	474.583	4.57	0	1240.030	3100.362

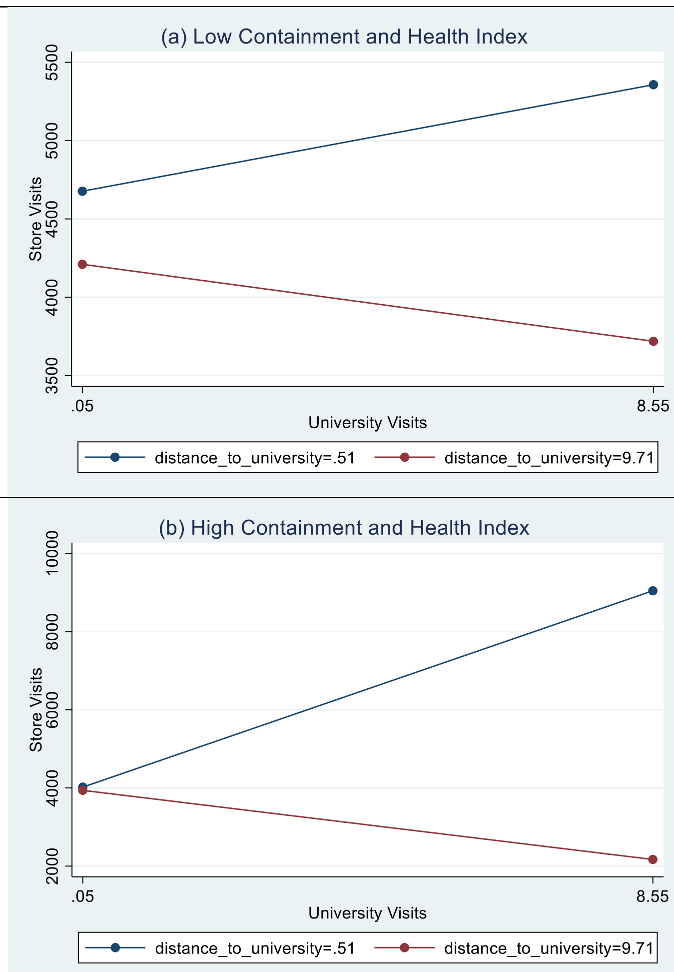

Figure 6: The effects of university visits and distance to university on store visits with respect to low-high containment and health index

4.3. Percent of Public Transit and Containment Health Index

4.3.1. The Direct Effects of Percent of Public Transit

The percentage of usage of public transit in the trade area may have effects on store visits. In Model 1.3, the coefficient for public transit percent is negative and significant (-10665.065, $p<0.1$). Figure 7 illustrates the marginal effect of percent of public transit on consumer footprints to stores using the estimation results of Model 1.3. As displayed in Figure 7, the increase in percent of public transit results in a linear drop in store visits. For example, as public transit percent increased from 0.00 to 0.22, average store visits decreased from 4879.576 to 2533.261 by 2,346.315 visits. *The results suggest that trade area transport mode such as percent of public transit is negatively associated with consumer footprints.*

Table 10: The effects of percent of public transit on store visits

At	Public Transit Percent	Margin	Delta-Method Std. Err.	z	P>|z|	[95% conf. interval]	
1	0.00	4879.576	232.238	21.01	0	4424.396	5334.755
2	0.22	2533.261	1056.235	2.40	0.016	463.078	4603.444

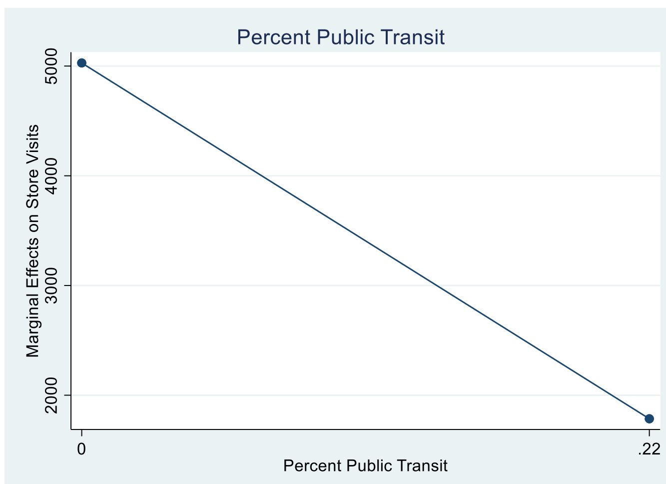

Figure 7: The effects of percent of public transit on store visits

4.3.2. The Moderating Effects of Percent of Public Transit

The impact of university footprint on store footprint may change with trade area commute modes. In Models 1.4, we include percent of public transit to observe the moderating effects. In Model 1.4, the coefficient for university visits is significantly positive, 108.981 ($p<0.001$), the coefficient for percent of public transit is significantly negative, -12484.633 ($p<0.1$), and the coefficient for the two-way interaction term is negative but insignificant, 17.399 ($p>0.1$). Figure 8 illustrates the marginal effect of university visits and percent of public transit on consumer footprints to stores using the estimation results of Model 1.4. As displayed in Figure 8, the increase in university visits results in a linear up rise in store visits; when university visits equal 0.05, as percent of public transit increases from 0.00 to 0.22, store visits decreased from 4762.875 to 2473.368 by 2289.507 visits; when university visits equal 8.55, as percent of public transit increases from 0.00 to 0.22, store visits decreased from 5372.238 to 3017.238 by 2355 visits. *The results imply that the increase of university visits brings more visits to stores in the trade area, but the percent of public transit significantly decreases the store visits, and the positive relationship between university visits and store visits does not significantly vary with trade area transport modes such as percent of public transit.*

Table 11: The effects of university visits on store visits with respect to percent of public transit

	University Visits	Public Transit Percent	Margin	Delta-Method Std. Err.	z	P>|z|	[95% conf. interval]	
1	0.05	0.00	4762.875	231.328	20.59	0	4309.480	5216.270
2	0.05	0.22	2473.368	1064.081	2.32	0.02	387.807	4558.928
3	8.55	0.00	5372.238	251.006	21.40	0	4880.276	5864.200
4	8.55	0.22	3017.238	1131.019	2.67	0.008	800.481	5233.994

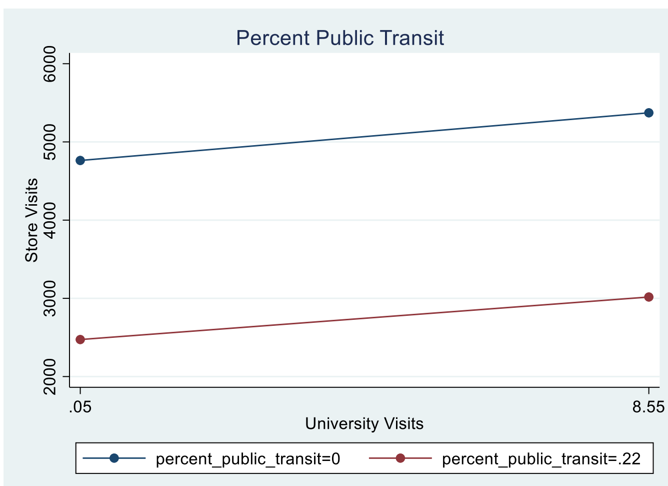

Figure 8: The effects of university visits on store visits with respect to percent of public transit

4.3.3. The Moderating Effect of Containment and Health Index

The effect that the commuting mode and the university footprint exert on store footprint may change with containment and health index. In Model 1.5, the coefficient for the two-way interaction term is negative and significant (-282.639, $p<0.1$) and the coefficient for the three-way interaction term is positive but insignificant (20.167, $p>0.1$). Table 12 and Figure 9 illustrates the impact of interaction of percent public transit and university visits on store visits with respect to low and high containment and health index. First, we consider scenarios 1-4 when containment and health index is low. In scenarios 1 and 2, when university visits are equal to 0.05 (10k) visits, as percent public transit increases from 0 to 0.22, store visits decrease from 4840.934 to 2690.475 by 2150.459; in contrast, in scenarios 3 and 4 where university visits is equal to 8.55 (10k), store visits decrease from 5121.990 to 2442.996 by 2678.994. Next, we consider scenarios 5-8 where the containment and health index is high. In scenarios 5-6, when university visits equal to 0.05

(10k) visits, as percent public transit increases from 0 to 0.22, store visits decrease from 4457.715 to 1627.774 by 2829.941, while in scenarios 7-8, when university visits equal to 8.55 (10k) visits, store visits decrease from 6369.010 to 5273.254 by 1095.756. Again, the value of university visits is dynamic instead of static. The change in university visits might be influenced by university closure. Since most universities closed immediately when the COVID-19 pandemic ran out of control, the number of university visits could collapse dramatically and thereby influence the store visits. *The results suggest that percent public transit exerts a negative effect on the positive relationship between university visits and store visits, which, the adverse effect, which does not vary with government containment and health response.*

Table 12: The effects of percent of public transit and university visits on store visits with respect to low-high containment and health index

At	Containment Health Index	University Visits (10k)	Percent Public Transit	Margin	Delta-Method Std. Err.	z	P>|z|	[95% conf. interval]	
1	0	0.05	0.00	4840.934	232.100	20.86	0.000	4386.025	5295.842
2	0	0.05	0.22	2690.475	1064.163	2.53	0.011	604.755	4776.196
3	0	8.55	0.00	5121.990	242.664	21.11	0.000	4646.378	5597.602
4	0	8.55	0.22	2442.996	1088.452	2.24	0.025	309.669	4576.323
5	60	0.05	0.00	4457.715	235.544	18.93	0.000	3996.056	4919.373
6	60	0.05	0.22	1627.774	1086.051	1.50	0.134	-500.847	3756.395
7	60	8.55	0.00	6369.010	411.206	15.49	0.000	5563.061	7174.959
8	60	8.55	0.22	5273.254	1633.138	3.23	0.001	2072.362	8474.147

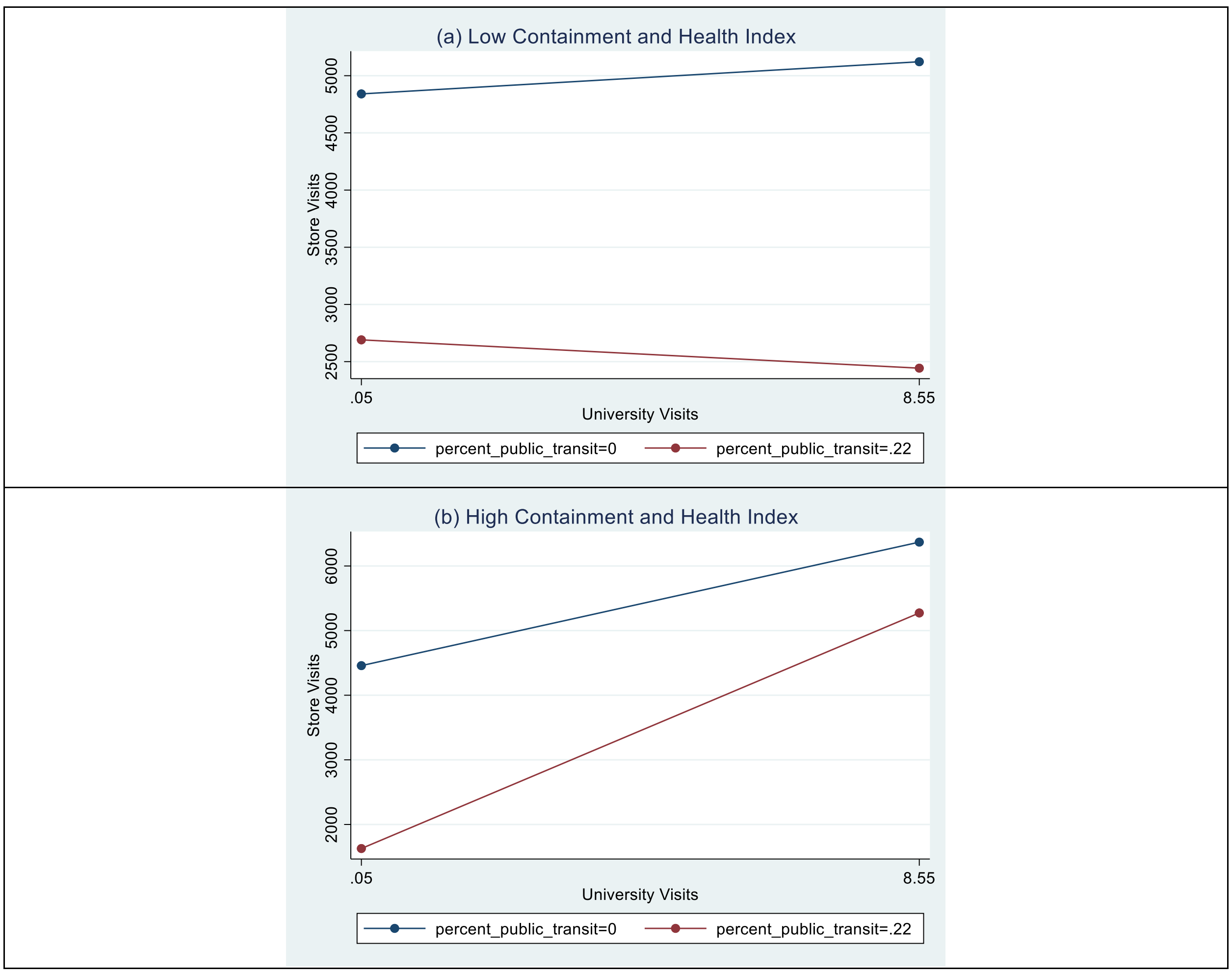

Figure 9: The effects of percent of public transit and university visits on store visits with respect to low-high containment and health index

5. Conclusion

In spite of the mixed effects of the measures employed, it is clear that change, for better or for worse, is widespread and has taken hold in college towns nationwide. While our paper remains limited by various factors, we focused on exploring two research questions of great significance; (1) how does the university footprint interact with spatial location and public transit in affecting the retailer footprint? And (2) how does the impact further change with government containment and health index during the pandemic? Our most significant findings are as followed; First of all, we determined the university footprints had a positive impact on store visits, distance to university had a negligible impact on store visits, and public transit percentage had a negative impact on store visits. However, another related point of interest is that the positive effect of university visits on store visits decreases as store-university distance increases but is not dependent on percent of public transit. Next, we find that the intensity of the containment and health index strengthens the negative effect exerted by store-university distance upon the positive correlation between university visits and store visits. Conversely, the effects of the university visits and percent of public transit on store visits does not vary with the containment and health index.

Our contributions span across a multitude of academic and practical domains. Firstly, on the academic side, our work expands trade area and spatial shopping literature as the study explores store footprint in college towns through a three-way interaction of university visits, trade area characteristics (travelling distance and commuting modes), and environmental variables (government containment and health index). Next, our study provides a new addition to studies on business in college towns (particularly in small to mid-sized college towns), which are again, scarce and limited in variety. Finally, from a methodology and application perspective, with the usage of big data analysis techniques on substantial data sets and being oriented towards the economic consequences of government policies during the pandemic, our findings can not only be valuable in aiding the post-pandemic recovery of commerce but also provide valuable experience for policymakers in understanding the economic consequence of public policy.

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