Households' Demand for Public Libraries

Anton Bekkerman[a] **and Gregory Gilpin**[b,*]

[a] Anton Bekkerman (anton.bekkerman@montana.edu) is an associate professor in the Department of Agricultural Economics and Economics at Montana State University–Bozeman, P.O. Box 172920, Bozeman, MT 59717-2920.

[b] Gregory Gilpin (gregory.gilpin@montana.edu) is an associate professor in the Department of Agricultural Economics and Economics at Montana State University–Bozeman, P.O. Box 172920, Bozeman, MT 59717-2920.

Both authors equally contributed to the development of the research and manuscript. Senior authorship is shared.

[*] **Corresponding author:** *306 Linfield Hall*
DAEE, Montana State University
P.O. Box 172920
Bozeman, MT 59717-2920
Ph: 406-994-5628
Fax: 406-994-4838

Households' Demand for Public Libraries

We combine three household-level datasets of public library use, status of children in public school, and home tax assessment values to provide a highly detailed panel analysis of public library demand. We find significant heterogeneity in how economic, school status, and distance characteristics affect households' library use. The data also show that public school breaks impact extensive and intensive library use behaviors, although these effects are not observed for households in the lowest socioeconomic quartile. Ultimately, we provide concrete evidence that differences in households' socioeconomic, school status, and geographic location can create both barriers and opportunities for effectively allocating public library resources.

Keywords: community, public libraries, public school, school break

JEL classification codes: H42, I42

Acknowledgments: This work was supported by the National Leadership Grants program administered by the Institute of Museum and Library Sciences, CDFA Number 45.312. We thank comments provided at the 2017 Federal Reserve System Community Development Research Conference, 2016 Association for Education Finance and Policy Annual Meetings, 2016 Southern Economics Association Annual Meetings, and 2016 Western Economic Association International Annual Meetings. All errors are our own.

1 Introduction

Public libraries serve 16,536 communities across the United States. With low monetary costs, almost any individual can obtain informational content across different mediums (printed, visual, audio) and participate in structured educational programming. Libraries are perhaps especially important resources for lower-income households and families with children. For example, data from the Public Library Survey indicate that 34% of content circulated by U.S. public libraries was material for children and 63% of all programming at public libraries targeted children (Institute of Museum and Library Sciences 2015). As such, along with sending their children to public schools, visiting public libraries and using their resources can be part of weekly or even daily routine for many families.

Despite the potential importance of public libraries to families, surprisingly little is known about factors that impact those families' decisions to use library resources and whether there is heterogeneity in these effects across the socioeconomic distribution. This study provides insights toward answering these questions. We combine unique household-level data on library use with information about whether households have children who attend public schools and the home tax value of those households. We also include data such as a household's distance to the library, weekly weather conditions, community events occurring near the library, and breaks in the academic calendar, all of which can affect patrons' decisions to visit and use a public library. The combined data represent over 10,000 households' weekly library use behavior between August 2013 and May 2015 for a public library in a Montana micropolitan city.

We use these data to model households' extensive and intensive measures of weekly library use. The data indicate that, on average, households visit the public library approximately once a month and check out about 1.5 items per week. However, households with a public school student check out nearly 40% more library items than those without a student and households in the lowest

socioeconomic status quartile are also the most active library users. Regression results provide additional insights about how these differences are influenced by various exogenous factors. For example, we find that higher precipitation levels have a greater impact on households with public school students for both the likelihood of visiting a library more often and increasing the number of checkouts. However, the results also show that while distance from the library and a household's relative income status have almost no impact on library use behaviors for households without a student, those with a public school student are substantially affected by these two factors.

In addition to investigating how socioeconomic and public school status characteristics impact households' library use behavior, we also assess the extent to which breaks in the public school calendar affect library use. Across all households with a public school student, the results show that there are significant increases in library visits and checkouts in weeks preceding a school break, and subsequent decreases during weeks that follow the break. The greatest changes are observed during the two-week period preceding the beginning and end of a school year. However, we also find that this variation in library use behavior is not observed for households in the lowest socioeconomic status quartile.

Our results provide two important interrelated insights. First, we present evidence that families increase their use of public libraries within school-year breaks, suggesting that public libraries may be viewed as complements to obtaining structured, directed educational content when it is not provided by public schools. Furthermore, we provide empirical evidence of differential library use across the socioeconomic spectrum. We find that lower socioeconomic status families do not use free, publicly available educational supplements at the same rate as higher socioeconomic status families during summer breaks, even though their overall library use is higher during the school year. The barriers to using libraries by lower socioeconomic families may be high opportunity costs and potential behavioral inertia. In these cases, municipal policies and initiatives by public

libraries, schools, and communities may be necessary to overcome those challenges and assist children in lower socioeconomic households to increase their public library use. Our findings that library demand is higher in weeks when organized community events occur in the vicinity of the library provide some evidence that targeted initiatives could be used to influence behavior.

2 Data Description

We combine three sets of data to characterize household-level weekly public library use, whether the household has children who attend public schools, and the tax value of the household's dwelling. These data are collected for households served by a public library and public school district in a Montana micropolitan area.[1] The U.S. Census Bureau defines a micropolitan area to have an urban core of between 10,000 and 50,000 people. A micropolitan area consists of one or more counties within which there is high degree of social and economic integration. In the micropolitan area for which we collect data, there is only one public library (with no bookmobiles or additional branches) and one school district. This implies that library use data for households within this area are not affected by borrowing materials at multiple locations and that patrons must physically visit the library to access library materials.[2]

2.1 Panel Library Use Data

The patron-level checkout records for nearly every Montana public library are centrally managed by the Montana State Library using the SirsiDynex software. Each individual library can

[1] For confidentiality, we do not provide the specific name of the location.

[2] Some library materials, such as ebooks and audiobooks, have become accessible remotely. However, the use of these materials remains small relative to the use of physical library materials. For example, in 2014, circulation of all electronic materials represented only 4.7% of the total circulation for the public library of interest. In the same year, only 56% of all U.S. public library systems had any electronic material circulation and of those, the circulation of electronic materials represented, on average, only 5.2% of total circulation (Institute of Museum and Library Sciences 2014). Therefore, patrons' demand for physical library materials represents the vast majority of public library use.

access information about their patrons' checkout histories using a web-based Director's Station application. This application generates reports that include each patron's residential address and historical counts of the number of items that the patron checked out since the inception of the account. For example, a report created on January 1, 2015 for patron i with a library account commencing on January 1, 2010 and a checkout history of 400 implies that between January 1, 2010 and 2015, the patron checked out a total of 400 items. Checked out items are primarily books, but also include audio and video materials, which account for a small proportion of overall check outs. Because each report provides a historical checkout count (i.e., the stock of checkouts), we calculate the number of media items checked out by each patron during each week (i.e., the flow of checkouts) by taking the difference between the number of checkouts in week t and those in week $t-1$ for each patron i.[3]

The script then aggregates the patron-level observations to the household level. This is done to reduce measurement error as families may regularly use the library but could check out materials under different family members' library cards. Using this process, we create weekly checkout data for each household using Director's Station reports generated every Tuesday between August 22, 2013 and May 19, 2015. All operations associated with cleaning, organizing, and geocoding weekly household-level data were performed at the public library using a computer script. Prior to making the final data available to researchers, the script removes all information that would allow for the identification of any specific household, replacing that information with a single randomly

[3]Patrons may check out items for a period of two to four weeks, depending on the type of media and demand. For example, newly acquired media may have a shorter period after which patrons must return the item or pay a late fee. For most items, patrons are allowed to renew once before returning the item to the library.

generated identification number.[4]

Some households in the data sample window never check out an item from the library. We remove these households to ensure sufficient household-level variation for the empirical analysis, restricting the dataset to only those who checked out at least a single item during the sample time window. The final panel describes 92 weeks of information about 10,168 households, represented by 560,247 unique observations. It should be noted that the panel is not perfectly balanced as new patrons enter and some exit when their library cards expire and they do not renew during the sample period.

2.2 Public School Attendance and Residential Property Value

Data about patrons' checkout behavior are particularly useful because they contain cardholders' residential address information. As such, we are able to link library use information with household-level characteristics about whether public school children live in a patron's household and with the tax value of a household's home.

First, we obtain a list of public school students' household addresses for each school year in our data. The data-sharing agreement with the local school district does not provide any other student-level characteristics, but for our purposes, their data were sufficient for determining which households could be classified as those with public school students. Additionally, because these data vary across school years, we can precisely identify whether households enter or leave the public school student classification depending on whether students enter or exit the public school system across academic years.

[4]The data do not provide information about specific titles or genres of the checked out items. Personal communications with American Library Association administrators indicated that this type of information is highly protected by public libraries to ensure confidentiality for their patrons. Additionally, while libraries collect information about patrons' use of other library services such as Internet use or children's programming, these data are only made available at the aggregate library level. Individuals are typically not required to use their library cards to access programming or Internet services and, therefore, this usage information is simply not available.

Next, we match each household record with property tax assessment values, which are publicly available from the Montana Cadastral system. Specifically, we geocode each household's address information to a longitude and latitude value. We then match each record to geospatial property location records in Cadastral using two criteria: a distance criterion that minimizes the distance between the geographic coordinates in both of the data sources and a fuzzy match criterion that matches the numeric and character values of each address. In this manner, we develop a reasonable proxy of household-level relative socioeconomic class based on property values. In cases when multiple patrons live at the same address (e.g., an apartment complex), each patron is associated with the proportional value of the property tax assessment (e.g., for a duplex, each resident is assigned half of the property value). Home values are provided in 2014 dollars.

2.3 Additional Factors Affecting Library Demand

In modeling household-level library demand, we consider additional factors that are exogenous to any specific household but that could affect their weekly library use behavior. Specifically, we focus on four such factors that are systematic and measurable: a household's distance from the public library, weather characteristics (temperature and precipitation), public community events that are unrelated to the library but which occur near the library, and breaks during the public school academic calendar.

A household's distance from a public library can be interpreted as a proxy for a household's relative cost to visit and check out library materials. Palmer (1981), Hayes and Palmer (1983), Japzon and Gong (2005), Sin and Kim (2008), and Bhatt (2010) show that distance is, on average, negatively associated with households' library demand. As such, we calculate the distance between each household in the data and the public library. Because micropolitan areas are less densely populated, traffic congestion is minimal and, as such, each household's distance to the public

library is proportional to the transportation costs the household would incur to visit the library.

Weather data are obtained from the U.S. National Oceanic and Atmospheric Administration and represent weekly average temperatures (measured in Fahrenheit) and precipitation (measured in inches) in the micropolitan area. To account for community events—which occur in the city's downtown core area and are within one mile of the public library—we collect information about the number of downtown events listed in the local municipal online calendar.[5] We exclude any events that were hosted by the public library.

Lastly, we determine school breaks using the academic calendar for the micropolitan area's public school district. The public library lies entirely in a single school district, implying that all public schools follow the same school-year schedule.[6] During the sample time window, we define school breaks as any period of two or more consecutive weekdays during which all primary and secondary public schools in the school district are closed, as specified by the school district's calendar.[7]

The 2013–14 school year began on August 29, 2013 and ended on June 10, 2014, during which there are four breaks: fall break (October 17–18), Thanksgiving break (November 27–29), winter break (December 23–January 3), and spring break (March 10–14). The summer break occurred between June 10 and September 2, 2014. The 2014–15 school year began on September 2, 2014 and ended on June 11, 2015, during which there are the same four breaks: fall break (October 16–17), Thanksgiving break (November 26–28), winter break (December 22–January 2), and spring break (March 9–13). The summer break occurred between June 11 and August

[5]The one-mile radius is chosen because it represents the approximate boundary of the downtown core area, within which most community events occur and within which the library is located.

[6]There is a limited number of private schools who all followed the local public school district's academic calendar during the sample time period.

[7]Early releases and other very short breaks during which students are required to attend at least part of the day are not considered. There are no breaks due to inclement weather or other reasons during the 2013–14 and 2014–15 school years.

31, 2015. School breaks during the school year represent 10.8% of the weekly observations in our sample, the summer break represents 28.3%, and weeks during which school is in session represent the remaining 60.9%.

2.4 Generalizability of Sample

One concern with these data is that the library and micropolitan area for which we obtained data are unique and may not be representative of other communities in the United States. To assess the extent to which our empirical analyses could be generalizable to public libraries and communities across the United States, we use propensity score matching (PSM) to identify other libraries and communities based on a number of key characteristics. To compare public libraries, we use the most recent 2014 Public Libraries Survey data, which are collected by the Institute of Museum and Library Services (IMLS) and represent an annual census of all U.S. public libraries. By comparing the location from which our data are generated both to other communities and to other public libraries across the United States, we are at least partially able to draw inferences about the extent to which our data can help characterize U.S. communities with similar preferences and delivery of services tied to public libraries.[8]

The PSM model is estimated based on libraries' total population of the service area; number of registered patrons; total library visits; circulation of all library materials; circulation of children's materials; total collection of books, audio, and video resources; and the total number of librarians and staff. To compare communities, we use the 2015 five-year average American Community Survey data, collected by the U.S. Census Bureau. We compare communities at the ZIP code level based on percent of the population employed, median household income, median home value,

[8]Ideally, data similar to those described above would be collected for every public library and community to provide direct comparisons. However, such efforts would require major resources and may still not fully capture the 8,373 public library service areas. Moving toward developing such datasets is, therefore, out of the scope of this study, but presents a fruitful opportunity for future research.

percent of the population with at least a bachelor's degree, and percent of households with at least one child. Because the micropolitan area in this study is also characterized by a predominately white population, we also consider how the inclusion of a variable that describes the proportion of the population that is white affects the PSM analysis. For both the library and community PSM assessments, any location that is estimated to have at least a 50% probability of a match is assumed to be sufficiently similar to the library and community in this study.

Figures A1(a) and (b) of the Appendix provide a visual representation of public libraries and communities, respectively, that are estimated to be similar to the public library and community in our study. Figure A1(a) shows that despite the library in this study being in Montana, its service-area characteristics, collection size, and circulation rates are more closely aligned with mostly urban and suburban public libraries that serve more densely populated communities. In Figure A1(b), the dark dots represent communities that are similar after controlling for all characteristics including the proportion of the population that is white. The lighter dots represent additional communities estimated as being similar if no controls for population race are included in the PSM model. Both the public library and community PSM results indicate that there do not appear to be pronounced spatial biases or patterns that would suggest that the library and community in our study may be unrepresentative of many other communities across the United States. In fact, 79% of communities identified as being similar in the PSM analysis were classified as either metropolitan or micropolitan statistical areas in the 2010 U.S. Census.

2.5 Data Summary

Table 1 shows the descriptive statistics for the variables in the empirical analysis. We present the data in subsamples to demonstrate the potential differences between households with and without public school children. The data show that both types of households check out at least

one item during a four-week period. However, the mean number of checked out items per week is approximately 0.50 items higher for households with a public school student than for households without school children. Additionally, households with students are also, on average, approximately two miles closer to the public library. However, the average home tax values between households with and without students is nearly identical.

Figure 1 presents a time series of average active visits and checkouts across the weeks in our sample. First, the figure shows that households with students consistently visit the public library more often and check out more items than households without students. This consistent behavior is observed throughout each year, despite seasonal variation. Second, the figure provides initial evidence that there may be systematic differences in library demand associated with the public school calendar. For example, Figure 1(a) shows that while both groups exhibit increases in library visits during weeks when holidays occur, those increases are somewhat larger for households with students. Moreover, the difference in library visits between the two types of households is at its highest throughout weeks that correspond to the summer school break, potentially suggesting that public libraries may serve as substitutes for schools during these periods. Figure 1(b) also shows that households with students increase the number of checked out items during the summer school break, while households without students maintain a relatively flat demand throughout the year.

3 Library Demand Model

We empirically estimate variation in public library demand by modeling extensive and intensive measures of weekly household-level public library use. The baseline model for a household's demand for library materials, D_{it}, by household i during week t is defined as

$$D_{it} = \beta_0 + \beta_1 \mathrm{H}_{i,t-z} + \boldsymbol{\beta_2} \mathbf{C}_t + \beta_3 M_i + \beta_4 V_i + \beta_5 S_i + \delta_i + \delta_m + \delta_y + \varepsilon_{it} \tag{1}$$

We estimate the demand for library materials using both an extensive and intensive measure of D_{it}: active visits (whether the household checked out at least one item during week t) and total checkouts in week t. The term $\mathrm{H}_{i,t-z}$ represents the number of times household i visited the library to check out items within the previous four weeks, which we use as a measure of potential habit formation that patrons may develop in response to library return and renewal policies. The four-week period is chosen because the library in this study requires that most media be returned or renewed within four weeks of checkout. The data also suggest that patrons have substantial habit formation in the number of items they check out from week to week. Vector $\mathbf{C}_t$ represents week-varying, community-level characteristics (i.e., number of community events, temperature, and precipitation), the terms δ_m and δ_y are month and school-year fixed effects that control for seasonal and yearly variation in library demand, and ε_{it} is the idiosyncratic error term.

Equation (1) represents two household-level specifications. We first characterize households using their fixed characteristics (thus excluded household-level fixed effects). These include M_i, the household's distance (in miles) from the library, V_i, the natural log of the tax assessed value of the household's home, and S_i, an indicator variable of whether the household has children attending a public school. Second, we instead include a household fixed effects, δ_i, and omit fixed household characteristics. While including the fixed effects reduces the estimation insights, they make the model particularly powerful. These variables control for unobserved fixed heterogeneity associated with each household, including those we explicitly model in equation (1) as well as other factors such as education level, preferences toward public libraries, and other time-invariant characteristics that cannot be measured but can influence library use decisions. Typically, selection issues may bias estimates; household fixed effects, however, substantially attenuate bias arising

from selection.[9]

The active visits models are estimated using a linear probability estimator with heteroskedasticity-robust standard errors. Household checkouts are a count variable, which we estimate using a Poisson estimator. Due to the complex covariance matrix structure of a fixed-effects Poisson estimator, we estimate standard errors using a 500 replication bootstrap.

3.1 Baseline Model Estimation Results

Table 2 presents estimates of the model measuring library demand based on active visits and Table 3 are the estimates for the checkouts model. For both the extensive and intensive measures, we present results for all households in the sample as well as subsamples based on whether a household has a student attending a public school. Within the full sample and two subsamples, Models 1 and 4 are estimated without household fixed effects and Models 2 and 3 include fixed effects.

Across all active visit models presented in Table 2, the habit formation variable is statistically significant regardless of whether household fixed effects are also included, although their inclusion does dampen the magnitude of the estimated coefficient. This suggests that households' library visitation behaviors may not only be attributable to a specific household's library use, but also households' history of library demand. That is, a library visits in the past four weeks increases the probability of visiting the library this week by 17.2 percent. This probability diminishes to 8.5% when the household's entire library history is considered; that is, after estimating the model that

[9]Our data contain individual-level information for each library card holder. However, when multiple individuals from the same household have separate cards, these individuals may interchangeably use different cards to check out library materials. For example, during one week, a parent uses to check out books for the entire household, including books for children in that household. The following week, a child from the same household uses their card to check out materials. Because we are unable to observe specific information about checked out materials and do not find consistent patterns in which individuals within a single household use their library cards interchangeably, we instead aggregate and use household-level data. Regression analyses using individual data result in similar statistical significance and estimated signs as household-level models, but individual-level regressions are more noisy.

includes household fixed effects.

Additionally, results of Models 3 and 4 indicate that a larger number of public events occurring near the public library tend to increase the likelihood of a library visit. This suggests that there are potential spillover effects and possible opportunities for public libraries to increase awareness and use of library materials through marketing efforts at such events. However, these effects appear to be greater for increasing demand by households without a public school student. Average temperature does not affect the library visit probability, but higher precipitation during a week substantially increases the likelihood of a visit by all households, with larger effects on households with a public school student. This suggests that when alternative outdoor activities (e.g., after-school athletics; other leisure activities and hobbies) may be limited due to inclement weather, these households' demand for public libraries increases.

Results in Model 4 of Table 2 also show that households' distance to the library and income level (using household's home value is a proxy) are both negatively associated with the likelihood of a weekly library visit. That is, households that incur higher costs to visit a library and those that are more affluent are less likely to visit the library as frequently as those that are closer or poorer. Additionally, these marginal effects are greater for households with a public school student, suggesting that heterogeneity of access to public libraries for these households is likely to be higher across the income and housing distributions. Lastly, Model 4 for the "all households" sample shows that, as expected, households with a public school student are more likely to visit a public library than households without a student.

Estimates of total checkouts in Table 3 provide generally similar insights as those associated with library visits. There are, however, three differences of note. First, both the statistical significance and magnitude of the habit formation variable is consistent across all four specifications and three subsamples, regardless of whether household fixed effects are explicitly

included in the model. This suggests that households' intensive measure of library demand is more aptly described by their historical borrowing patterns rather than characteristics specific to any particular household. Second, distance to the library appears to be a factor only for households with public school students, while the likelihood of checking out more or fewer items by households without a student is insensitive to that household's geographical location. Finally, the results show that, on average, there are no discernible differences in library checkouts associated with a household's home value. While the coefficient of home value is always negative, it is statistically insignificant at conventional levels.

3.2 Robustness Analyses

We conduct several robustness analyses to determine the sensitivity of our estimation results to various specification changes. First, we estimate the full models described above using eight different household habit-formation variables. Each of the eight specifications is estimated separately for the active visits and the circulation measures of library demand and across the three samples of households. The eight competing habit-formation variables include one- to four-week lags of active visits and lagged circulation. Table A1 in the appendix presents the estimation results for these alternative specifications. The results show that the habit-formation variable is always statistically significant in explaining library demand and there is minimal variation in parameter magnitudes. However, models with the habit-formation variable specified using the numbers of active visits in the previous four weeks always result in the highest model fit.

The second robustness analysis considers changes to the Poisson estimator. That is, we estimate the fully specified library demand model using ordinary least squares. Table A2 presents the estimated OLS parameters for the circulation model using the all household sample. The estimated marginal effects are largely consistent with those in the Poisson specification. However, the log-

likelihood value for the Poisson estimator is substantially larger than that of the OLS estimator, suggesting that the Poisson model is a more appropriate estimator.[10]

Lastly, the micropolitan area for which the sample is collected includes a university. To determine whether our analysis is affected by behaviors of patrons who are also likely to be college students, we re-estimate the fully specified models of active visits and circulation using a subsample that omits the Census tract that includes the university. Table A3 shows that the estimation results for this subsample are nearly identical to those in the analysis that includes all households. This is likely because university students more frequently use the nearby university library, which maintains a much more specialized collection and is more relevant to courses and research conducted at the institution. Additionally, the population of public library members who reside within the Census tract that includes the university represents only 1.5% of households in our sample.

4 Impacts of Socioeconomic Status and Distance

An important research question that these data provide an opportunity to investigate is the extent to which public library use differs across households' distance to the library and socioeconomic status. Because public libraries are so widely accessible by individuals who live in highly heterogeneous communities, understanding how library demand differs across these communities could help libraries to better target and allocate resources. Furthermore, it can provide opportunities to reduce potential library access inequities across socioeconomic classes, especially

[10]We also consider modeling the data using a negative binomial estimator. However, we have reservations about the appropriateness of using this model. First, there is relatively modest evidence of overdispersion. In such cases, the negative binomial model is less robust to distributional misspecification than the Poisson and may be inconsistent even if the conditional mean is correctly specified in the maximum likelihood estimator (Cameron and Trivedi 2005, 2009). Additionally, Wooldridge (2010) shows that the fixed effect Poisson estimator has very strong robustness properties for estimating the parameters in the conditional mean. Moreover, Wooldridge (1999) demonstrates that the fixed-effect panel Poisson estimator is consistent under only the conditional mean assumption.

in urban and suburban settings where such separation can often occur as a result of households' differential mobility and school choice opportunities. Such segregation has been shown to reduce learning outcomes regardless of students' socioeconomic class (for example, see Gurin et al. 2002; Borman et al. 2004; Rumberger and Palardy 2005).

Despite the potential benefits of increasing equity in public library access across socioeconomic characteristics, there is little empirical information about the extent to which differences in library use exist across socioeconomic status and physical distance to a library. Understanding these differences—within the context of supplemental education benefits—can help better design and direct policies that seek to reduce differential public library use behaviors. As such, we assess for differences in library demand during school breaks using household-level home tax assessment values and households' distance to the library.

Figure 2 shows weekly active visits and checkouts across our data sample for households in lowest and highest socioeconomic quartiles. The figure makes evident that households in the lowest quartile of home values consistently visit the library more frequently and check out more materials than households in the highest socioeconomic quartile. Table 4 presents more detailed summary statistics of active visits and checkouts across both home value quartiles and distance to the library. The data indicate that regardless of a households' distance to the library, households in the lowest socioeconomic quartile, on average, visit the library more frequently and check out more books per week. This distinction is particularly visible for households within two miles of the public library, but tends to almost fully dissipate for households that are not within walking distance of the library. Furthermore, the distinctions across households' distance and socioeconomic status are of greater magnitude for households that have a public school student.

The unconditional data suggest that there may be important distinctions and interactions among households' geographical access to the library, socioeconomic class, and public school status. As

such, we formally assess these potential differential effects by extending the model in equation (1) by adding household's distance to library indicator variables and estimating these models for three home value subsamples: the lowest quartile, second and third quartiles, and the highest quartile. Similar to the baseline models, we estimate these specifications across all households, for households without a public school student, and those with a student.

Table 5 presents the results of active visits and checkout models of library demand across socioeconomic and household distance indicators. For the active visits models, the broad insights are that households without a public school student are particularly sensitive to distance, but this sensitivity is substantially dampened for households with a public school student. For the former group of households, living farther away from the public library tends to be associated with a lower frequency of library visits. Additionally, this behavior is strongest among households in the lowest socioeconomic quartile, suggesting that transportation costs for these households may be the most binding. The negative relationship between visits and distance is also evident for the highest socioeconomic quartile, perhaps indicating the ability of these households to simply privately acquire materials that are available at a public library. Households in the middle two socioeconomic status quartiles appear to be insensitive to distance, suggesting that these households may still obtain a higher return to using public library materials relative to the transportation costs they incur to acquire those materials.

For households with a public school student, households that live within a mile of the public library are more likely to visit, with the largest increases by those in the lowest socioeconomic quartile. This positive differential effect dissipates for households located farther away, but, with the exception of the middle socioeconomic group, does not seem to attenuate visitation likelihood. This suggests that for households with students, higher transportations costs are not necessarily a deterrent in the same way that they are for households without students.

Results for the checkouts models of library demand show distance is much less a factor in the intensity of library use. For households without public school students, only checkouts for those in the highest socioeconomic quartile are negatively affected by distance to the library. And only the lowest socioeconomic quartile households that are between 0.5 and 1.0 miles are positively affected. When combined with insights from the active visits models, these results suggest that distance from the library is likely to affect the decision to visit the library, but once the decision is made, the overall demand for library materials is not particularly sensitive to the household's relative location.

5 Library Demand Across Breaks in the School Calendar

Families are provided with a school calendar well in advance of the school year and know when school breaks occur. As such, it is conceivable that households with public school students may change their behavior toward visiting and checking out library materials before or after breaks. For example, a family may skip visiting the library after a break as they already have library items, or may check out library materials a week before a school break in anticipation of having to provide children with educational materials during the school break. We empirically investigate the potential impacts of school break timing to assess the degree to which inter-temporal substitution occurs between weeks.

We use the fully specified models of active visits and checkouts represented by equation (1) and add lag and lead variables to characterize household-level library use behavior before, during, and after school breaks. Specifically, we assess two-week pre- and post-school break effects by including five school-year break indicators: $\{\text{Schl\_brk}_{t-2},\ \text{Schl\_brk}_{t-1},\ \text{Schl\_brk}_{t},\ \text{Schl\_brk}_{t+1},\ \text{Schl\_brk}_{t+2}\}$. Due to the substantial length of the summer break, using a similar time indexing approach would not provide useful insights.

Instead, we test whether differential impacts exist across two distinct time periods associated with the summer break: a two-week period immediately following the end of the school year, and a two-week period immediately preceding the beginning of the school year. This delineation provides an ability to test for differential impacts associated with the availability of competing non-school activities.[11] Finally, we include indicator variables for four specific breaks during the school year: October (fall) break, Thanksgiving (November) break, Christmas (December) break, and spring (mid-March) break.

Table 6 presents the regression results of the library demand models for all households in the sample with a public school student and households with students who fall into the lowest socioeconomic quartile. The results indicate that, on average across all households with public school students, both the likelihood of a visit and the intensity of checkouts increases during periods leading up to a break that occurs within a school year. However, during the school-year break and for one and two weeks after, visitation and checkouts are more likely to be lower than during other weeks throughout the academic calendar year. This suggests that households seem to increase their demand and even build up an inventory of library materials for use during a school break, and these additional stocks affect households' library use for a significant amount of time after the break.

A similar pattern is observed during the two weeks following the end and the two weeks preceding the beginning of a school year. These increases in active visits and checkouts are substantially larger than those observed during the within-school year breaks, which could indicate a higher degree of substitution between public schools and libraries. That is, during the summer

[11] For example, during the summer, families may have higher opportunity costs of using public libraries because they are more likely to take family vacations, place children into camps, or participate in outdoor recreational events. However, because many of these activities may not begin immediately following a school year and do not immediately precede the beginning of a new academic year, differential school break effects on library demand may occur during these intermediate periods. These effects could be veiled if the entire summer break is considered as a single school break period.

break shoulder seasons, households with public school children may not yet be engaging in activities such as family vacations, camps, and others. However, because public schools have not yet started, these households are likely to substitute toward public library resources. Lastly, we find that the largest impacts on active visits and checkouts occur during the October and Thanksgiving breaks, with no tangible differences in library demand during the Christmas and spring breaks.

In contrast to the overall results for households with public school students, those households that fall into the lowest home value quartile has distinctly different behaviors. In fact, these households appear to only alter their behavior in the lead-up to a school-year break, but there are no statistically significant differences in library demand behaviors during other parts of the year. This suggests that these households may have a high degree of behavioral inertia and/or constraints that result in highly consistent library use outcomes throughout the calendar year. While it is plausible and likely probable that individuals understand the potential benefits of using public libraries as supplemental education instruments (i.e., it is unlikely that individuals simply do not know that public libraries provide educational resources), households are less likely to change their behaviors to take advantage of library resources during school breaks when they are already large consumers of library materials and/or there are high opportunity costs of altering those behaviors.

For example, the data indicate that households in the lowest socioeconomic quartile are already the largest consumer of library materials. As such, changes in the academic calendar and other external factors may not be sufficient to alter their behaviors on the margin. Additionally, for lower socioeconomic status households, altering daily routines may be more costly (e.g., inflexible work schedules, high adverse income effects of not attending work) than for higher socioeconomic families. Our empirical results suggest that somewhere between the first and second socioeconomic indicator quartiles, the opportunity costs become sufficiently lower (i.e., cross a threshold) such

that families become more likely to use public libraries during school-year breaks.[12]

6 Discussion

We use an information-rich, patron-level longitudinal dataset to empirically evaluate households' extensive and intensive uses of public library resources. The data provide important insights about households' use patterns across numerous dimensions that are likely to impact visitation and checkout decisions. Our results show that there is substantial heterogeneity in these decisions across households' socioeconomic characteristics, relative costs for visiting a library, and the presence of a student in the household. We find that while there are important differences across socioeconomic status and households' relative distance for patrons who do not have a public school student in the household, many of those differences are not observed for households with students. This suggests that the relative perceived (and likely observed) benefits from library materials derived by households with students largely outweigh the costs of visiting a library.

These results also provide suggestive evidence that libraries could provide important venues for student interactions across geographical and socioeconomic divides that may exist across public schools. That is, while students may attend different schools based on the geographical location of a household (which may be largely determined by households' socioeconomic status), our results indicate that such factors are not large determinants of households' decisions to visit and use public library resources. As such, libraries can act as a conduit to increasing atypical peer interactions that have been shown to have significant learning benefits across a wide distribution of students. Undoubtedly, further research is needed to directly link library

[12] It is certainly possible that a portion of the lower socioeconomic population participates in other summer programs, which could act as substitutes for attending the library. However, for the area of study, there is little evidence of either these possibilities. There are few summer camp opportunities, and costs for those that are made available by the municipality are between $245 and $350 per week (which likely represents a substantial portion of disposable income for lower SES patrons). In summer programs for which costs are subsidized, enrollment is limited and the demand far out paces available openings.

use behaviors with educational outcomes, but our work is the first to provide highly detailed insights about the degree of heterogeneity that exists across households with different school status characteristics, socioeconomic status, geographic constraints, and timing of school-year breaks. Our results provide important counsel that any future research in this area must carefully consider distributional differences rather than focusing only on average effects.

In addition to the research insights of this work, the results also offer practical guidance for developing strategies to increase the demand and use of their resources. Specifically, libraries can engage in "pull" initiatives that directly market the benefits of library use to households and "push" campaigns that nudge patrons to alter their extensive and intensive demands. Two examples of "pull" initiatives by public libraries might include mobilizing library resources—such as bookmobiles that travel to different locations in a community to provide more limited library resources and programs—and/or establishing increased promotion of library programs (or even temporary branches at targeted public schools) during summer breaks.

"Push" initiatives may provide additional cost-effective methods for using established infrastructures to encourage public library use. For example, public schools can increase informational campaigns about local library materials and programs in weeks preceding a school break and with intermittent electronic communications throughout a summer break. Such "push" strategies that encourage human capital accumulation would be akin to nudges that have been shown in the behavioral economics literature to be successful in increasing financial accumulation in savings and retirement accounts and health outcomes (for example, see Thaler and Benartzi 2004; Blumenthal-Barby and Burroughs 2012; Liu et al. 2014). Our empirical results suggest that such "push" campaigns may be particularly useful during public community events. That is, evidence of positive spillover effects between public events and library use could potentially be leveraged to increase community-based investments to expand the use of library resources.

References

Bhatt, R. 2010. "The impact of public library use on reading, television, and academic outcomes." *Journal of Urban Economics* 68:148 – 166.

Blumenthal-Barby, J., and H. Burroughs. 2012. "Seeking Better Health Care Outcomes: The Ethics of Using the Nudge." *The American Journal of Bioethics* 12:1–10.

Borman, K., T. Eitle, D. Michael, D. Eitle, R. Lee, L. Johnson, D. Cobb-Roberts, S. Dorn, and B. Shircliffe. 2004. "Accountability in a postdesegregation era: The continuing significance of racial segregation in Florida's schools." *American Educational Research Journal* 41:605–631.

Cameron, C., and P. Trivedi. 2005. *Microeconometrics: Methods and Applications*. Cambridge university press.

—. 2009. *Microeconometrics Using Stata*, vol. 5. Stata press College Station, TX.

Gurin, P., E. Dey, S. Hurtado, and G. Gurin. 2002. "Diversity and higher education: Theory and impact on educational outcomes." *Harvard educational review* 72:330–367.

Hayes, R., and S. Palmer. 1983. "The effects of distance upon use of libraries: case studies based on a survey of users of the Los Angeles Public Library–Central Library and Branches." *Library research* 5:67–100.

Institute of Museum and Library Sciences. 2014. "Public Libraries Surveys." https://www.imls.gov/research-evaluation/data-collection/public-libraries-survey/explore-pls-data/pls-data, last accessed February 2017.

—. 2015. "Public Libraries Surveys." https://www.imls.gov/research-evaluation/data-collection/public-libraries-survey/explore-pls-data/pls-data, last accessed February 2017.

Japzon, A., and H. Gong. 2005. "A neighborhood analysis of public library use in New York City." *Library research* 75:446–463.

Liu, P., J. Wisdom, C. Roberto, L. Liu, and P. Ubel. 2014. "Using Behavioral Economics to Design More Effective Food Policies to Address Obesity." *Applied Economic Perspectives and Policy* 36:6.

Palmer, S. 1981. "The effect of distance on public library use: a literature survey." *Library research* 3:315–354.

Rumberger, R., and G. Palardy. 2005. "Does segregation still matter? The impact of student composition on academic achievement in high school." *Teachers college record* 107:1999.

Sin, S., and K. Kim. 2008. "Use and non-use of public libraries in the information age: A logistic regression analysis of household characteristics and library services variables." *Library & Information Science Research* 30:207 – 215.

Thaler, R., and S. Benartzi. 2004. "Save More Tomorrow: Using Behavioral Economics to Increase Employee Saving." *Journal of Political Economy* 112:S164–S187.

Wooldridge, J. 1999. "Distribution-Free Estimation of Some Nonlinear Panel Data Models." *Journal of Econometrics* 90:77–97.

—. 2010. *Econometric Analysis of Cross Section and Panel Data*. MIT press.

Table 1: Descriptive Statistics

	Mean	Std. Dev.	Minimum	Maximum
Households without students				
Dependent Variable				
Active Visits (per week)	0.25			
Checkouts (per week)	1.29	3.17	0.00	20.00
Independent Variables				
Distance to Library (miles)	4.73	4.65	0.07	40.79
Home Tax Value ($10,000s of 2014 dollars)	37.79	46.07	0.01	1,830
Number of Downtown Events (per week)	2.70	1.95	0.00	9.00
Temperature (degrees Fahrenheit)	48.06	18.17	4.14	81.29
Precipitation (inches per week)	0.37	0.36	0.00	1.66
Household-Week Observations		370,668		
Households with students				
Dependent Variable				
Active Visits (per week)	0.27			
Checkouts (per week)	1.80	3.98	0.00	20.00
Independent Variables				
Distance to Library (miles)	2.88	2.14	0.13	21.17
Home Tax Value ($10,000s of 2014 dollars)	37.59	40.73	0.08	1,040
Number of Downtown Events (per week)	2.70	1.95	0.00	9.00
Temperature (degrees Fahrenheit)	48.06	18.17	4.14	81.29
Precipitation (inches per week)	0.37	0.36	0.00	1.66
Proportion of Weeks for School-year Breaks	0.13			
Proportion of Weeks for Summer Break	0.15			
Household-Week Observations		189,579		

Notes: "Active Visits" are equal to 1 if a patron is observed to have checked out at least one item from the library during a week.

Table 2: Estimates of the Baseline Library Active Visits Model, All Households and By School Status

	All Households				HHs w/o Public School Student				HHs w/Public School Student			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Active visits in past four weeks	0.172***	0.084***	0.085***	0.172***	0.171***	0.086***	0.087***	0.171***	0.174***	0.080***	0.080***	0.174***
	0.000	(0.001)	(0.001)	0.000	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Num. Downtown Events			0.003***	0.004***			0.003***	0.004***			0.002***	0.003***
			0.000	0.000			0.000	0.000			(0.001)	(0.001)
Average Temperature			-0.000***	-0.000***			-0.000***	-0.000***			-0.000*	-0.000***
			0.000	0.000			0.000	0.000			0.000	0.000
Total Precipitation			0.014***	0.027***			0.011***	0.024***			0.020***	0.035***
			(0.002)	(0.002)			(0.002)	(0.002)			(0.003)	(0.003)
Distance to Library				-0.001***				-0.001***				-0.003***
				0.000				0.000				0.000
Log(Home Value)				-0.001***				0.000				-0.004***
				(0.001)				(0.001)				(0.001)
HH w/Pub. School Student				0.006***				—				—
				(0.001)								
Individual Fixed Effects	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No
Month Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	560,247	560,247	560,247	560,247	370,668	370,668	370,668	370,668	189,579	189,579	189,579	189,579
Log Pseudo-likelihood	-276,678	-193,982	-193,971	-276,257	-179,553	-125,029	-125,020	-179,299	-96,950	-68,551	-68,544	-96,807

Notes: The abbreviation HH refers to household. Number of downtown events are functions organized by the municipality and occur within one-mile of the public library. Average weekly temperatures are measured in degrees Fahrenheit and total weekly precipitation is measured in inches. Home values are the state-assessed property tax value. Distance from a household to the library is measured in miles. Values in parentheses are estimated heteroskedasticity-robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Full results available on request.

Table 3: Estimates of the Baseline Library Checkouts Model, All Households and By School Status

	All Households				HHs w/o Public School Student				HHs w/Public School Student			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Active visits in past four weeks	0.299***	0.292***	0.293***	0.301***	0.321***	0.313***	0.315***	0.323***	0.260***	0.253***	0.255***	0.262***
	(0.010)	(0.006)	(0.006)	(0.010)	(0.012)	(0.007)	(0.007)	(0.013)	(0.015)	(0.009)	(0.009)	(0.015)
Num. Downtown Events			0.020***	0.021***			0.023***	0.023***			0.017***	0.017***
			(0.002)	(0.002)			(0.003)	(0.003)			(0.003)	(0.003)
Average Temperature			0.000	0.000			0.000	0.000			0.000	0.000
			0.000	0.000			0.000	0.000			(0.001)	(0.001)
Total Precipitation			0.047***	0.048***			0.035***	0.036***			0.063***	0.064***
			(0.010)	(0.010)			(0.012)	(0.012)			(0.016)	(0.016)
Distance to Library				-0.008*				-0.002				-0.022*
				(0.004)				(0.004)				(0.012)
Log(Home Value)				-0.013				-0.012				-0.003
				(0.028)				(0.037)				(0.054)
HH w/Pub. School Student				0.101				—				—
				(0.063)								
Individual Fixed Effects	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No
Month Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	560,247	560,247	560,247	560,247	370,668	370,668	370,668	370,668	189,579	189,579	189,579	189,579
Log Pseudo-likelihood	-950,490	-911,384	-911,161	-950,213	-579,671	-553,884	-553,737	-579,520	-369,711	-355,954	-355,866	-369,618

Notes: The abbreviation HH refers to household. Number of downtown events are functions organized by the municipality and occur within one-mile of the public library. Average weekly temperatures are measured in degrees Fahrenheit and total weekly precipitation is measured in inches. Home values are the state-assessed property tax value. Distance from a household to the library is measured in miles. Values in parentheses are estimated heteroskedasticity-robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Full results available on request.

Table 4: Average Active Visits and Checkouts by Distance from Library, Home Value, and School Status

		Active Visits per Week											
		All Households, by Home Value				*HH w/o Pub. School Student , by Home Value*				*HHs w/Pub School Student , by Home Value*			
		All	Low	Middle	High	All	Low	Middle	High	All	Low	Middle	High
Dist. to Library	All	0.22	0.22	0.22	0.21	0.21	0.21	0.21	0.20	0.23	0.24	0.23	0.23
	Less than 0.5 miles	0.25	0.27	0.23	0.24	0.25	0.28	0.22	0.25	0.24	0.24	0.25	0.23
	0.5 to 1 mile	0.24	0.26	0.24	0.23	0.21	0.22	0.22	0.20	0.31	0.35	0.29	0.31
	1 to 2 miles	0.23	0.23	0.24	0.22	0.22	0.22	0.23	0.20	0.26	0.26	0.25	0.26
	2+ miles	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21
		Checkouts per Week											
		All Households, by Home Value				*HH w/o Pub. School Student, by Home Value*				*HH w/Pub. School Student, by Home Value*			
		All	Low	Middle	High	All	Low	Middle	High	All	Low	Middle	High
Dist. to Library	All	1.25	1.32	1.25	1.18	1.11	1.14	1.13	1.03	1.53	1.74	1.48	1.48
	Less than 0.5 miles	1.34	1.43	1.31	1.30	1.29	1.41	1.15	1.41	1.45	1.49	1.57	1.06
	0.5 to 1 mile	1.36	1.60	1.28	1.22	1.04	1.04	1.09	0.92	2.13	3.17	1.73	1.90
	1 to 2 miles	1.33	1.45	1.31	1.22	1.11	1.23	1.11	0.93	1.76	1.87	1.69	1.77
	2+ miles	1.20	1.19	1.22	1.15	1.10	1.10	1.14	1.04	1.38	1.43	1.36	1.38

Notes: The abbreviation HH refers to household. "Low" refers to households that fall into the lowest quartile of home tax value, "Middle" represents the second and third home value quartiles, and "High" is the highest home value quartile. "Active Visits" are equal to 1 if a patron is observed to have checked out at least one item from the library during a week.

Table 5: Estimates of Distanced-Based Library Demand Models by Households' School Status and Home Value

Active Visit Models

		All Households, by Home Value				*HH w/o Pub. School Student, by Home Value*				*HH w/Pub. School Student, by Home Value*			
		All	Low	Middle	High	All	Low	Middle	High	All	Low	Middle	High
Distance to Library	0.5 to 1 mile	-0.001	-0.002	0.002	-0.004	-0.011***	-0.019***	-0.001	-0.020***	0.022***	0.038***	0.011*	0.028***
		(0.003)	(0.005)	(0.004)	(0.005)	(0.003)	(0.006)	(0.004)	(0.006)	(0.005)	(0.009)	(0.006)	(0.010)
	1 to 2 miles	-0.004*	-0.011**	0.001	-0.008	-0.008***	-0.021***	0.003	-0.019***	0.004	0.011	-0.002	0.011
		(0.002)	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.006)	(0.004)	(0.007)	(0.005)	(0.009)
	2+ miles	-0.014***	-0.022***	-0.010***	-0.015***	-0.016***	-0.030***	-0.005	-0.019***	-0.012***	-0.006	-0.018***	-0.006
		(0.002)	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.006)	(0.004)	(0.007)	(0.005)	(0.008)
	Observations	560,247	140,224	280,118	139,905	370,668	99,262	178,333	93,073	189,579	40,962	101,785	46,832
	Log Likelihood	-274,820	-66,253	-140,630	-67,134	-173,323	-44,748	-85,050	-42,369	-99,667	-21,081	-54,284	-23,874

Checkout Models

		All Households, by Home Value				*HH w/o Pub. School Student, by Home Value*				*HH w/Pub. School Student, by Home Value*			
		All	Low	Middle	High	All	Low	Middle	High	All	Low	Middle	High
Distance to Library	0.5 to 1 mile	0.005	0.112	0.025	-0.248*	-0.116	-0.067	-0.018	-0.429**	0.312**	0.432*	0.166	0.300
		(0.071)	(0.160)	(0.099)	(0.145)	(0.086)	(0.183)	(0.119)	(0.168)	(0.122)	(0.248)	(0.171)	(0.228)
	1 to 2 miles	-0.045	-0.032	0.021	-0.282**	-0.139*	-0.1	-0.028	-0.460***	0.122	0.077	0.093	0.18
		(0.062)	(0.114)	(0.091)	(0.138)	(0.075)	(0.121)	(0.108)	(0.165)	(0.109)	(0.219)	(0.159)	(0.203)
	2+ miles	-0.064	-0.049	0.004	-0.235*	-0.076	-0.063	0.028	-0.304**	-0.006	0.003	-0.038	0.056
		(0.057)	(0.098)	(0.086)	(0.122)	(0.069)	(0.108)	(0.104)	(0.143)	(0.101)	(0.207)	(0.148)	(0.175)
	Observations	560,247	140,224	280,118	139,905	370,668	99,262	178,333	93,073	189,579	40,962	101,785	46,832
	Log Likelihood	-974,458	-247,411	-491,446	-225,684	-579,523	-159,585	-280,132	-137,666	-369,608	-80,991	-199,325	-87,799

Notes: Each column represents a separately-estimated subsample model that includes all control variables in the baseline model as well as yearly and monthly indicators. "Low" refers to households that fall into the lowest quartile of home tax value, "Middle" represents the second and third home value quartiles, and "High" is the highest home value quartile. The abbreviation HH refers to household. Home values are the state-assessed property tax value. Distance from a household to the library is measured in miles. Values in parentheses are estimated heteroskedasticity-robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Full results available on request.

Table 6: Estimates of the Library Demand Model Across Breaks in the Public School Calendar

	Households with Public School Students						**Households with Public School Students, Lowest Home Value Quartile**					
	Active Visits	Checkouts	Active Visits	Checkouts	Active Visits	Checkouts	Active Visits	Checkouts	Active Visits	Checkouts	Active Visits	Checkouts
2-wk before school-year break			0.033*	0.012***					0.001	0.012*		
			(0.017)	(0.003)					(0.035)	(0.007)		
1-wk before school-year break			0.033*	0.014***					0.014	0.018***		
			(0.018)	(0.003)					(0.034)	(0.007)		
School-year break	0.020	-0.010***	0.017	-0.008**			-0.027	-0.013**	-0.024	-0.006		
	(0.016)	(0.003)	(0.019)	(0.003)			(0.031)	(0.006)	(0.040)	(0.007)		
1-wk after school-year break			0.005	-0.008**					0.043	0.002		
			(0.019)	(0.003)					(0.033)	(0.007)		
2-wk after school-year break			-0.053***	-0.017***					-0.01	-0.006		
			(0.020)	(0.003)					(0.038)	(0.007)		
2-wk after school year end	0.166***	0.011	0.169***	0.022**	0.163***	0.011	0.007	0.004	0.034	0.018	0.001	0.002
	(0.046)	(0.009)	(0.047)	(0.009)	(0.046)	(0.009)	(0.091)	(0.019)	(0.092)	(0.019)	(0.091)	(0.019)
2-wk before school year start	0.256***	0.084***	0.199***	0.033***	0.253***	0.084***	0.152	0.081***	0.089	0.026	0.149	0.081***
	(0.047)	(0.009)	(0.048)	(0.009)	(0.047)	(0.009)	(0.102)	(0.019)	(0.102)	(0.019)	(0.102)	(0.019)
October Break					0.091***	-0.024***					0.091	-0.009
					(0.035)	(0.007)					(0.065)	(0.014)
Thanksgiving break					-0.015	-0.030***					-0.02	-0.030**
					(0.036)	(0.006)					(0.069)	(0.012)
Christmas break					0.011	0.000					-0.033	0.000
					(0.024)	(0.005)					(0.047)	(0.010)
Spring break					-0.008	-0.002					-0.106*	-0.021*
					(0.031)	(0.005)					(0.063)	(0.011)
Observations	189,579	189,579	189,579	189,579	189,579	189,579	40,962	40,962	40,962	40,962	40,962	40,962
Log Pseudo-likelihood	-96,720	-369,218	-91,613	-347,337	-96,709	-369,196	-80,885	-20,594	-76,035	-19,472	-80,872	-20,592

Notes: Each column represents a separately-estimated subsample model that includes all control variables in the baseline model. Values in parentheses are estimated heteroskedasticity-robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Full results available on request.

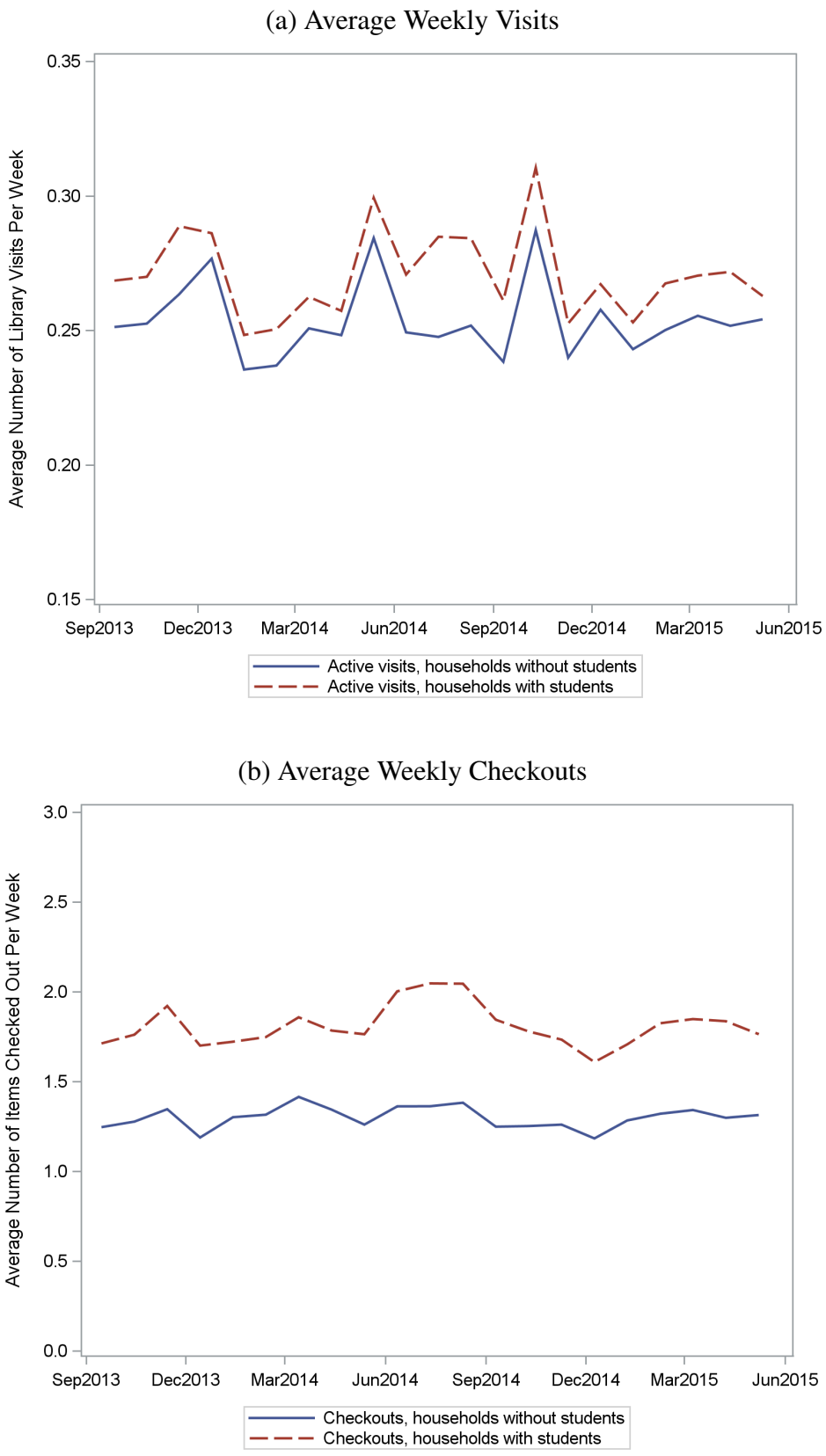
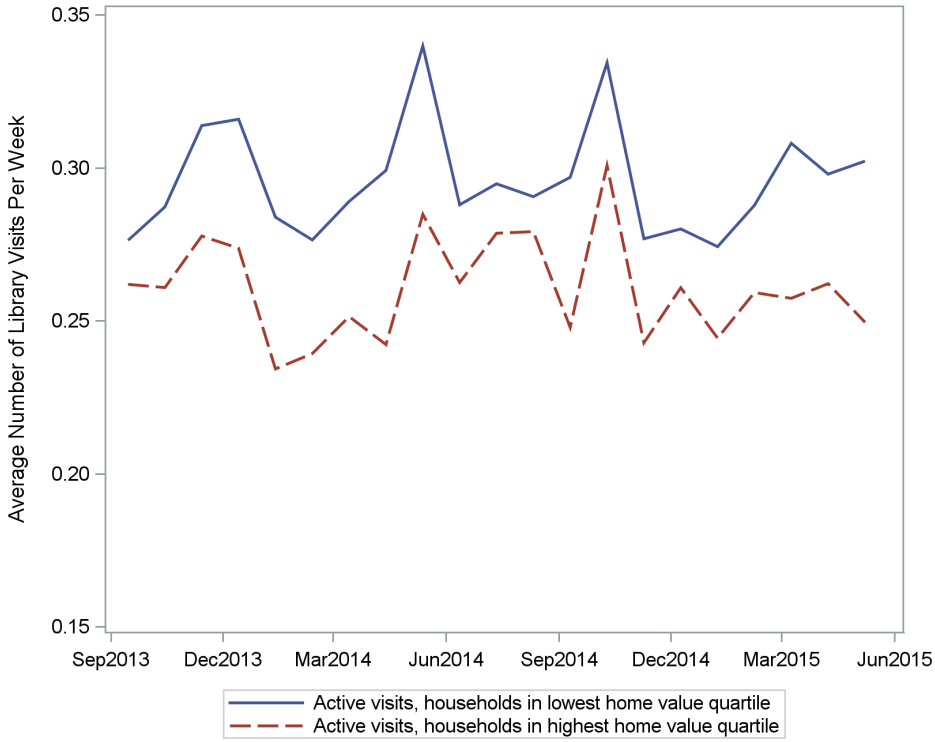


Figure 1: Weekly Active Visits and Checkouts, by Households' Student Status

Notes: Weekly active visits and average checkouts represent data that have been detrended to account for difference across calendar years. "Active Visits" are equal to 1 if a patron is observed to have checked out at least one item from the library during a week.

(a) Average Weekly Visits



(b) Average Weekly Checkouts

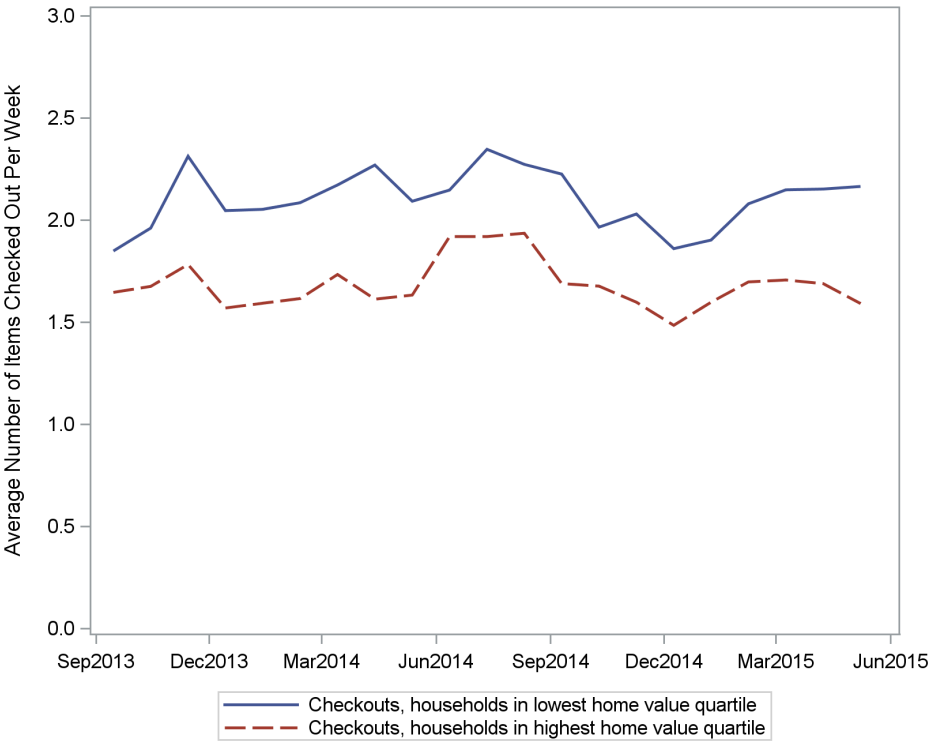


Figure 2: Weekly Active Visits and Checkouts, by Households' Home Value

Notes: Weekly active visits and average checkouts represent data that have been detrended to account for difference across calendar years. "Active Visits" are equal to 1 if a patron is observed to have checked out at least one item from the library during a week.

Appendix A. Supplemental Tables and Figures

Table A1: Habit-formation Specification Robustness Analysis

	All Households		HHs w/o Pub. Sch Student		HHs w/Pub. Sch Student	
	Circulation	Active Visits	Circulation	Active Visits	Circulation	Active Visits
Active visits, last week	0.332***	0.141***	0.382***	0.146***	0.248***	0.130***
	(0.016)	(0.003)	(0.020)	(0.004)	(0.024)	(0.005)
	-909,232	-190,060	-551,986	-122,304	-355,619	-67,400
Active visits, last two weeks	0.335***	0.111***	0.377***	0.116***	0.264***	0.101***
	(0.011)	(0.002)	(0.013)	(0.003)	(0.017)	(0.003)
	-900,748	-187,424	-545,757	-120,319	-353,371	-66,755
Active visits, last three weeks	0.294***	0.090***	0.325***	0.093***	0.241***	0.082***
	(0.008)	(0.001)	(0.010)	(0.002)	(0.013)	(0.003)
	-896,195	-186,295	-542,721	-119,519	-351,949	-66,442
Active visits, last four weeks	0.293***	0.085***	0.315***	0.087***	0.255***	0.080***
	(0.006)	(0.001)	(0.007)	(0.001)	(0.009)	(0.002)
	-887,090	-182,898	-537,056	-117,296	-348,691	-65,305
Items checked out, last week	0.006***	0.005***	0.006***	0.005***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	-911,148	-193,970	-553,737	-125,020	-355,866	-68,544
Items checked out, last two weeks	0.007***	0.005***	0.008***	0.006***	0.006***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	-908,378	-192,446	-551,743	-123,899	-355,095	-68,129
Items checked out, last three weeks	0.007***	0.005***	0.007***	0.005***	0.006***	0.004***
	(0.001)	0.000	(0.001)	(0.001)	(0.001)	(0.001)
	-906,412	-191,662	-550,452	-123,308	-354,453	-67,925
Items checked out, last four weeks	0.007***	0.005***	0.008***	0.005***	0.007***	0.004***
	(0.001)	0.000	(0.001)	(0.001)	(0.001)	(0.001)
	-902,468	-189,873	-548,250	-122,184	-352,803	-67,287
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Month Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	560,247	560,247	370,668	370,668	189,579	189,579

Notes: Each column-row combination represents a separately-estimated subsample model that includes all control variables in the baseline model. The abbreviation HH refers to household. *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1% levels, respectively. Full results available on request.

Table A2: Estimates of the Baseline Library Checkouts Model, OLS Estimator

	Circulation
Active visits, last four weeks	1.236***
	(0.005)
Number of downtown events	0.040***
	(0.003)
Average temperature	-0.003***
	(0.001)
Total precipitation	0.195***
	(0.015)
Distance to library	0.006***
	(0.001)
Log(Home Value)	-0.048***
	(0.005)
Household with pub. school student	0.342***
	(0.009)
Individual Fixed Effects	No
Month Fixed Effects	Yes
Year Fixed Effects	Yes
Observations	560,247
Log pseudo-likelihood	-1,448,263

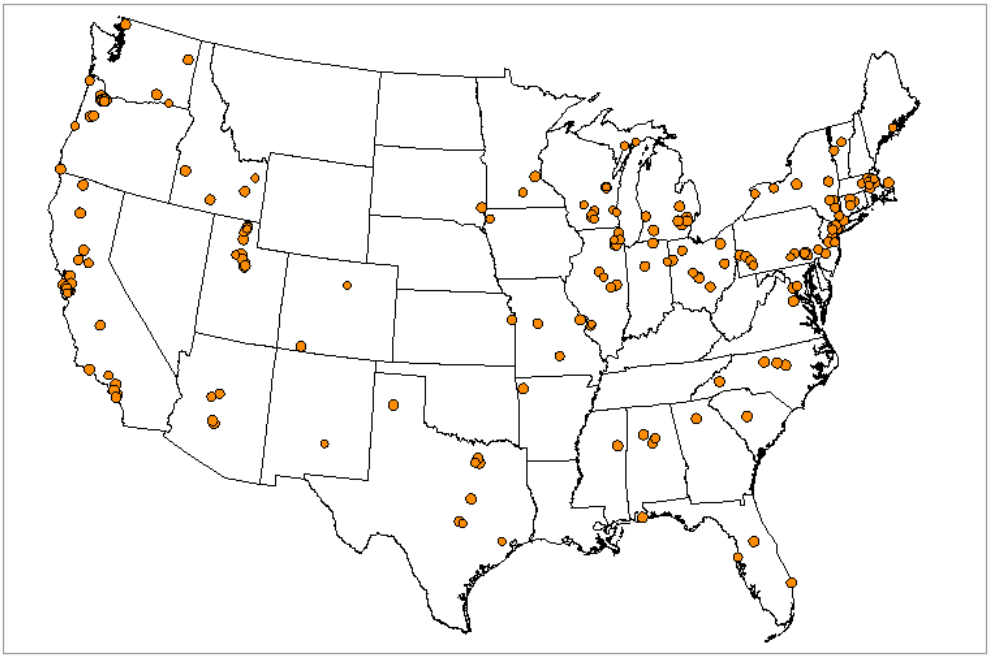
Notes: Home values are the state-assessed property tax value. Distance from a household to the library is measured in miles. Values in parentheses are estimated heteroskedasticity-robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Full results available on request.

Table A3: Estimates of the Baseline Library Checkouts Model, Exclude University Census Tract

	Active Visits	Circulation
Active visits, last four weeks	0.172***	0.299***
	0.000	(0.010)
Number of downtown events	0.004***	0.020***
	0.000	(0.002)
Average temperature	-0.000***	0.000
	0.000	0.000
Total precipitation	0.028***	0.050***
	(0.002)	(0.010)
Distance to library	-0.001***	-0.008*
	0.000	(0.004)
Log(Home Value)	-0.001***	-0.018
	(0.001)	(0.029)
Household with pub. school student	0.005***	0.103
	(0.001)	(0.063)
Individual Fixed Effects	No	No
Month Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	552,045	552,045
Log pseudo-likelihood	-271,902	-934,788

Notes: Home values are the state-assessed property tax value. Distance from a household to the library is measured in miles. Values in parentheses are estimated heteroskedasticity-robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Full results available on request.

(a) Similar Public Libraries



(b) Similar Communities

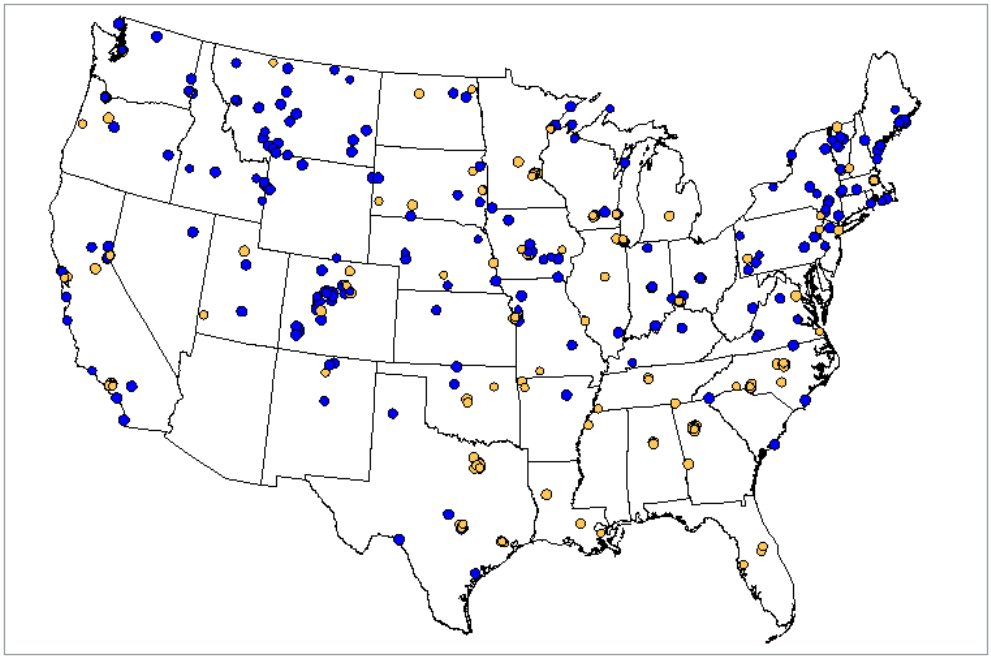


Figure A1: Similar Public Libraries and Communities Estimated Using Propensity Score Matching

Notes: In figure (b), dark dots represent communities that are similar after controlling for all characteristics including the proportion of the population that is white. Lighter dots represent additional communities estimated to be similar if no controls for population race is included in the propensity score matching model.