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Evaluating the Impact of Library Children's Program Attendance on Circulation of Library Materials

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Libraries play an important role in the life of their local communities. Many libraries rightly focus on increasing children's participation in library activities, aiming to inspire a life-long love of learning and reading. Many libraries attempt to use library children's programs as a means of introducing children to library services and circulation materials. This raises an obvious question: Does library children's program attendance affect the volume of children's library material circulation transactions?

In order to answer this question, we will begin with a review of the existing literature, followed by an examination of the conceptual theory that informs our existing thinking on the subject. After this, we will examine the data and methodology used to examine this topic, followed by results and conclusions drawn.

I. LITERATURE REVIEW

A number of studies have examined the positive impacts of reading on children's time use and development. One recent study by Bhatt (2009), using information from the Current Population Survey and the American Time Use Survey found evidence that regular library use increased the time children spent reading by 27 minutes/day on average (Bhatt 2009). Evidence was also provided that regular library use increased average parental time spent reading to or with children by 14 minutes/day (Bhatt 2009). In addition to increasing the amount of time spent reading, Bhatt also found evidence of a corresponding decrease in time spent watching television by 59 min/day, and evidence of an increased homework completion rate (Bhatt 2009).

Reading is also associated with increased vocabulary. For example, Ann E. Cunningham and Stanovich (2001), in a series of studies in the early 1990s, found evidence that increased reading volume increased child vocabulary, even while controlling for a number of other cognitive factors, indicating that supplying children with books to read may increase their ability to expand their reading and writing skills.

Evidence also exists supporting the premise that participation in language arts programs increases children's reading scores. Durkin (1975) found evidence of increased mean reading scores as a result of participation in a two-year language arts program by 4-year olds. She found statistically significant differences in student achievement on reading tests in Grades 1 and 2 with children participating in the program scoring higher than their non-participating counterparts, controlling intelligence levels constant (Durkin 1975). This effect was not statistically significant in Grades 3 or 4, however (Durkin 1975).

Libraries also provide children with a variety of literature to choose from, encouraging reading for pleasure. The National Center for Education Statistics and Department of Education's 2004 National Assessment of Educational Progress found children who read for pleasure scored higher on standardized reading tests than students who did not (NCES 2004).

ther studies have been conducted showing at least an anecdotal increase in circulation due to children's programs. For example, a survey of 30% of Pennsylvania libraries conducted by the Pennsylvania Department of Education (Celano and Neuman 2001) found 75% of respondents indicated circulation increased between 6 and 10% during the duration of children's summer reading programs, with 49% of respondents indicating circulation increases of greater than 10% (Celano and Nueman 2001).

While studies have been conducted evaluating the efficiency of public libraries, or attempting to model the positive impacts of reading on children, the researchers have faced difficulty finding any econometric studies of the effects of children's programs on library children's circulation. The use of comprehensive, U.S. public library data obviously situates the work in a specific political and cultural context, which may differ from library structures in other parts of the world.

II. THEORY

I hypothesize that annual attendance at children's library programs in a library system will increase the number of circulation transactions for public library children's materials conducted in a year by that system.

Library materials in general have a number of interesting characteristics. First, children's library materials are generally available free of monetary charge to users. While nominally "free", accessing library materials does cost library patrons time spent travelling to and searching for materials at the library, time spent registering for a library card, and monetary costs, such as costs of transportation to and from the library, fines, etc.

Library materials, usually books, audio files, etc. are by nature private goods, rival and excludable, being provided by a public source of free of monetary charge. Libraries can prevent individuals from accessing such materials for a variety of reasons, including lack of a library card, overdue books, or unpaid fees, making them excludable. Usage of these public library materials is also rival in the sense that if Jack checks out the only copy of a specific book from the local library, Jill is not able to check out the same book until Jack returns it. As a result of the materials' rival natures, the risk of failing to find the book one wants increases as others use the library.

Young (1973) likens the decision to use library services to similar consumer decisions and gambles regarding shopping at retail outlets. He posits potential demanders of library services balance the costs of traveling to and searching the library with the likelihood of finding the particular book or information they want (Young 1973). Bekkerman and Gilpin (2013) also take a similar theoretical approach in their work on the effects of whether or not Internet access serves as a substitute or a complement for library usage. Their examination of U.S. library and FCC Internet access data covering a time period of 2000-2008 found evidence of Internet access and library usage as complements, which they theorized may potentially be the result of Internet access to library catalogues and other information decreasing the risks of failing to find desired materials at the library, thus decreasing the opportunity cost of visiting the library (Bekkerman and Gilpin 2013). This idea of library usage or shopping as a gamble based on expected utility

is an outgrowth of work in institutional economics and builds on the microeconomic works of game theorists and the Von Neumann-Morgenstern utility theorem.

Since the use of public libraries takes time and effort, and the likelihood of successfully obtaining desired materials is dependent on whether or not others have checked out the materials in question, I find that going to the library, despite the lack of upfront monetary costs, does come with costs, and a variable payout. In this sense, using library services represents a form of gambling, as library patrons generally must spend time and effort for potentially variable gains.

While this sort of theory of expected utility from gambling is usually used in terms of money risked for a potential monetary payout, our situation involves a significant time component. Those placing a greater value on their time will be more risk-averse in terms of gambling their time on going to the library, while those with lower opportunity costs of time and a greater utility gain from reading or attending the library will likely be more risk-loving in our gambling model of the decision to use library services.

While this idea of a gamble works fairly well when evaluating rational decision-makers with a relatively static utility gain from consumption of library materials, I face a number of challenges in applying such a model to children's desire to consume library materials. First, children are usually, if not always, dependent on adults to transport them to the library, and sometimes have little to no say in whether or not they attend the library. This may hamper their exposure to reading. On the other hand, parental encouragement of children's engagement in improving human capital by attending library programs could increase children's exposure to reading.

This conflict in time allocation and resource consumption between children and parents has given rise to interesting economic literature using game theory to model parent-child relationships. For example, Lundberg, Romich, and Tsang (2009) attempted to construct non-cooperative bargaining models to evaluate the decision-making of parents and children. This work builds on the work of earlier economists such as Burton, Phipps, and Curtis (2002) who created a non-cooperative bargaining model involving simultaneous decision-making by children and parents.

Related applications of game theory to household decision-making have also been used by Browning, Bourguignon, Chiappori, and Lechene (1994) to evaluate bargaining between husbands and wives. The primary theoretical difference between Browning et al. (1994) and the others being that Browning et al. (1994) assumes husband-wife decision-making is cooperative, allowing for Pareto efficiencies unobtainable in Lundberg, et. al (2009) and Burton et. al's (2002) non-cooperative parent-child decision-making models.

In a different vein, households are also assumed to take advantage of economies of scale that may incentivize attendance of library programs. Browning and Lechene (2002) outline a number of effects children have on household consumption, including the finding that children increase household economies of scale in the consumption of public goods. This could increase children's participation in library programs and their consumption of children's materials, which may serve as cheaper means of entertainment than other more expensive forms of consumption.

In addition to questions of child-parent decision-making, children's tastes and preferences may still be under development, affecting their propensity for library use prior to attendance of a library program. Many children may have minimal exposure to reading culturally or in the home, and may view reading as primarily a chore assigned them in school. Due to lack of exposure to reading for pleasure, children who have an innate predilection for reading might not realize how much they enjoy it until exposed to it. Put in a more theoretical way, if such children are exposed to the utility gains of reading, their utility curves, and thus demand for library children's circulation materials, may change, shifting outward.

Having previously examined a few examples of the positive impact reading, including reading for pleasure, has on children's learning, it is understandable that public libraries often attempt to engender a love of reading in children through library programs. While not usually thought of explicitly in economic terms, library programs are functionally a form of advertising conducted by the library in an attempt to shape consumer (children's) time-use preferences and demand for library services.

Many of the most popular library programs are summer reading programs, which are often attended by organized groups of children such as daycares or pre-schools. Other library programs aim to provide services to a particular local community or after-school instruction to students. While these sorts of programs would likely attract students already interested in or regularly attending the library, we would also expect these programs to attract students not necessarily interested in reading, such as those attending the program with a school group, preschool, daycare, or afterschool program. We might expect that the exposure of children to reading by these library programs could alter their tastes and preferences, increasing their desire to consume library materials, altering their utility curves, and increasing demand for children's circulation materials, and thus increasing a library's children's material circulation transactions.

III. DATA AND METHODS

The primary data source is a cross-sectional survey of 9,009 public library districts in the United States conducted by the Federal Government's Institute of Museum and Library Services (IMLS) in 2013. Authorized by Congress, this survey of all individual public library branches and public library districts throughout the U.S. is administered by IMLS annually. I use cross-sectional data from 2013 for this study because I expect certain technological changes may impact library usage, as supported in the work of Bekkerman and Gilpin (2013), and wish to avoid introducing unnecessary complexity to the model by introducing time-series data, and the accompanying technological changes which would likely have entered into the equation with it.

The variables, as described above, are measured in terms of annual numbers for 2013. While most of the information was provided to directly to IMLS by public libraries, certain data points where respondents did not respond were calculated by IMLS using other datasets collected, historical trends for the library, and previous reported results.

My dependent variable KIDCIRCL's mean was 89833.14 transactions. The variable had a standard deviation of 377,526 transactions. The median for KIDCIRCL was 13,218 transactions.

I chose to use ordinary least squares regressions since I was examining the effects of changes in a specific independent variable, total attendance at library children's programs, on a specific dependent variable, children's circulation transactions per year. This form of regression provides a way to examine this effect, isolating it from other variables which may also impact children's circulations. The first regression used the following equation:

(1) $KIDCIRCL = \beta_1 + \beta_2 KIDATTEN + \beta_3 POPU\_UND + \beta_4 BKMOB + \beta_5 TOTSTAFF + \beta_6 TOTINCM + \beta_7 BKVOL + \beta_8 EBOOK + \beta_9 HRS\_OPEN + \beta_{10} VISITS + \beta_{11} REGBOR + \beta_{12} GPTERMS + \beta_{13} AUDIO\_PH + \beta_{14} VIDEO\_PH$

Table 1: Expected Variable Signs

β	Variable Name	Variable Description/Units of Measurement	Expected Sign of β
--	KIDCIRCL	Children's Circulation Transactions Annually	N/A
1	Constant	Constant	+
2	KIDATTEN	Total attendees at library's children's programs	+
3	POPU_UND	Population of the public library's legal service area	+
4	BKMOB	Number of bookmobiles operated by the library	+
5	TOTSTAFF	Number of staff members employed by the library	+
6	TOTINCM	Total funding library receives	+
7	BKVOL	Number of books (Print Volumes) held by library	+
8	EBOOK	Number of e-books held by library	+
9	HRS_OPEN	Number of hours library is open annually	+
10	VISITS	Number of visits to library annually	+
11	REGBOR	Registered users of library in a year	+
12	GPTERMS	Number of library computers available to the general public	-
13	AUDIO_PH	Number of audio files held by library	+
14	VIDEO_PH	Number of video files held by library	+

I expected most of the variables to have positive signs, signaling positive impacts on the dependent variable KIDCIRCL (number of children's material transactions by a library). GPTERMS, which measured the number of library computers available to the general public was the only exception to this expectation, since increased availability of computers could distract children from perusing library circulation materials, decreasing circulation of children's library materials.

The primary independent variable of study was KIDATTEN, which measures the total number of attendees at children's library programs in a given year. β_2 measured the expected change in KIDCIRCL accounted for by changing independent variable KIDATTEN, holding all other

variables constant. I expected β_2 to be positive since I hypothesized attendance of children's library programs would increase circulation of library materials.

Another variable of importance was POPU_UND. β_3 measured the expected change in KIDCIRCL accounted for by changing independent variable POPU_UND, which measures the population of the public library's legal service area, holding all other variables constant. I expected β_3 to be positive since a larger population base for the library could lead to greater usage and thus greater circulation of children's library materials. Other variables of note included BKVOL, EBOOK, BKMOB, and the ADUIO_PH, and VIDEO_PH variables.

V. RESULTS

Table 2: 1st Ordinary Least Squares Regression
Dependent Variable: KIDCRCL

	Coefficient	Standard Error	T-Ratio	P-value	10 Percent Significance	5 Percent Significance	1 Percent Significance
Constant	6024.98	2041.70	2.951	0.003	*	*	*
KIDATTEN	5.107	0.164	31.05	0.000	*	*	*
POPU_UND	0.262	0.037	7.037	0.000	*	*	*
BKMOB	13278.0	4813.90	2.758	0.006	*	*	*
TOTSTAFF	-1382.68	172.169	-8.031	0.000	*	*	*
TOTINCM	0.019	0.002	12.24	0.000	*	*	*
BKVOL	-0.245	0.010	-25.30	0.000	*	*	*
EBOOK	0.420	0.060	6.956	0.000	*	*	*
HRS_OPEN	-8.737	0.585	-14.94	0.000	*	*	*
VISITS	0.408	0.013	31.83	0.000	*	*	*
REGBOR	0.816	0.060	13.64	0.000	*	*	*
GPTERMS	-167.763	42.426	-3.954	0.000	*	*	*
AUDIO_PH	2.18980	0.171627	12.76	0.000	*	*	*
VIDEO_PH	-0.262	0.185	-1.418	0.156			

A confidence interval of 95% was used, providing an alpha value of 5%. I conducted a two-tailed test with 9,295 degrees of freedom, leading to a critical t-value of 1.960. The R-Squared value of 0.8415888 informed us that the variance in the included variables explained approximately 84% of the observed change in the dependent variable. The adjusted R-Squared Value of 0.841367, which took into account the number of independent variables I included, was quite similar. However, since I have such a large sample size (9,309 records), the adjusted R^2's difference naturally became smaller, as the effect of K on the overall adjusted R^2 equation is minimal.

Of the independent variables tested, all of them, except VIDEO_PH appeared to have statistically significant impacts on the number of children's material circulations. However, the directions of the signs were more complex than expected. Surprisingly, staff levels, book volume, number of hours open, and number of computers available for public use all demonstrated evidence of statistically significant negative impacts on the number of children's circulation transactions.

The significantly high KIDATTEN t-ratio of 31.05 supplied us with initial evidence to reject the null hypothesis, and conclude there was strong evidence to support the hypothesis that children's library program attendance positively impacts library children's material transactions. On average, each additional person attending a children's program increased the number of children's material transactions issued by the library district by about 5 transactions, all other variables being held constant. I also found an f-value of 3798.554, well above the necessary f-critical value. This indicated that using the projected coefficients for each variable to predict the number of children's transactions for a library district would be more accurate than simply taking the average number of children's transactions for each library district in a year. However, a number of problems with the initial regression required changes to the eventual model used.

VI. PROBLEMS WITH THE REGRESSION

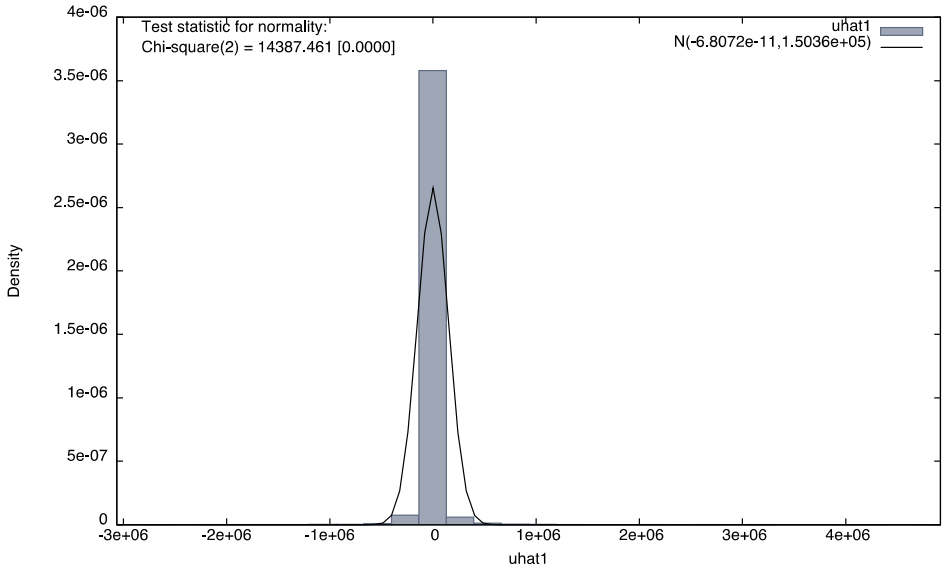


Figure 1

The frequency distribution exhibited a fairly normal bell curve. However, a q-q residuals graph did indicate some issues with the data, as the actual distribution diverged from the expected trend line, particularly at the tails.

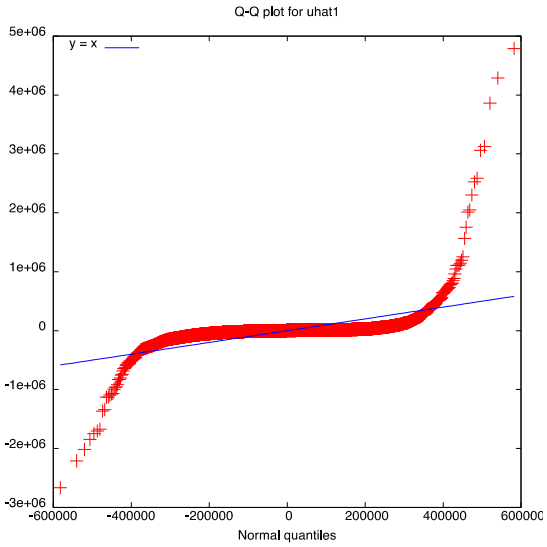


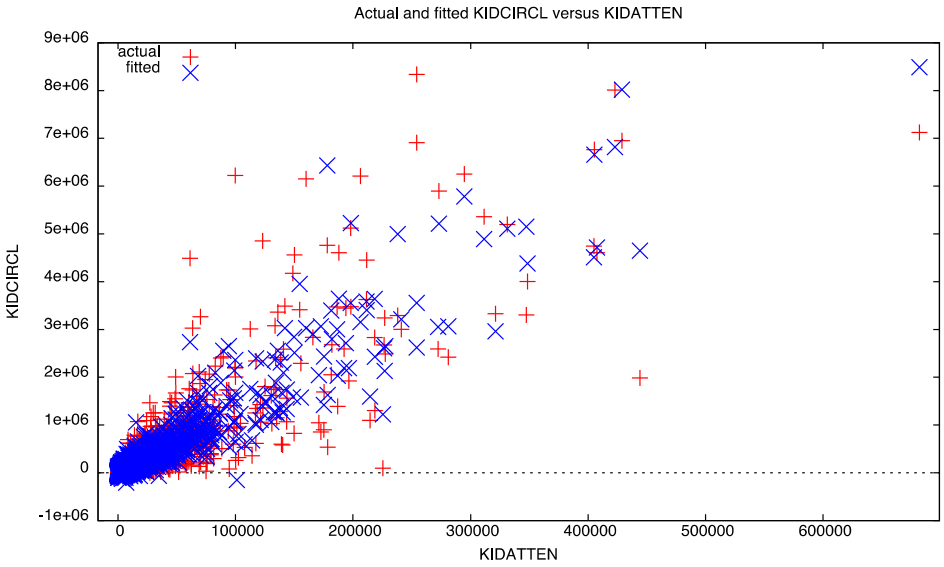
Figure 2

I was also concerned about the effects of collinearity. After running the first regression I realized that a number of the variables were likely collinear, including the population, total staff, total funding level, and visit variables, all of which likely measure overlapping impacts, since book volume, visits, and ability to run a library depend on funding levels. Tests for collinearity found significant evidence that the variables were collinear.

Table 3: Variance Inflation Factors
Minimum possible value = 1.0

KIDATTEN	6.198
POPU_UND	9.651
BKMOB	1.280
TOTSTAFF	**33.036**
TOTINCM	**26.067**
BKVOL	4.656
EBOOK	1.104
HRS_OPEN	9.742
VISITS	**22.521**
REGBOR	**8.673**
GPTERMS	7.935
AUDIO_PH	4.541
VIDEO_PH	7.552

Particularly problematic collinear variables were TOTSTAFF, TOTINCM, and VISITS, all of which overlapped with the other variables and one another. I was also concerned about the REGBOR variable, which while not having as high a VIF score as the other variables, appeared to overlap with POPU_UND, which I considered a more useful variable than registered users, since many children may use their parents library cards to check out books. Since the regression produced a fairly high R-squared result, I eliminated four of these collinear variables (TOTSTAFF, TOTINCM, VISITS, and REGBOR) in an attempt to reduce collinearity within the model.



I was also concerned about heteroskedasticity in the model. The fan-shape of the distribution indicated heteroskedasticity was likely present. Both the Breusch-Pagan, and White's tests for heteroskedasticity detected heteroskedasticity in the initial regression model.

VII. SECOND REGRESSION

For the second regression, I removed 4 independent variables (TOTSTAFF, TOTINCM, VISITS, and REGBOR) that contributed to collinearity in the initial regression. The TOTSTAFF, TOTINCM, and VISITS variables were removed due to high VIF scores. REGBOR was also removed because I expected its effects would overlap with those of POPU_UND, a stronger variable that I wished to retain in the equation. This resulted in the following revised equation:

(2) $KIDCIRCL = \beta_1 + \beta_2 KIDATTEN + \beta_3 POPU\_UND + \beta_4 BKMOB + \beta_5 BKVOL + \beta_6 EBOOK + \beta_7 HRS\_OPEN + \beta_8 GPTERMS + \beta_9 AUDIO\_PH + \beta_{10} VIDEO\_PH$

The results of the second regression are displayed in Table 4:

Table 4: Regression 2 Ordinary Least Squares

	Coefficient	Standard error	T-ratio	P-value	10%	5%	1%
Constant	-10395.8	2195.76	-4.734	0.000	*	*	*
KIDATTEN	7.697	0.162	47.61	0.000	*	*	*
POPU_UND	1.035	0.034	30.33	0.000	*	*	*
BKMOB	17951.5	5276.26	3.402	0.001	*	*	*
BKVOL	-0.188	0.010	-19.05	0.000	*	*	*
EBOOK	0.401	0.067	6.019	0.000	*	*	*
HRS_OPEN	-4.629	0.608	-7.613	0.000	*	*	*
GPTERMS	193.707	44.830	4.321	0.000	*	*	*
AUDIO_PH	2.605	0.182	14.35	0.000	*	*	*
VIDEO_PH	2.875	0.184	15.62	0.000	*	*	*

While removing variables reduced the R-Squared and Adjusted R-squared by approximately 0.04 with an R^2 value of 0.807413 and an Adjusted R^2 value of 0.807227 for the second regression, the strong explanatory power of the model persisted, with the changes in the independent variables explaining a significant portion of the change in the dependent variable. Testing for collinearity also showed removal of the variables in question reduced the threat of collinearity. I saw increased t-critical values for most of the remaining variables. This indicated the removed variables reduced the coefficients of the variables in the first regression, implying overlap between the effects of the variables in the initial model. The second regression's higher t-score for independent variable KIDATTEN indicated a stronger and more statistically significant relationship between children's attendance of library programs and circulation of children's library materials.

Despite these changes, however, the White Test for Heteroskedasticity continued to detect strong evidence of heteroskedasticity in the second regression, meaning the t-values were likely overestimated. This finding of heteroskedasticity in the second regression aligned with the results portrayed in Figure 3:

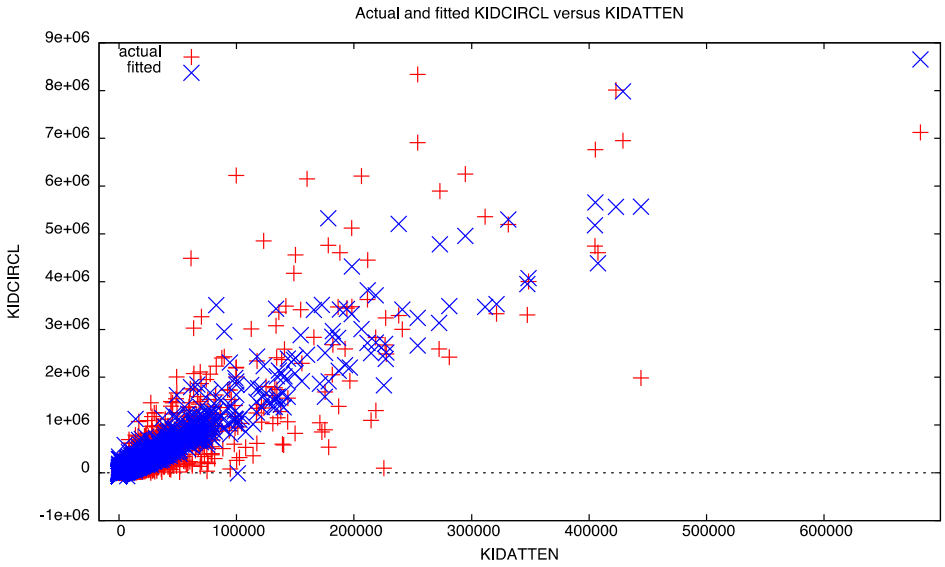


Figure 3

This threat of heteroskedasticity posed significant challenges to the legitimacy of the t-statistics. One potential solution considered was a transformation of the dependent variable (KIDCIRCL) from children's circulation transactions to children's circulation transactions divided by the population of the library's service area (KIDCIRCL/POPU_UND). However, I were uncomfortable with this solution, since the primary population demanding children's materials (children) is not necessarily equivalent to the general population accounted for by POPU_UND. At the same time, the general population's size likely has an impact on the attractiveness of a library's quality of library material since many libraries rely heavily on local and state funding sources, meaning the POPU_UND variable is expected to contribute to the quantity and quality of the children's materials. Larger library service populations may also provide economies of scale which could increase the likelihood children would find the circulation materials they desire.

I did, in an attempt to exercise due diligence, run a regression with this proposed modified variable, removing the POPU_UND independent variable and transforming the KIDCIRCL to a KIDCIRCL/POPU_UND variable as described. The new results significantly reduced the regression's R^2 value from 0.80 to 0.05, reducing the explanatory value of the independent variables. Transformation also failed to eliminate heteroskedasticity problems, with White's test continuing to indicating the likely presence of heteroskedasticity. For these reasons, I opted not to transform the dependent variable in this way.

Instead, I ran a Newey-West heteroskedasticity-corrected regression using the second regression's variables and the non-transformed KIDCIRCL dependent variable in an attempt to determine more accurate t-values. I did not include any correction for autocorrelation since the variance plots did not provide evidence of patterns in error terms. This made theoretical sense because the data were cross-sectional rather than time-series. While cross-sectional data can still be auto-correlated, such as through geographic connections, it was unlikely that such

autocorrelation would occur since library membership is usually limited to residents of a particular library district.

The Newey-West heteroskedasticity-corrected standard error regression provided the results listed in Table 7:

Table 7: Newey-West Heteroskedasticity-corrected Ordinary Least Square Results

	Coefficient	Standard error	T-ratio	P-value	10%	5%	1%
Constant	-10395.8	5702.29	-1.823	0.068	*		
KIDATTEN	7.697	1.435	5.365	0.000	*	*	*
POPU_UND	1.035	0.205	5.058	0.000	*	*	*
BKMOB	17951.5	28565.9	0.628	0.530			
BKVOL	-0.188	0.075	-2.512	0.012	*	*	
EBOOK	0.401	0.193	2.080	0.038	*	*	
HRS_OPEN	-4.629	2.920	-1.585	0.113			
GPTERMS	193.707	390.880	0.500	0.620			
AUDIO_PH	2.605	2.251	1.157	0.247			
VIDEO_PH	2.875	1.795	1.602	0.109			

After adjusting for heteroskedasticity, I found smaller, but still positively significant t-values for the KIDATTEN, POPU_UND, and EBOOK variables. I also found that the negative BKVOL variable remained statistically significant, providing evidence to support the counterintuitive idea that increased book volume could decrease the number of children's transactions, while holding the other independent variables included constant. However, adjusting for heteroskedasticity did diminish the t-ratios for variables BKMOB, HRS_OPEN, GPTERMS, AUDIO_PH, and VIDEO_PH to insignificant levels.
Specifically, the results indicated that, within the sample, a one-person increase in annual children's program attendance resulted in an average increase of 7.6966 annual library children's material circulation transactions, holding our other independent variables constant. Similarly, a one-person increase in the population of the library's legal service area increased annual library children's material circulation transactions by an average of 1.03 transactions, holding all other independent variables constant.

Unfortunately, Hausman tests indicated problems of endogeneity with this regression, placing the results of our ordinary least squares test into question. After discovering the endogeneity problem, I was able to simplify the regression by removing many of the potentially endogenous variables, while leaving my two most statistically significant variables, KIDATTEN and POPU_UND within the model, along with other likely non-endogenous variables. After running the simplified regression, we found continued evidence of a statistically significant evidence of a positive relationship between variables KIDATTEN and POPU_UND and KIDCIRCL. Unfortunately, a lack of theoretically non-endogenous variables within our data source prevents us from completely eliminating omitted variable bias, and also limits our ability to use instrumental variable regression substitution to address the problem of endogeneity in the more complex regression.

VIII. CONCLUSIONS

After adjusting the regressions to account for collinearity, heteroskedasticity, and endogeneity, we find significant evidence supporting the hypothesis that attendance at children's library programs increases the number of children's material circulation transactions, holding other variables constant. We also find evidence of a similar positive population effect. We find that many of our other significant variables, including library ebook holdings and book volume are endogenous, informing us that library decisions about how many materials to stock are at least partially based on the number of transactions being conducted.

After adjusting for collinearity and heteroskedasticity, there was no evidence of statistically significant relationships between a number of the independent variables and the annual number of children's circulation material transactions. Specifically, no significant relationships were found between the number of bookmobiles operated by the library district, the number of hours a library was open in a year, the number of computers available for use by the general public, or the number of audio or visual file files held by the library and the number of children's circulation material transactions annually.

These results support the theoretical idea that children's participation in library programs increases their utilization of library services. Library programs expose children to new sources of knowledge and entertainment, allowing them access to goods they may not have considered consuming prior to participating in a program. Public libraries seeking to increase children's engagement and use of library services could do well to examine children's library programs as a potential means of increasing children's interest in, and use of library circulation materials.

While these results provide a useful examination of the effects of library children's program attendance on children' material circulation, a relationship largely overlooked and untested in the existing literature, it is worth remembering that circulation transactions are merely an output measure for libraries, not a measure of efficiency. More holistic studies on the effects of library children's program attendance on library efficiency, or the effects of library children's program attendance on library children's programs' goals such as children's literacy or educational achievement would provide libraries with better information regarding how best to allocate scarce funding dollars, especially during tight budgetary times.

These caveats aside, we find strong evidence that library children's programs are associated with increased circulation of library children's materials. This is encouraging as libraries seek to better engage with the children and families they serve. Those libraries seeking to increase the distribution of their children's materials would do well to consider the increased implementation of children's library programs.

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