The Graphical Analysis on the Gap between Supply and Demand for Early Ed Childcare Services

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Abstract

Community Labor United is a non-profit organization that is currently working to investigate the negligence in childcare provision for low and middle-income families within the Greater Boston Area, in order to promote reforms within the current system provided by the Department of Early Education and Care. Using interactive maps, the research outlined in this paper highlights two gaps in the current childcare structure. The first being how the hours that early education childcare providers keep do not support families that work primarily nonstandard schedules. The second being how the number of slots for early education provision does not align with the number of children age five and under that live within each neighborhood and census tract. The interaction between these two gaps drastically impacts the livelihood of working class families and it is our hope that this research will provide evidence that the current system in place needs to be reconstructed, in order to support all households in Massachusetts.

Introduction

Community Labor United

Community Labor United (CLU) is a non-profit organization, operating in the Greater Boston Area, that works with other community-based establishments and labor unions across Massachusetts to cultivate strategic campaigns that protect and promote the interests of low and middle-income working class families [1]. Their overall goal is to promote policies that advocate for accessible jobs, healthcare, childcare, housing and environmental justice for working class households [1]. Through their *Our Care That Works* coalition that launched publicly this year, Community Labor United aims to bring together various local cooperative groups to confront the child care crisis in Massachusetts. More specific to this research, CLU is interested in examining the inconsistencies in childcare within the Greater Boston Area, caused by the negligence of the Department of Early Education and Care (EEC). This investigative exploration into childcare provision gaps within the Greater Boston Area will allow Community Labor United to communicate to the EEC the demand for the standardization of childcare within Massachusetts.

EEC Literature Review

"The ethical imperative of a society to support the care of inevitable dependents makes care a social responsibility and therefore creates an important role for the state" (p. 150) [2]. The Department of Early Education and Care's mission is to maintain the growth and development of all children, by providing quality childcare programs and

resources for families within their communities [3]. However, the research led by Community Labor United and their affiliated organizations shows that the EEC has been unable to effectively execute their commitment for low and middle-income working class families [1]. The reason CLU's attention is on low and middle-income families is because more than five million Americans are not only scheduled for fewer hours, days, or weeks than they prefer working, but the daily timing of their work schedules can often be irregular or unpredictable [4]. According to the General Social Survey obtained by the Economic Policy Institute, the lowest income workers typically face the most irregular work schedules [4]. As contemporary research shows, having a fluctuating and unpredictable work schedule puts working-class families at a disadvantage to finding accessible, reliable childcare [5].

One of the biggest hurdles to researching the impact nonstandard hours have on the livelihood of low and middle-income families, is that the existing measures in national data sets do not capture multiple dimensions of work schedules [5]. This makes it difficult to accurately assess the number of families that are working outside the "typical" 9am - 5pm office job. In turn, this hinders the ability for researchers and advocates to highlight the need for childcare reform, to include operating hours that accommodate more nonstandard schedules. There should be additional items on national surveys that gather information on divergence from the "typical" work arrangement to make it possible to examine fluctuations in work schedule timing and hours [5]. However, until national data sets are able to reflect more inclusive and diverse lifestyles, research conducted to help highlight the needs of families who work nonstandard hours will remain difficult to gather and interpret [5].

There is a need for focus on understanding the childcare demands of low and middle-income families, in order to address the pressing social problems of our time surrounding inadequate provision of quality care to the elderly, children, and those who are ill or disabled [2]. More specifically, projects should include completing empirical mapping of childcare, to provide a bridge between the goals of care theorists and the specific policy context of care in a given local area [2]. Paired with an accurate representation of the childcare demands of the community, mapping the current childcare supply will allow the opportunity to understand the gaps in the childcare system provided by the Department of Early Education and Care [6]. This will hopefully push the state to create more consistent and accurate policy implementations surrounding the issue of early education childcare.

Research Question

As noted above, the general goal for this research is to examine the inconsistencies in the EEC, by highlighting childcare provision gaps in the Greater Boston Area. More specifically, this project focuses on illustrating a disparity in operating hours and capacity for childcare providers on the neighborhood level and census tract level. Because Community Labor United is concentrated on understanding how the low and middle-income households are impacted by the current childcare system, our project emphasizes the childcare demands needed for working class families. Additionally, CLU is interested in concentrating on early education provision care, which encompasses childcare for children ages five and under. For operating hours, we look at how the non-typical work week is affected by the early education provision that is currently supplied, since people with low and middle-incomes work at times that operate outside the typical 9:00am - 5:00pm job. We want to understand if there were a sufficient number of childcare facilities that could offer early education provision outside Monday - Friday, 7:30am - 6:00pm, for people in the Greater Boston Area. Similarly for capacity, we want to highlight the lack of available slots for early education provision for working households with children age five and under. This is because working-class families

typically have all parents in the household in the workforce, so it is crucial that the childcare capacity supply matches the demand.

Individually, the child provision gaps in hours and capacity shows how the Department of Early Education and Care has neglected low and middle-income families in specific ways. However, we also think it's important to understand how the interaction between lack of available childcare hours and lack of early education provision spots impact these households overall. To best convey that interaction, we have compiled our visualizations and supporting information on an easily accessible platform. This allows for the user to quickly navigate the various maps for hours and capacity, and also share these findings with all appropriate parties. It is our hope that Community Labor United will be able to use the visualizations we've created to motivate the Department of Early Education to make reforms to the current childcare system to be more accommodating for all families in Massachusetts, regardless of occupation or availability.

Method

In order to quantify the gap in supply and demand for childcare in the Greater Boston Area, we highlight the capacity of the existing childcare providers in comparison to the number of children who need childcare, as well as the hours that providers are able to provide childcare in comparison to the hours when childcare is most needed by those who work outside standard hours. We focus on these areas both for their urgency in affecting access to and need for childcare, as well as for the lack of existing research that exists on the gaps between the childcare that exists and the childcare that is needed.

Data

The data from our main analyses consists of two data sources, one addressing the supply side of the gaps in childcare, and the other addressing the demand. The supply data source comes from *Community Labor United*, and it is a collection of providers from the Department of Early Education and Care (EEC) in Massachusetts. The initial dataset consists of 8,318 observations, with each row representing a childcare provider in Massachusetts. Since our project focuses specifically on the Boston area, we filtered the dataset to contain only neighborhoods in Boston. leaves us with 764 remaining childcare providers. We include 13 neighborhoods: Allston, Boston, South Boston, Brighton, Charlestown, Dorchester, East Boston, Hyde Park, Jamaica Plain, Mattapan, Roslindale, Roxbury, and West Roxbury. Neighborhoods with the highest number of providers include central Boston (100), Dorchester (203) and Roxbury (70).

There is no existing dataset that tells us about childcare demand specifically. So to research this topic we use census data, specifically the *American Community Survey* (ACS), and filter for certain variables of interest. The following methodology will discuss specific variables in detail, but all data is derived from the 2016 American Community Survey and is filtered for Suffolk County, Massachusetts.

We want to convey the gap in childcare by a geography that is big enough to generalize our conclusions, but small enough so that we don't overlook any areas that might have results of interest. Through consultation with CLU's Senior Researcher, here we convey our results by the neighborhood level. To do this, we access Boston neighborhood shapefile data [7] and assign each EEC childcare provider to a certain neighborhood. Since the census data of interest is only accessible by tract, we develop a file that matches each census tract to a neighborhood, and includes both tract geometry and neighborhood geometry to allow for easy mapping. More about this process is discussed in the challenges section.

Capacity

Supply

To get a sense of the slots available for early education provision, we take the EEC dataset and filter only for providers that provide early education childcare. We use the tidyverse package [8] to group the providers by census tract, and calculated the total number of slots for early education childcare in each tract. Since we are interested in looking at differences on both the tract level and the neighborhood level, we repeat this process for neighborhood so that we also have the total number of slots for early education childcare in each neighborhood. We merge these datasets with the respective geometry for each geography, to allow us to map the results.

Demand

Demand for capacity of childcare is assessed through the use of the 2016 ACS. The tigris and tidycensus [9,10] packages are used in congruence with an API key, in order to access census data in R. We use the American Community Survey, as opposed to other forms of census data, because it is the only survey that is easily compatible with R. Additionally, it also has data available for all variables of interest on the tract level for Suffolk County.

To quantify the number of children that need childcare, we use the ACS variable "B23008", which gives estimates per tract of the number of children under six in two-parent households with both parents in the labor force, as well as single parent households (either mother or a father) with the parent in the labor force. We then add up these variables, with the assumption that anybody with all parents in the labor force would need childcare. See Table 1 for descriptive statistics. To get a percentage of children under six with all parents in the labor force, we divide this number by the total number of children under six. All calculations are per tract.

Table 1: Working Force Children Demand Summary Statistics

	n	mean	sd	min	max
Count Children Under 6	204	175.83	142	0	700

Maps

Three maps are made as a final product for visualizing the gap in capacity. Two of these maps look at supply and demand at the tract level. The first (Figure 1) is mapping the raw number of children under six with all parents in the workforce, while the second (Figure 2) shows the raw number of slots available for early education care per tract. This allows for the supply and demand side of capacity to be easily compared to one another. The third map (Figure 3) quantifies the difference in supply and demand by neighborhood, as a ratio of children to childcare slots. We create this ratio by dividing the number of children under six with working parents by the number of childcare slots available. We create this ratio based on the Center for American Progress' definition of a childcare desert, which says that in any census tract with over 50 children under age five, a ratio of over 3:1 of children to childcare slots classifies that census tract as a childcare desert [11]. However, this definition is by census tract. Since it is unrealistic that one would restrict their childcare search to within their census tract, a rather small boundary, we want to give a more sensible range of how far a childcare search might go, hence our rationale for grouping by neighborhood.

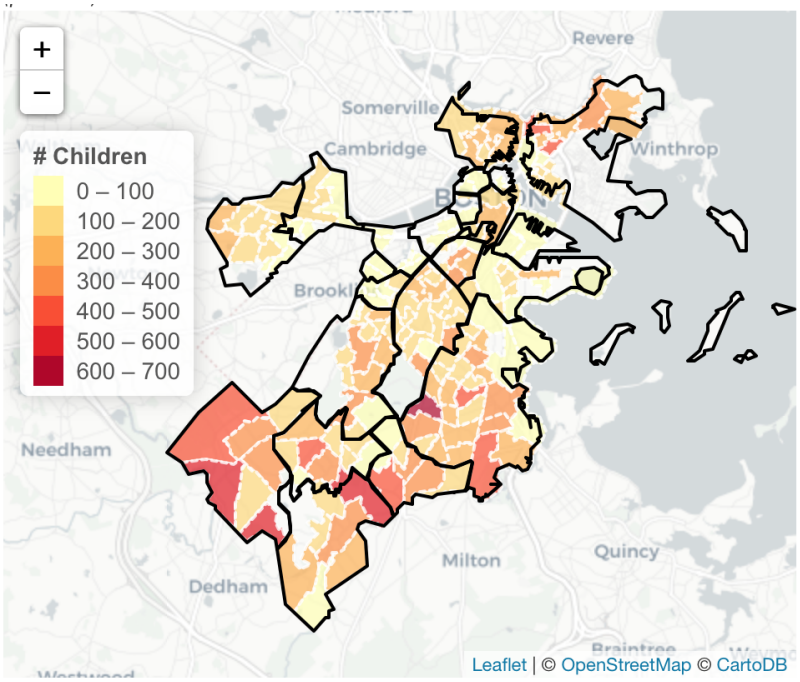

Fig 1. Number of children under 6 from working families

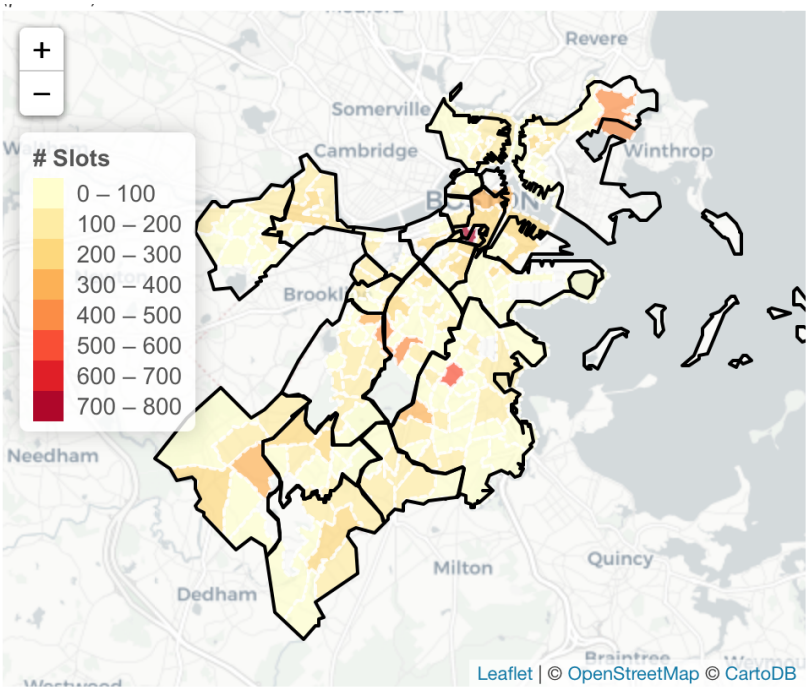

Fig 2. Number of slots available for early ed by tracts

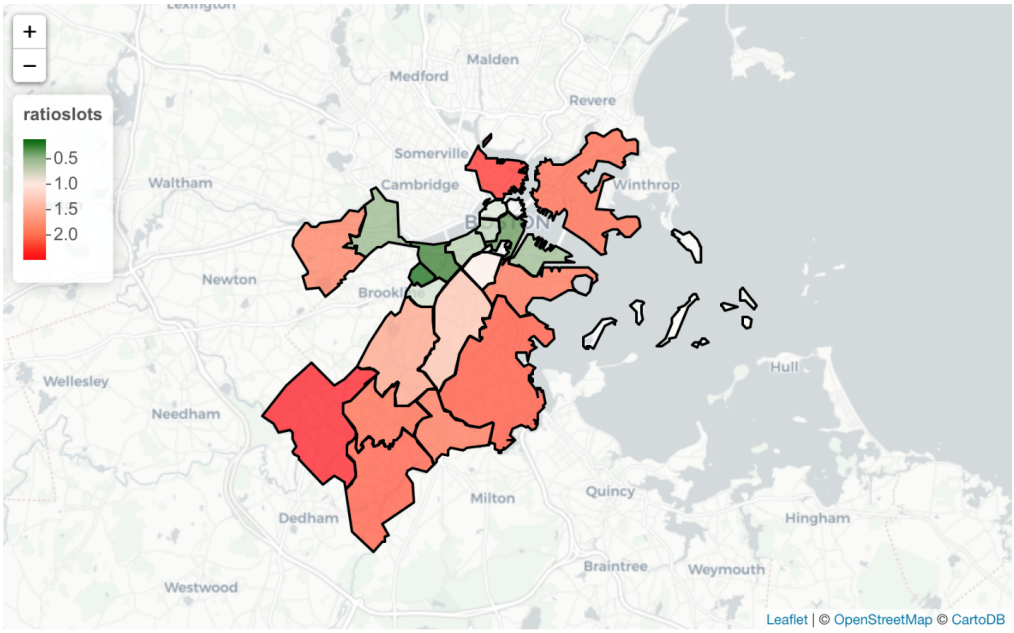

Fig 3. Ratio of children under 6 from working families to slots

Hours

Supply

Our main focus with the question of hours was to get a sense of the providers who provide childcare outside of the typical standard workday, which we define as anytime outside of 7:30am - 6:00pm on weekdays [1]. We did not include weekday care since there are only a few providers that provide any weekend care at all. Therefore, to get our dataset for supply, we create a variable based on the information about hours in the EEC dataset to flag any provider that provided care during nonstandard hour. Then we summarize the number of slots they had for those hours.

Demand

One large problem with census data is that for any workday related variables, the census assumes workers work 5 days a week, with the same number of hours every day. This definition contradicts the purpose of our study, which is to investigate the resources available to those who work nonstandard hours. Therefore, the only census variable that we find appropriate to use when investigating hours is the time the indivual is leaving work. Using previous ACS methodology given to us by CLU's Senior Researcher, we split the nonstandard times leaving for work into three categories: early mornings (if they leave for work anytime between 12am-6:29am), evenings (if they leave for work anytime between 11am-3:59pm), and late evening/overnight (if they leave for work anytime between 4pm-11:59pm). We use the ACS variables corresponding to these responses in variable B08302, and divide the number of people in each category by the total number of people in the workforce. This gives use the percentage of people who work early mornings, evening, and late evening/overnight shifts. We also summarize the number of people in the three nonstandard time chunks to get a total percentage of people leaving during any nonstandard hour. See Table 2 for descriptive statistics.

Table 2: Hours Demand Summary Statistics					
	n	mean	sd	min	max
Count Early Morning Shifts	198	336.56	263.18	0	1270.00
Count Evening Shifts	198	191.21	147.10	0	772.00
Count Overnight Shifts	198	129.31	94.41	0	505.00
Percent Early Morning	198	16.38	9.40	0	67.61
Percent Evening	198	9.92	7.19	0	54.10

Maps

There are five maps which visualize the gap in supply and demand for hours. Three of the maps are choropleth maps by tract that visualize the percentage of people who leave for work at each of the nonstandard times: early morning, evening, and late evening/overnight. We present a similar map, on the tract level, using the aggregated percentage of all people leaving during any of these nonstandard hours. Finally, to visualize supply, we present a map of the number of slots available for nonstandard hours of childcare by provider by tract.

Results

In this section we summarize the data used and how the maps we create to illustrate the gap between demand and supply of childcare services for children under six in the Greater Boston Area. We start by presenting the summary statistics of the data sets, analyzing each individual map, and then proceed to analyze the relationships between them.

Summary Statistics

Table3: #slots for early ed (unit: slot)					
	N.Valid	Mean	Std.Dev	Min	Max
#slots by neighborhood	811	1668.93	1063.58	6	3430
#slots by providers	811	25.45	36.37	3	325
#slots by tract	811	210.26	200.29	6	1014

Table 3 presents the summary statistics of the number of slots available for children under six, which is what we use to quantify the supply of early education childcare service in the Greater Boston Area. The average capacity of a single provider in this area is 24.7 slots. The average capacity of a neighborhood in total is 1669 slots, and the average capacity per tract is 210 slots.

Table4: Weekdays nonstandard-hour #slots for early ed (unit: slot)					
	N.Valid	Mean	Std.Dev	Min	Max
#off-hour slots by neighborhood	17	41.18	39.86	8	140
#off-hour slots by providers	17	26.35	35.45	6	140
#off-hour slots by tract	17	26.35	35.45	6	140

Table 4 presents the summary statistics of the number of slots available for children under six during nonstandard hours (i.e., 6pm-7:30am) on weekdays, which is what we use to quantify the supply of off-hour early education childcare service in the Greater Boston area. The average off-hour capacity of a single provider is 26 slots, per neighborhood in Boston is 41 slots, and per tract in Boston is 26 slots.

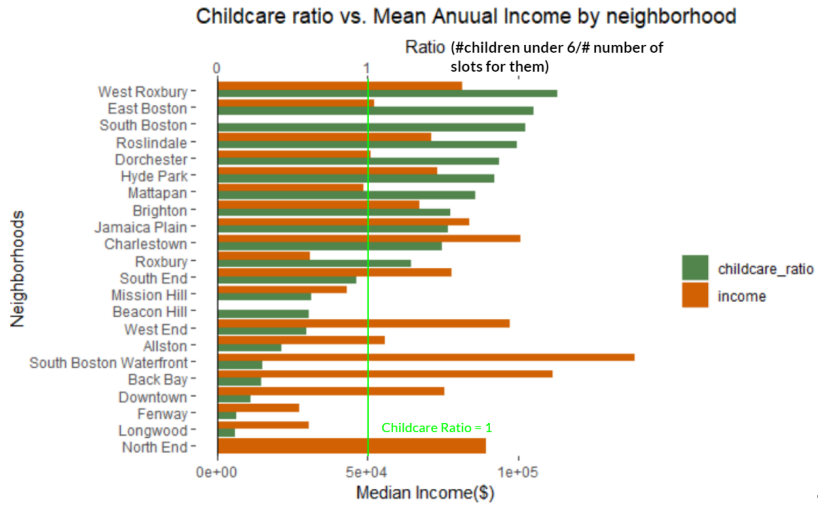

Fig 4. Bar chart of income level and ratio of children to slots

Graphs for Capacity

In this section we conduct graphical analysis on our variables of interest: capacity and hours.

Figure 1 shows the total number of children under six of whom at least one parent is in the labor force (i.e., actively looking for or having a job) in each tract of the Greater Boston Area, which is how we quantify the demand of early ed childcare service. We have interest in this population group since they are target consumers of childcare services for early education. The more children with parents in the labor force indicates a higher demand for childcare. According to this map, the tracts that have the largest number of children who might need childcare are mainly located in East Boston, West Roxbury, Hyde Park, and Dorchester.

Figure 2 shows a map of the number of childcare slots available for children under six on the level of tracts, which is how we quantify the supply of childcare service for children under six. The tracts that contain more slots are located in East Boston, Downtown Boston, and Dorchester, but compared to the map showing demand, the slots are more evenly distributed across tracts. We note that providers in the east and west parts of Boston where there is a large number of children under six with one parent in the labor force, do not offer enough number of slots to fulfill the need of working families in these areas. The difference between supply and demand explains the high ratio of children that might need childcare to slots available in these neighborhoods as shown in Figure 3.

Figure 3 shows the ratio of children under age five to the cumulative child care capacity in the neighborhoods of Boston. The higher the ratio, the more children are competing to obtain a licensed child care slot, and therefore the harder it is for a child in the neighborhood to obtain the childcare service they need. Conversely, the less children are competing to obtain a licensed child care slot the easier it is for a child in the neighborhood to obtain the childcare service they need.

To more closely analyze the ratio map, we present a bar chart which ranks the neighborhoods by the childcare ratio as shown in the Figure 4. The chart shows that no neighborhood achieves 1:1 target ratio–mostare facing a surplus or deficit of early ed childcare services. Secondly, the bar chart indicates that West Roxbury, East Boston, South Boston, Roslindale, and Dorchester have the highest ratio and therefore are facing the most insufficient supply of early education childcare services. Although the

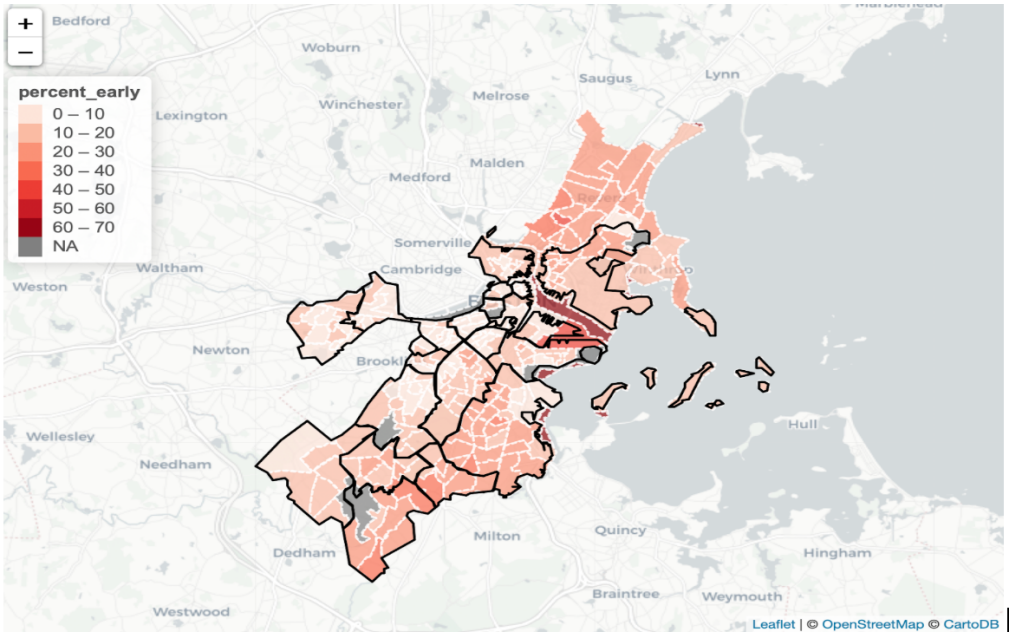

Fig 5. Percentage of people that depart to work in the early morning by tract

relationship between the gap in childcare availability and income was not the focus of this project, one explanation for this could be income. For example, South Boston Waterfront has a good ratio of .3 children to every one slot, meaning there is a surplus of childcare slots, and an average annual income of approximately $138,545. East Boston on the other hand has a ratio of 2.1 children to every 1 childcare slot, meaning there is a deficit of slots, and an average income of $52,008. As seen in Figure 4, there appears to be a negative relationship between average income and ratio of children to slots. This indicates an area to be explored in the future.

Graphs for Hours

In addition to the capacity variables, we also visualize the gap between supply and demand through the hours variable, since irregular working hours is one of the main issues faced by low-income working parents. In this section, we look into the working hours of families and the operating hours of providers to examine whether there is a mismatch.

Figure 5 shows the percentage of parents in tracts who depart for workplaces 12:00am to 6:59am in the early morning. On average, people who live in the East Boston and West Boston leave earlier for work than people who live in other regions. These are also the regions where there are relatively larger number of children under six in need of childcare services as shown in in Figure 3. Specifically, the tracts where the largest percentages of people leave for jobs early are located at are waterfront areas of South Boston and Dorchester.

Figure 6 shows the percentage of people in tracts who leave for work in the early evening between 11:00am and 3:59pm. On average, the number of parents in East Boston, West Boston , and waterfront tracts of Brighton and Allston that leave for work during this period of time is more than in other areas. The tracts where the largest percentages of people leave for work during this time period are located at Roxbury and the waterfront areas of Jamaica Plain.

Figure 7 shows the percentage of people in tracts who leave for work between the

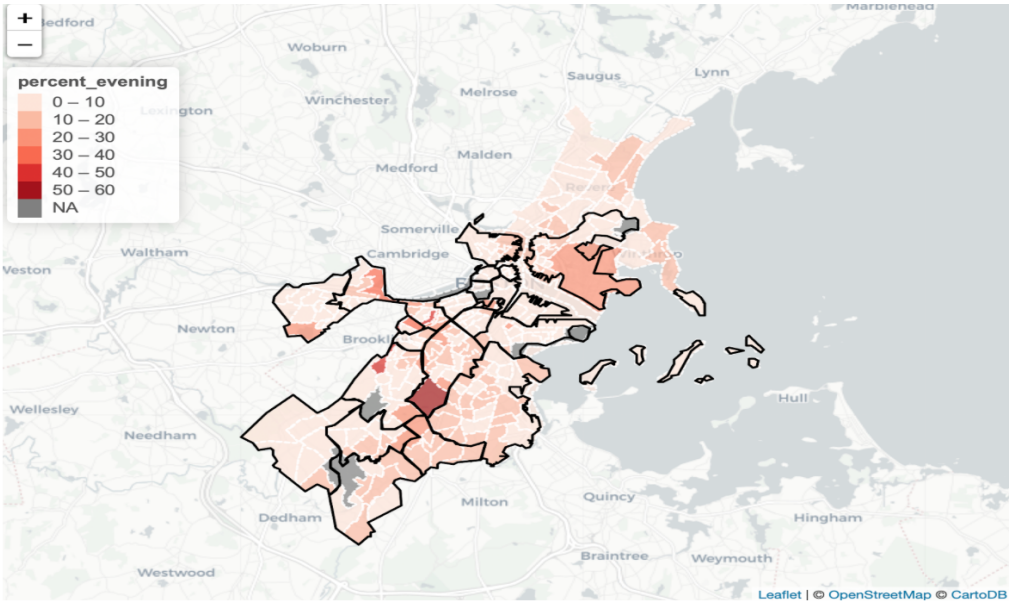

Fig 6. Percentage of people that depart to work in the early evening by tract

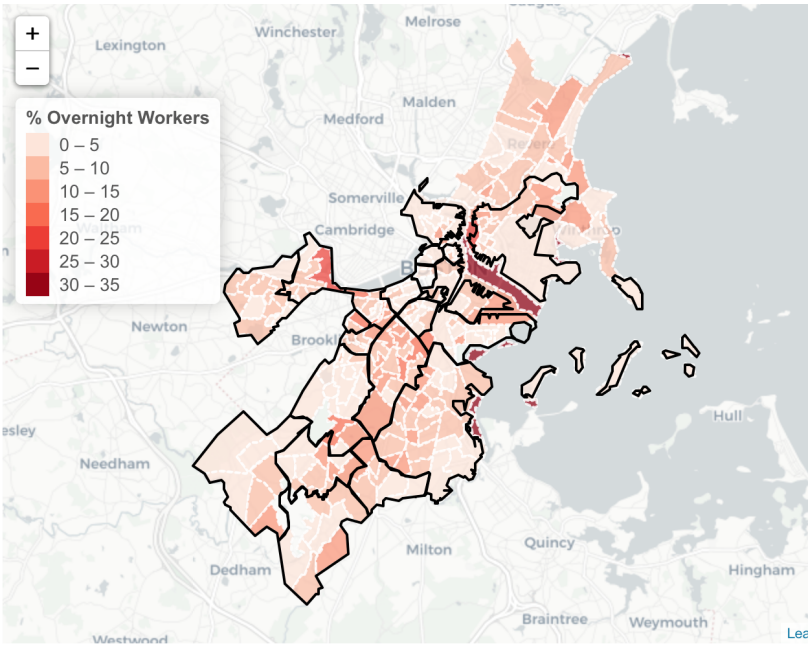

Fig 7. Percentage of people who depart to work overnight by tract

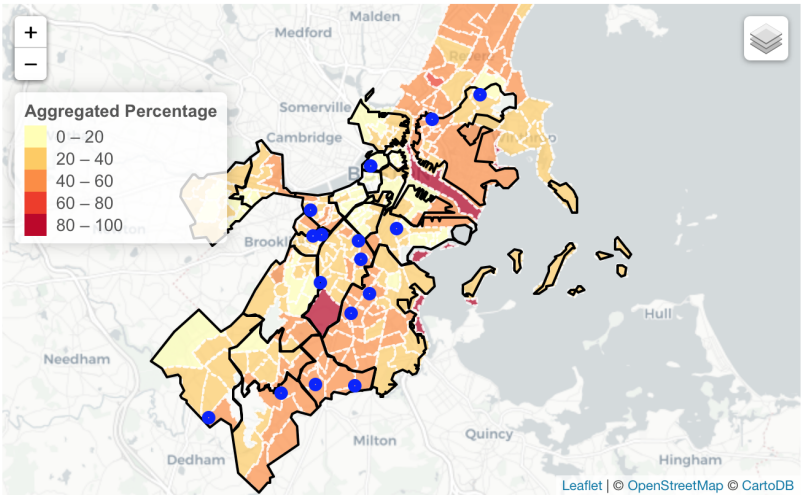

Fig 8. Number of slots in certain tracts by providers who operate off hour during weekdays for early ed

hours of 4:00pm-11:59pm, who we refer to as people that work late evening/overnight shifts. On average, people who live in downtown Boston, West Boston, and South Boston leave later for workplaces than people who live in other regions. These are also the regions where a larger percentage of people leave early and where there are a relatively larger number of children under 6 in need of childcare services. However, the tracts where the largest percentages of people leave for jobs overnight are located in waterfront areas of South Boston and Dorchester.

Figure 8 shows the aggregated percentage map of all people that work nonstandard hours, which we create by adding the percentages found in Figures 5 through 7. The blue dots represent providers that offer nonstandard hour services for children under 6. This map indicates that, generally, East Boston, downtown Boston, Roxbury, South Boston, and waterfront areas are places where the largest amount of people have nonstandard working schedules. However, we can see that there are only a few providers that can take care of children from families in these regions and these providers are located in the areas most in need of off-hour early ed childcare services. There is no provider in the Roxbury or waterfront areas at all. There is a significant lack of irregular hour early ed childcare services across all areas.

Challenges and Limitations

Challenges

There are two main challenges that we faced this project. The first is data cleaning of the EEC dataset. The EEC dataset has a messy data format and a lot of columns that contain information on various variables. For example, to extract information that we need to create the capacity and hours variables, we use various functions and packages from R and Python to clean, merge, and spread several variables from the original dataset. This ncludes minimum age, rates, open and close time of providers (that are composed of strings), and special characters.

The second challenge is the geographical classification. One of the narratives of this project is to look at the supply and demand by the tract and neighborhood levels, the information of which are not provided in the original datasets we are given. We dealt with this issue by geocoding the providers' locations. Using the over function from the

rgeos package, we are deciding which polygon each provider falls within.

Limitations

Our primary limitations in the dataset came from dealing with ACS data, which entirely consists of estimates, as well as the issue of matching variables from census dataset with those from EEC datasets.

First, census data in general consists entirely of estimates. This means that there is inherently a margin of error in all the work that we present, which is not present in any of the maps or tables primarily due to time restraints. Second, some of the variables from the census datasets are based on assumptions different from more practical and realistic situations. Specifically, people's departure time for work is created based on the assumption that people work for the same amount of hours everyday. However, the parents we are most interested in are those that have irregular working hours.

The third limitation was our general lack of ability to match census data variables with childcare provider variables, when trying to quantify the same construct. Although we successfully create the ratio of the number of children under six from working families to the number of slots, using the capacity and children population variables from the provider and census datasets, there are many other variables that the project does not deal with perfectly or could look into. These variables include income level of citizens and subsidy of providers. In addition, the percentage maps we create based on people's departure time for works include the entire recorded population, while our project actually focuses on working parents.

Finally, there is an overall lack of data in the EEC dataset about important variables, such as the capacity of each provider by age groups and subsidy amount in dollars. The absence of these variables prevents us from looking more deeply into the supply side for early education childcare services.

There are many variables that we clean, but do not look into due to the limited amount of time we have. For example: subsidy, availability of drop-in, and emergency services.

Discussion and Conclusion

To examine the inconsistencies in the EEC by highlighting childcare provision gaps in the Greater Boston Area, we use EEC datasets and census datasets to create maps that illustrate a disparity in operating hours and capacity for childcare providers on the neighborhood and census tract level. In short, East Boston and West Boston neighborhoods (including Allston, Boston, South Boston, Brighton, Charlestown, Dorchester, East Boston, Hyde Park, Jamaica Plain, Mattapan, Roslindale, Roxbury, and West Roxbury) are the regions where the gaps apparently exist.

According to the visualizations of the "capacity" variable, providers in East Boston and West Boston, where there is a large number of children under six, do not offer enough number of slots to meet the demands of families in these areas. Similarly, the maps on the "hours" variable indicates that there is a lack of childcare off hour services for working families living in East Boston, West Boston, South Boston, and the waterfront areas of Allston, Brighton, and Jamaica Plain. According to the median income level map of Boston, most of these neighborhoods are also regions where income levels are lower than the average income level of the Boston area [12]. The limited financial capabilities of citizens in these areas might force them to work during irregular hours and to send their children to the childcare providers. On the other hand, the providers in these regions could not provide enough slots for children under six as they could not earn as much money from these low-income families as they could from

families in the central areas. The policy intervention and support from EEC could be urgent to resolve the gap.

In conclusion, our graphical analysis successfully illustrates the existence of the gap between supply and demand for early ed childcare services in the Greater Boston Area. For researchers who are interested in digging more deeply into this topic in the future, we suggest several directions to further explore. First, people could match more variables on the demand for childcare services with variables on the supply for childcare services, to better illustrate the existing gaps. Second, people could try to obtain a more comprehensive dataset from the EEC, to have a closer look at the supply of childcare services for different age groups. Third, people could conduct a childcare survey by themselves to have first-hand information from the providers and families in need of childcare services in Boston. Fourth, people could broaden our research to look at Massachussetts as a whole. There is a lot more that could be done in terms of researching the gaps between supply and demand of early education childcare services, however we hope this research provides a foundational jumping off point.

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