The Journal of
Regional
Analysis
& Policy

JRAP 39(1):71-85.

Understanding Geographic Differences in Child Care Multipliers: Unpacking IMPLAN's Modeling Methodology

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Abstract. Local service sectors including child care have received increasing interest from scholars and policy makers for their role in regional economic development. The IMPLAN input-output modeling system is the most widely used tool to measure the economic importance of the child care sector. Using state-level IMPLAN models for all 50 states and D.C. in the U.S., this paper explores how child care is treated in the IMPLAN system, and how its production functions in state-level models are derived from a national benchmark model. We examine the extent to which such methodology may explain geographic differences in child care multipliers in addition to other exogenous demographic and child care policy variables. Our analysis facilitates interpretation of geographic differences in child care multipliers in state economies and identifies areas for improvement in modeling methodology.

1. Introduction

Recently scholars and policy makers have given increasing attention to local service sectors as "supporting" sectors in the regional economy that promote quality of life (Kay, Pratt and Warner, 2007; Warner and Liu, 2005, 2006; Florida, 2002; Williams, 1997). Similarly, local services have drawn increasing attention as social infrastructures for short-term and long-term economic development (Clavel, Pit, and Yin, 1997; Goozner, 1998). Child care also has received much attention from economic developers and business leaders in recent years (see Warner, 2006, for an overview). Economically, child care is considered an important service sector not only for its size of employment or gross receipts, but also for its linkage effects in the regional economy.

Over seventy state and local teams have conducted regional economic impact studies of the child care sector in recent years, and the IMPLAN system is the most common input-output modeling program used by these studies (e.g., Brown and Traill, 2006; Domazlicky, 2005; Scott, 2005; McMillan and Parr, 2004; Nagel and Terrell, 2005).[1] Multipliers are generated from the IMPLAN input-output system to estimate the sector's linkage effects and economic significance in the state or local economy.

While most studies using I-O models emphasize export-based sectors such as manufacturing, recent literature has applied the method to economic impact analysis of service sectors such as education, public infrastructure, stadiums and sports events (e.g., Wagner, 1997; Blackwell, Cobb, and Weinberg, 2002). Some economists have argued that to more effectively estimate service sectors, a total linkage measure (derived from hypothetical extraction) might be a better measure of economic importance than a backward linked multiplier (Kay, Pratt and Warner, 2007; Pratt and Kay, 2006; Miller and Lahr, 2001). However, the teams conducting child care I-O analysis typically use standard multipliers, and that is the approach adopted in our analysis.

Our interest is in what explains the geographic differences in child care multipliers across states – to what extent it can be explained by the demographic or economic structure of the state, key child care policies,

[1] For a list of studies, please see http://economicdevelopmentandchildcare.org/economic_impact_studies

or the structure of the IMPLAN modeling program itself. IMPLAN is a standardized computer modeling system, and modeling results may depend on the way in which the IMPLAN model is structured, as well as the extent to which data are available for building an input-output model. Child care is an emerging market sector and the quality of national economic data on the child care sector is incomplete. When building regional I-O models, IMPLAN has to estimate necessary database components for the regional model from available data in the national benchmark model. This methodological foundation has direct implications for child care multipliers calculated for state or local economies. A thorough examination of this methodology will help scholars better understand the strengths and weaknesses of IMPLAN I-O modeling, and may identify areas for improvement in modeling the economic linkage of child care and other service sectors.

We start by examining how IMPLAN works in estimating multipliers for state-level I-O models. Using IMPLAN 2000 data, we construct state-level IMPLAN models for each of the 50 states and the District of Columbia (DC). The next section describes output and employment multipliers of child care – Type I and Type II – generated from state-level IMPLAN models, as well as the variance across the 50 states and DC. We then explore how child care, as a service sector, is treated in the IMPLAN system, how its production functions in state-level models are derived from a national benchmark model, and how such methodology affects modeling results with respect to child care multipliers. For the convenience of discussion, we use New York and Alabama as two examples of state economies and focus on output multipliers of child care. By comparing these two contrasting state economies, we show how the IMPLAN methodology affects cross-state differences in child care production functions, and how state output multipliers of the child care sector are generated from IMPLAN models.

Next, we assess the extent to which geographic differences in multipliers are a function of the IMPLAN model structure itself, or are related to state-level differences in demographics, child care policy or overall characteristics of the state economy. We present correlation and regression analysis to assess how geographic variance in child care multipliers is related to cross-state variance in demographics, the structure of the state economy, child care policies, or the modeling methodology adopted by IMPLAN. Discussion of policy and methodological implications is presented in the last section.

2. Child care multipliers from Input-Output modeling

Input-output modeling is based on export base theory in which final demand drives economic growth. The input-output matrix provides a picture of both backward and forward linkages between sectors and with consumers in the regional economy. However, typical input-output analysis, as well as the multipliers derived from it, estimate only backward linkages and economic growth due to changes in final demand. Such final demand includes not only exports, but also household consumption, investment (or dissaving), and government purchase (Pratt and Kay, 2006).

In a state economy, federal funding is an important source of exogenous demand for economic sectors such as child care. Federal funding has grown almost threefold since welfare reform (from $2.5 to $6.5 billion from 1997-2000) (Mezey et al., 2002) and the child care subsidy program has promoted parent labor force participation (Davis and Jefferys, 2007). These subsidies have increased the effective demand of low income parents and resulted in an increase in formal center based child care supply, especially in urban markets with high concentrations of low income and minority residents (Covington, 2007). Using input-output models to analyze changes in federal funding is similar to using them for export-based demand. In other words, although child care is not a typical export-based sector like manufacturing, input-output modeling provides a useful means to describe the nature of backward linkage effects in the regional economy brought by changes in final demand including household consumption as well as federal funding.

We conducted I-O analyses using IMPLAN for each of the fifty states and the District of Columbia using IMPLAN data from 2000. We found that output multipliers of child care are larger than those of most other sectors in most state economies (Warner and Liu, 2005, 2006). On average across the 50 states and D.C., the child care sector ranks in the topmost percentile across all sectors with regards to both Type I and Type II output multipliers. By contrast, child care employment multipliers tend to be lower than other sectors. The child care sector is a labor intensive sector and tends to purchase from less labor-intensive sectors.

Our analysis here is concerned with geographic differences - how and why child care multipliers vary across states. We analyze multiplier results from all 50 states and map them in Figures 1 and 2. Type I output multipliers (not shown) range from a low of 1.32 (Mississippi) to a high of 1.60 (Minnesota, Missouri, and

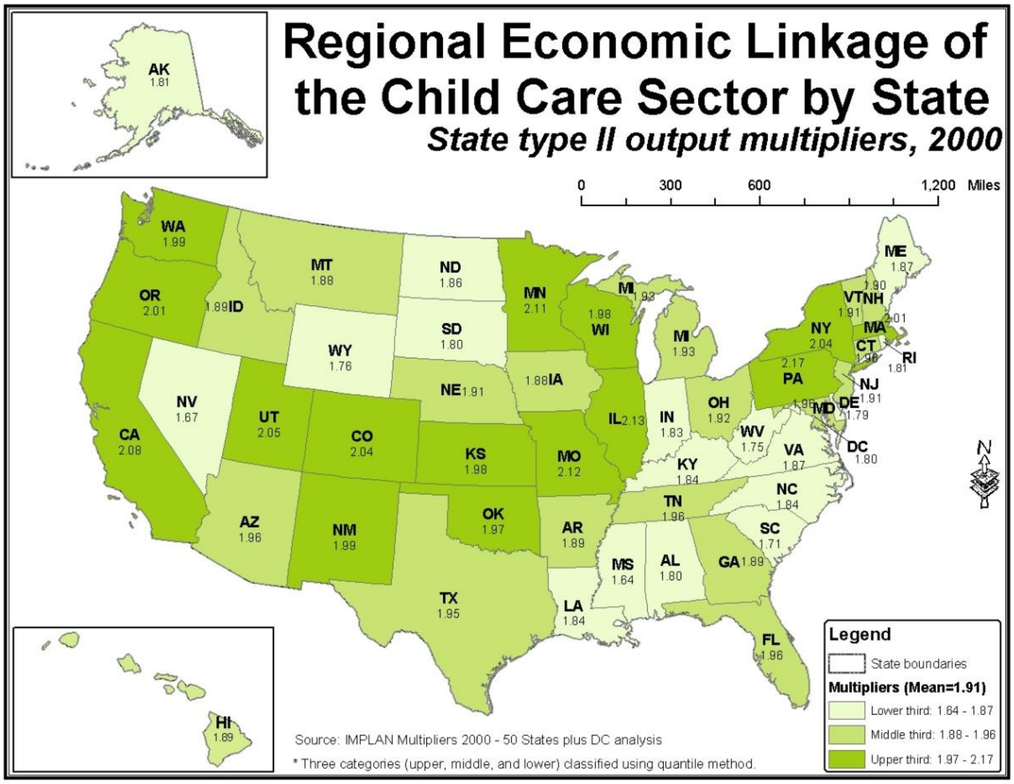

Figure 1: Type II output multipliers of the child care sector by state, IMPLAN 2000

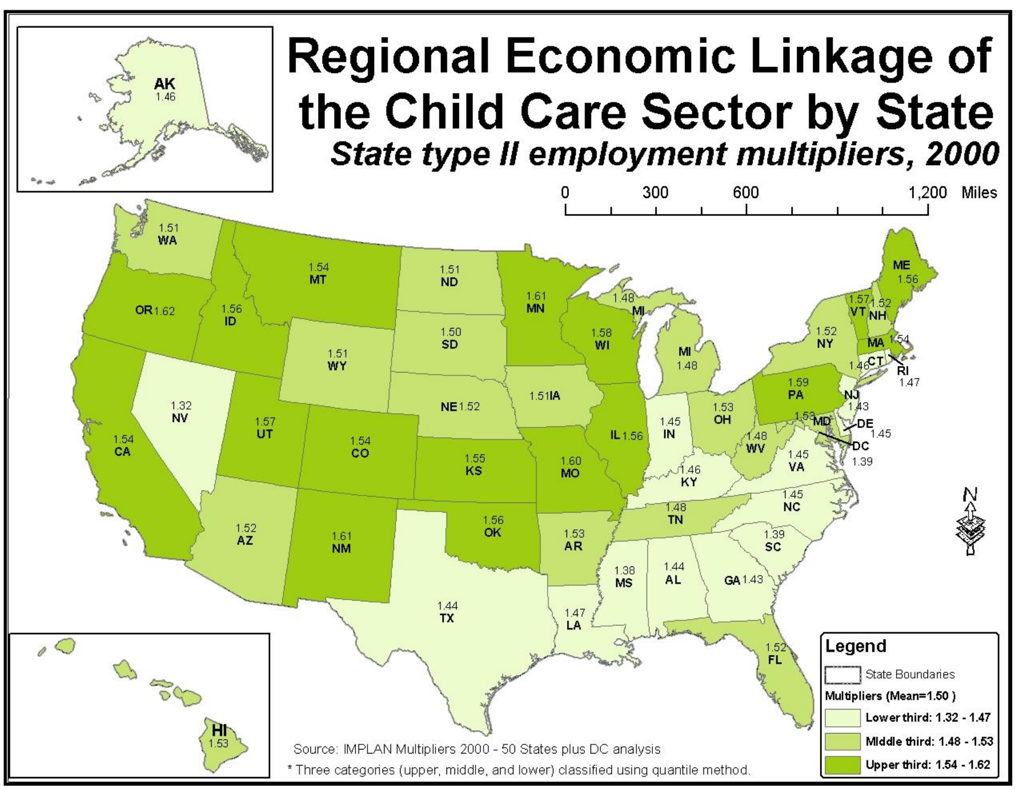

Figure 2: Type II employment multipliers of the child care sector by state, IMPLAN 2000

Pennsylvania)[2], and Type II output multipliers range from a low of 1.64 (Mississippi) to a high of 2.17 (Pennsylvania) (see Figure 1). Child care employment multipliers show less variation across states. Type I employment multipliers of child care (not shown) range from a low of 1.17 (Nevada) to a high of 1.34 (New Mexico), whereas Type II employment multipliers range from a low of 1.32 (Nevada) to a high of 1.62 (Oregon) (see Figure 2).

Figures 1 and 2 map the spatial variation in Type II output and Type II employment multipliers of child care by state. Both maps show similar patterns of cross-state variation. Figure 1 shows that states with lower Type II output multipliers tend to be smaller and have more rural economies such as South Carolina, Mississippi, and Alabama. These smaller economies also have lower child care Type II employment multipliers than other states (Figure 2). States with relatively high Type II output multipliers and Type II employment multipliers tend to be those states with larger economies such as California and Pennsylvania. These larger economies may have greater ability to capture more inter-industry and household purchases and avoid leakages, thus yielding higher multipliers. But important exceptions also exist such as Utah, Oregon, and New Mexico, which have smaller economies but relatively high Type II output multipliers, these higher linkages may be due to the relative geographic isolation of these economies.

However, it is important to recognize that, as a standardized computer modeling system, IMPLAN is based on its own set of assumptions and theories regarding the structure of the regional economy and sources of economic growth. Modeling results often depend on the way in which the IMPLAN model is structured, as well as the extent to which disaggregated data are available for building an input-output model. This is especially true when it comes to regional I-O models and thus IMPLAN often has to derive necessary database components from the national benchmark model in order to build a regional model (Minnesota IMPLAN Group, 2000). What are the implications of IMPLAN methodology for child care multipliers generated from state-level IMPLAN models and their geographic differences across states? This requires an examination of IMPLAN's methodological foundation for construction of regional I-O models.

3. IMPLAN methodology for estimating child care multipliers in state I-O models

Analysis using IMPLAN starts with constructing an I-O transaction table that specifies the inter-industry flows among all sectors and between sectors and final demand in the regional economy using data provided and regularly updated by IMPLAN. In IMPLAN, the production function – the columns of the coefficient matrix in the I-O model (i.e., the 'A' matrix) (Minnesota IMPLAN Group, Inc., 2000, p.101) – shows the relationship between the output of a good and the inputs required to produce that good (IMPLAN Manual, Glossary p. 287). For instance, the child care sector in a state economy needs to purchase from value added sectors (especially labor) and from commodities produced by other sectors. The child care sector may purchase commodities from local producers or import from other states and abroad. Only local purchases constitute intermediate inputs and provide linkage effects in the local economy, whereas purchases of imports lead to leakages. The child care sector's purchase pattern varies across states, leading to different production functions of the child care sector in different state economies.

Ideally, constructing an I-O model requires survey-based information on sales and expenditures by industry in order to identify inter-industry flows as well as imports and exports of goods and services (Harris and Liu, 1998). Yet, unlike methods such as the primary data-based econometric methodology (Lazarus, Platas, and Morse, 2002), IMPLAN builds input-output models using secondary data mainly from sources such as the Bureau of Economic Analysis and the Bureau of Labor Statistics.[3] IMPLAN collects data at national, state, and county levels; however, only at the national level are all data available. At the state level, data reflecting employment and employment compensation are more readily available, but data reflecting inter-industry flows are particularly difficult to collect. Similar data availability problems exist in I-O modeling analysis in other countries such as the U.K. (Harris and Liu, 1998). When constructing a state I-O model, IMPLAN estimates unavailable data information, particularly components of inter-industry flows, based on the national benchmark I-O matrices. Upon collecting national-level data and adjusting it to the state level, the IMPLAN model in 2000 (used in this analysis) then distributes all data into 528 sectors (4 digit SIC in

[2] Complete results can be found in the working paper Liu, Ribiero and Warner, 2004.

[3] Data used by IMPLAN to derive its databases are primarily from federal sources including the Input-Output Accounts from the Bureau of Economic Analysis (BEA), the Covered Employment and Wages Program (ES-202) from the Bureau of Labor Statistics (BLS), and others (Minnesota IMPLAN Group, Inc., 2000).

manufacturing and 2-3 digit for other sectors). This methodology to address data availability problems is key to I-O modeling results regarding child care multipliers.

The rest of this section presents a detailed discussion of how IMPLAN estimates state-specific production functions of child care from the national benchmark production function by taking the states of New York and Alabama as two examples. According to IMPLAN 2000 data, in New York State child care output multipliers are 1.52 for Type I and 2.04 for Type II, whereas in Alabama child care output multipliers are 1.44 for Type I and 1.80 for Type II (author analysis using IMPLAN, 2000). The industry balance sheet report for the child care sector in each state provides the basis for the analysis in this section. This report shows from which sectors and in what proportion child care buys in order to produce one dollar of output, as well as how much it purchases locally. It also includes information about child care purchases from value-added sectors such as employee compensation.

3.1 National production function of the child care sector

The national production function provides the benchmark for IMPLAN to estimate the child care production function in the regional economy. Table 1 provides a summary of the national child care production function, which can be derived from the IMPLAN 2000 National Benchmark I-O Model. In the U.S. economy, about 60% of purchases by the child care sector are goods and services produced by other sectors. The remaining 40% are expenditures on value-added elements including Employee Compensation, Proprietor Income, Other Property Type Income, and Indirect Business Taxes. Among all intermediate inputs, child care purchases primarily from service sectors (26%) and secondarily from manufacturing (12.5%) and FIRE (Finance, Insurance and Real Estate) (11.7%).

Table 1. Summary of child care production function: national and average of 50 states and D.C., IMPLAN2000

	National Production Function	Purchase as percent of total child care expenditure			Local purchase as percent of child care purchase from the sector		
		Mean	Min	Max	Mean	Min	Max
Manufacturing	12.5%	12.8%	11.1%	14.5%	21.1%	4.7%	31.4%
FIRE	11.7%	12.0%	10.4%	13.6%	59.1%	32.5%	70.0%
Services	26.0%	26.7%	23.1%	30.2%	74.4%	40.4%	90.8%
All industries	59.7%	61.3%	53.0%	69.3%	60.5%	40.6%	71.8%

Notes: Mean = Average proportion across 50 states plus D.C.; Min = : Minimum proportion across 50 states plus D.C.; Max: Maximum proportion across 50 states plus D.C.
Source: Author Analysis using IMPLAN, 2000

Moreover, child care's commodity purchases may come from local businesses or from imports. On average, 74.4% and 59.1% of child care purchases from services and FIRE, respectively, are made locally. By contrast, only 21.1% of child care purchases from manufacturing are made locally. The local dependence of child care's inter-industry purchase, relative to other economic sectors, explains the higher Type I multipliers of the child care sector (Warner and Liu, 2005: 45). Table 1 also shows variance in child care purchase patterns across states. The lowest share of child care expenditures on commodities is 53%, while the highest share is 69.3%. Variation in the share of local purchase by child care is even greater, with the lowest share being 40.6% and the highest 71.8% (Table 1). Similarly as shown in Table 2, a higher share of total input by child care is from value-added sectors in New York State (45 percent) than in Alabama (35 percent). This is in part a reflection of higher child care worker wages in New York.

3.2 Adjusting national production function to state models

How does IMPLAN estimate child care production functions for New York and Alabama, given that only information about the national production function is available? As discussed earlier, total input of child care includes its purchases from value added sectors and from commodities. The share of child care purchases from each commodity is the *gross absorption coefficient* of the child care sector to that commodity, and the share of all commodity purchases is the *total* *gross absorption coefficient*. The share of child care purchases from value added sectors is the *value added coefficient*. The two coefficients add up to 1.00 and show the relative proportion of purchases from value added sectors or commodities (industries) to produce one dollar output.

First, both national and regional data are available for determining child care's value added coefficient and total gross absorption coefficient. Table 2 compares both coefficients for New York and Alabama. With respect to the child care sector, the proportions for value added and commodities are, respectively, 45% and 55% in New York State, and 35% and 65% in Alabama (Table 2). After obtaining the coefficients for both national and state models, an absorption adjustment ratio is calculated for the state model by dividing the state-level total gross absorption coefficient by the national coefficient (59.66% for child care as shown in Tables 1 and 2). In New York and Alabama, the absorption adjustment ratios are 0.92 and 1.08, respectively (Table 2). This means that a higher proportion of child care expenditures go to industries rather than labor (value added) in Alabama than in New York.

Table 2. Generating the absorption adjustment ratio for New York and Alabama

	New York	Alabama
Total Gross Absorption Coefficient (Purchases from commodities)	54.79%	64.53%
Value Added Coefficient	45.21%	35.47%
Total Purchases (equal to total output)	100%	100%
National Total Gross Absorption Coefficient	***59.66%***	***59.66%***
Absorption Adjustment Ratio	*0.9184*	*1.0816*

Note: Absorption Adjustment Ratio = state total gross absorption Coefficient/national total gross absorption coefficient.
Source: Author Analysis using IMPLAN, 2000

Second, regionalization is completed by proportionally adjusting the national gross absorption coefficients of child care to the state-level model. This is achieved by multiplying the gross absorption coefficient associated with each sector in the national model times the absorption adjustment ratio for each state model (see Table 3). The resulting column shows the estimated proportion of each element of commodity purchases by the child care sector in the state economy. For instance, the share of child care purchases from services is 24% in New York compared to 28% in Alabama (Table 3). The second largest commodity purchase by child care is from manufacturing, accounting for over 11% of total child care inputs in New York and over 13% in Alabama. As can been seen in Table 3, the absolute values of the coefficients vary by state, but the relative share of the elements of commodity purchases remains the same and is consistent with the national benchmark share.

In addition, child care sector purchases from each commodity may come from local business or imports from other states. The share of local purchase to total purchase is the *regional purchase coefficient* (RPC) of the commodity from which any sector makes purchases. IMPLAN estimates the RPCs for all commodities, that is, how much any sector, such as child care, purchases from a certain commodity locally or through imports.[4] Therefore, the third step in deriving state-specific child care production functions involves multiplying each element of the state-adjusted gross absorption coefficients by the RPC of the commodity purchased. This leads to the proportion of child care's intermediate input from each economic sector in the state economy (Table 4), in other words, the production function of the child care sector in the state I-O model.

For instance, in New York State the RPC of the Services sector is 91%, which implies that 91% of child care purchases from services are from businesses within the state. While in total the share of child care purchases from services is 24%, the share of intermediate input from services to child care is 22% in New York State. By contrast, in Alabama, only 60% of child care purchases from services are made locally. Thus, although child care purchases a higher portion from services in Alabama than in New York, the share of intermediate inputs from services is only 17%, indicating a higher degree of leakage. This may explain the lower Type I output multiplier of child care in Alabama as compared to New York.

[4] In a state model, each commodity has only one RPC estimated by IMPLAN, which does not vary by sector that purchases this commodity.

Table 3. Deriving state-specific gross absorption coefficients for each industry from the national production function, New York and Alabama

10 Aggregated sectors	National Average Gross Absorption Coefficient	New York State Gross Absorption*	Alabama State Gross Absorption*
Agriculture	0.14%	0.12%	0.15%
Mineral	0.01%	0.01%	0.02%
Construction	1.54%	1.42%	1.67%
Manufacturing	12.47%	11.45%	13.48%
Transportation/ Communications/ Utilities	4.20%	3.85%	4.54%
Wholesale	2.21%	2.03%	2.39%
Retail	0.43%	0.39%	0.46%
FIRE	11.68%	10.73%	12.63%
Service	26.01%	23.89%	28.15%
Public Administration	0.97%	0.89%	1.05%
Total Gross Absorption Coefficient	59.66%	54.79%	64.53%

Notes: State Gross Absorption Coefficient = National Average Gross Absorption Coefficient * State Absorption Adjustment Ratio. The Absorption Adjustment Ratio of New York State is 0.9184, whereas that of Alabama is 1.0816.
Source: Author Analysis using IMPLAN, 2000

Table 4. Deriving the child care production function based on regional gross absorption coefficients and RPCs, New York and Alabama

	New York			Alabama		
10 Aggregated sectors	Gross Absorption Coefficients	RPCs	Production Function (A_{ij})	Gross Absorption Coefficients	RPCs	Production Function (A_{ij})
Agriculture	0.12%	0.4221	0.05%	0.15%	0.6580	0.10%
Mineral	0.01%	0.0590	0.00%	0.02%	0.0796	0.00%
Construction	1.42%	0.9394	1.33%	1.67%	0.9486	1.58%
Manufacturing	11.45%	0.2217	2.54%	13.48%	0.2092	2.82%
Transportation/ Communications/ Utilities	3.85%	0.6511	2.51%	4.54%	0.6458	2.93%
Wholesale	2.03%	0.9949	2.02%	2.39%	0.6711	1.60%
Retail	0.39%	0.7470	0.29%	0.46%	0.8813	0.41%
FIRE	10.73%	0.6999	7.51%	12.63%	0.5521	6.98%
Service	23.89%	0.9078	21.69%	28.15%	0.5963	16.78%
Public Administration	0.89%	0.6456	0.57%	1.05%	0.7449	0.78%
Total	54.79%	0.7030	38.52%	64.53%	0.5266	33.98%

Note: Production Function = Gross Absorption Coefficients * RPCs
Source: Author Analysis using IMPLAN, 2000

3.3 Summary: implications for child care production functions and multipliers

The above discussion identifies three steps in IMPLAN's methodology for developing the production function of child care for the state I-O model. First, the absorption adjustment ratio of child care needs to be calculated for each state based on available data regarding total inputs and inputs from value-added sectors. The ratio is generated by comparing the total gross absorption coefficient in the state model and the national coefficient. Second, national gross absorption coefficients are adjusted to state-level gross absorption coefficients according to the adjustment ratios. This leads to adjusted gross absorption coefficients that estimate the share of each element of commodity purchases by child care in the state. Third, the RPCs of commodities, estimated based on regional analysis by IMPLAN, are used to adjust the gross absorption coefficients to the column of the child care production function in state-level models (the child care sector column of the A matrix in the I-O model) and are the key to child care multipliers.

This procedure, however, is not unique to state-level child care multipliers, but reflects IMPLAN's methodology for developing regional I-O databases. For more information, please refer to IMPLAN Professional Manual (Minnesota IMPLAN Group, 2000). This exploration of the IMPLAN methodology implies that two elements of data information are critical in the state-level IMPLAN model. The extent to which the child care production function varies across states first comes from the variation in the state absorption coefficient adjustment ratio. It secondarily is determined by the RPCs of each commodity from which child care purchases. In fact, Table 3 and Table 4 show that how much child care purchases each commodity locally plays a more significant role in determining the variation in child care multipliers by state than the distribution of total child care expenditures across sectors (i.e. gross absorption coefficient). As only local purchases of goods and services by child care creates multiplier effects in the regional economy, the variation in the RPCs across the states determines the geographic differences in child care multipliers[5]. These elements represent the estimates of the structure of the regional economy in terms of the child care sector and the inter-industry linkages.

4. Understanding geographic differences in child care multipliers

Previous sections explained the way in which the IMPLAN methodology may influence the estimates of child care multipliers for state or local level I-O models. Yet maps 1 and 2 suggest that multipliers tend to be larger in larger economies where there is greater ability to capture more inter-industry and household purchases and avoid leakage. Policy variables also may be associated with spatial variances in child care multipliers (Morrissey and Warner, 2007, p. 60). In order to better understand such geographic differences, we conduct correlation and regression analyses of child care multipliers with key demographic, economic, policy, and IMPLAN-generated variables. We consider two different dependent variables: Type II output multipliers of child care and Type II employment multipliers of child care, derived from the state-level IMPLAN models. Our sample includes the 50 states plus the District of Columbia (N=51).

4.1 Correlation analysis

Table 5 shows results from correlation analysis of child care multipliers – Type II output and Type II employment – with key demographic, economic, and policy variables. As can be seen, most of the correlations with child care output multipliers are significant, whereas fewer variables are significantly correlated with employment multipliers.

Type II output multipliers are positively correlated with larger economies as measured by total gross receipts, total state employment, and total population (Table 5). Also, level of urbanization is positively correlated with the Type II output multiplier. Larger and more urban economies are more likely to have the diversity of economic sectors to capture more spending within the state. We also find states with higher median family income have higher child care Type II output multipliers, and states with a higher percentage of children under 6 living with two parents in the labor force have higher child care employment multipliers. This indicates that in states where households have more purchasing power, output linkages are higher; and in states with higher parental labor force participation, employment linkages are higher.

With respect to policy variables, correlation analyses show that child care Type II multipliers tend to be higher in states that spend more federal funds on child care and those that have higher enrollment in state-funded prekindergarten, both of which could increase effective demand for early education services (Table 5). Child care Type II output multipliers are also higher in states that have higher child care worker wages and in states that set subsidy rates at the 75th percentile of market rates. Both variables capture higher receipts to the sector and its workers, leading to higher induced effects. States with lower child-staff ratios (i.e., that require more employees per children served – a measure of higher quality) tend to have higher output and employment multipliers as well. These results suggest a mutually reinforcing relationship between economic linkage and state policies promoting investment in quality (Morrissey and Warner, 2007).

[5] IMPLAN estimates the RPC for each commodity in each state model through a regression model with a small number of variables including total regional employee compensation for industry i, regional employment in industry i relative to U.S. employment in industry i, relative employment shares of industry i in the region, and regional land area as a share of U.S. land area (Minnesota IMPLAN Group, Inc., 2009). However, some economists have challenged the accuracy of RPCs (Stevens, Treyz, and Lahr, 1989). Modifying the estimates of the RPCs of major purchase components of the child care sector may be an approach to achieve better modeling results.

However, these results could be confounded by the fact that many of the states promoting quality and investment in child care also have larger economies. To control for these effects a multivariate approach is needed.

Table 5. Coefficients from correlation analysis of child care multipliers with key demographic, economic, and policy variables

Variables	Type II Output Multiplier	Type II Employment Multiplier
Gross Receipts Total Economy (Logged)	.528(**)	0.016
Employment Total Economy	.470(**)	0.063
Total Population (Logged)	.514(**)	0.055
Percent Urban	.373(**)	-0.057
Population Below Poverty Line as a Percent of Total Population	-.329(*)	-.267
Family Median Income	.334(*)	.037
Children under 6 living with two parents (both parents in labor force) as a share of total children under 6,	.127	.390(**)
Federal Funds (Logged)	.481(**)	0.041
State Funds (Logged)	.580(**)	0.06
Enrollment in State Funded Pre-Kindergarten	.344(*)	0.025
Child/Staff Ratio for 4yr olds	-.365(**)	-.423(**)
Price of Care (75th Percent of Market Rate)	.402(**)	0.184
Child Care Average Wage	.307(*)	0.05

Notes: ** Pearson correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).
Source: IMPLAN Multipliers 2000 - 50 States plus D.C. analysis

4.2 Regression model: dependent and independent variables

We run regression models to examine the extent to which IMPLAN's methodology for estimating state-level production functions, as well as other exogenous variables, accounts for geographic differences in child care multipliers. For the IMPLAN methodology, we include two IMPLAN-generated variables – gross absorption coefficient of the child care sector and local purchases as percent of child care purchases from Services. We choose four other sets of independent variables reflecting the complexity of the state economy, possible leakages from the state economy, induced effects in the child care sector, and a set of demographic factors as control variables. See Table 6 for descriptive statistics for dependent and independent variables.

Complexity of the State Economy: Greater complexity of the state economy suggests higher linkages between economic sectors, hence possibly higher child care multipliers. We consider urban population as a percentage of total population from Census 2000 data to reflect a more complex structure of the state economy. We also include two variables measuring relative linkage of the state economy: median multipliers across all sectors in the state, and the state-specific regional purchase coefficient for child care, both from IMPLAN 2000 data. States with a higher percentage urban population, larger median multipliers, and larger child care RPCs are expected to have larger child care multipliers.

Possible Leakages from the State Economy: We first consider two variables: median family income and size of the state measured by land area in square miles, both from Census 2000 data. Whereas higher median family income may suggest higher household purchasing power – as indicated in the correlation analysis – high-income families also have a greater tendency to spend outside the state, causing higher leakages from the state economy and driving down child care multipliers. States which are larger in size are expected to have lower leakage and hence higher child care multipliers. To account for child care sector structure, we include as variables the percent of children under six in paid care and children receiving subsidies in center-based care as a percent of all children receiving subsidies. Informal child care services and formal family-based care are undercounted in the input-output model due to IMPLAN's reliance on BEA establishment data, which does not include self-employed providers. A higher percentage of center-based care means backward linkages are more likely to be captured in the model, and thus lead to higher child care multipliers.

Variables related to Induced Effects: Child care wage rates provide a measure of child care worker spending which is captured in the induced effects component of the child care multipliers. Government involvement in the child care market not only affects the final demand for child care services, but also the value-added sectors in child care (e.g. wage increases), thereby leading to higher induced effects and higher child care multipliers. We incorporate child care policy variables including the reimbursement rate at the 75th percentile of market rate, percent of eligible children receiving subsidies, and total federal Child Care Development Funds (CCDF) for each state.

Other Control Variables: We also include a set of control variables in the model such as non-white population as a percent of total population from Census 2000 data, unemployment rate from BLS 2000 data, and percent of children under 6 living with two parents (both in labor force). All three variables are considered "demand shifters" to the child care sector, with the former two reducing demand for child care in the formal market and the last variable increasing demand. Although they may not directly relate to linkage effects in the state economy, it is worthwhile to control possible influences by demand shifters in the regression model. In fact, correlation analysis found the latter two variables may have significant explanatory power on variation in child care multipliers (Table 5).

Table. 6 Descriptive statistics of dependent and independent variables

Variable Names and Data Sources	Min	Max	Mean	Std. Dev.
Child Care Output multipliers (Type II), IMPLAN	1.64	2.17	1.91	0.12
Child Care Employment multipliers (Type II), IMPLAN	1.32	1.62	1.50	0.06
Median output multipliers (Type II) across all sectors, IMPLAN	1.46	1.82	1.64	0.09
Median employment multipliers (Type II) across all sectors, IMPLAN	1.59	2.24	1.96	0.15
Regional Purchase Coefficient for child care, IMPLAN	0.65	1.00	0.95	0.10
Urban population as a percent of total population, Census	38.2	100.0	72.2	15.3
Land area in square miles, Census	61	571,951	69,362	85,696
Median family income in 1999, Census	36,484	65,521	49,184	7,049
Percent of children under 6 in paid care: Kids Count Data Book 2003 (CPS est. 1999-01)	20.0	47.0	28.8	6.0
Center as percent of total: licensed or regulated, CCB 1999 (missing value -NH)	12.8	97.2	52.1	20.5
Average annual wage for child care workers, BLS	12,990	21,060	15,828	1,751
Reimbursement rate 75th percentile as of March 2000 (monthly - in dollars), CDF 2000	260	844	473	133
Percent eligible children receiving child care subsidies (CCB 1999)	3.00	25.00	11.55	4.37
Total Federal Funds (Logged), CCB 1999	16.7	21.0	18.6	1.1
Non-white Population as a share of total population Census	3.1	75.7	21.5	14.5
Unemployment rate, BLS	2.2	6.7	3.9	1.0
Children under 6 living with two parents (both in labor force) as a percent of total children under 6, Census	21.0	53.4	38.9	6.5
Total Child Care Expenditure (Gross Absorption Coefficient) IMPLAN	53.0	69.3	61.3	3.6
Child Care Purchases from the Services Sector (spent locally) IMPLAN	40.4	90.8	74.4	11.97

Notes: IMPLAN, BLS, and Census Data are from the year 2000. N= 51 (50 states plus D.C.).

4.3 Model results

We run four models for each of the two dependent variables. In Model 1, we include all independent variables. In Model 2, we leave out two IMPLAN-generated variables we found to be key sources of difference in state-level child care production functions (gross absorption coefficient of child care and child care purchases from the Services sector spent locally). In Model 3, we also exclude median multiplier for the state. It is not a structural input to the IMPLAN modeling system (our primary focus) but an output. However, excluding it allows us to assess the explanatory power of other policy, demographic and economic variables exogenous to the IMPLAN model. In Model 4, we include only IMPLAN-generated variables. The results of the models are shown in Table 7 and Table 8.

Table 7. Regression results: child care Type II output multipliers

	Model 1	**Model 2**	**Model 3**	**Model 4**
	Coefficients	**Coefficients**	**Coefficients**	**Coefficients**
(Constant)	-0.53	-0.473	0.145	-0.267
Median output multipliers (Type II)	0.982 (***)	1.223 (***)		0.989 (***)
RPC of child care	0.039	0.13	0.179	0.022
Percentage urban population	0.001 (**)	0.002 (**)	0.004(***)	
Land area in square miles	-7.76E-08	-1.19E-07	1.56E-07	
Median family income in 1999	-7.74E-07	-4.59E-06(*)	-6.5E-06	
Percent of children under 6 in paid care	3.56E-05	-0.002	-0.004	
Center as percent of total: licensed or regulated	1.18E -04	-0.001	-0.001	
Average annual wage for child care workers	1.34E-06	1.65E -05 (**)	9.67E-06	
Reimbursement rate 75th percentile as of March 2000 (monthly - in dollars)	3.49E-05	5.47E-05	-3.3E-05	
Percent of eligible children receiving federal child-care subsidies in FY 1999	3.29E-04	0.001	0.002	
Total Federal Funds (CCB 1999) logged	-2.2E-04	-0.017	0.062(***)	
Percent Non-white population	9.85E-05	0.001	0.000	
Unemployment rate	0.003	0.023 (*)	-0.002	
Percent of children under 6 living with two parents (both in labor force)	0.002	0.009 (***)	0.012(**)	
CC Gross Absorption Coefficient	0.004			0.002 (**)
CC purchases from the services sector (spent locally)	0.005 (***)			0.005 (***)
R square	0.969	0.868	0.591	0.956
Adjusted R Square	0.954	0.815	0.444	0.952

Notes: Dependent Variable: Output multipliers (Type II) for the child care sector, IMPLAN 2000
(***) Variable significant at 0.01 level; (**) Variable significant at 0.05 level; (*) Variable significant at 0.10 level.

Median output multiplier and percentage urban population are significant in all models where they are included, and the coefficients are positive, confirming that states with more complex economies tend to have higher child care output multipliers (see Table 7). In Model 1, percentage urban population is the only non-IMPLAN variable that shows significant impact on child care output multipliers, but further exploration shows multicollinearity among variables in Model 1[6].

In Model 2, where two IMPLAN-generated variables describing the child care production function are dropped, more demographic, economic, and policy variables appear significant. Among all variables reflecting leakages only median family income is

[6] Multicollinearity diagnosis for Model 1 shows that variables with the most serious collinearity problems are percent of children under six living with both parents in labor force (VIF=8.5) and gross absorption coefficient (VIF=6.4). Excluding gross absorption coefficient in Models 2 and 3 significantly improves the situation, although the VIF for percent of children under six living with both parents in labor force remains about 6.9. Excluding median output multipliers in Model 3 does not change the results.

significant, and the coefficient is negative. This result is in contrast to prior correlation results, but may reflect the greater savings rate and higher tendency to spend outside the state economy (i.e., higher leakage) among higher income earning groups. In addition, higher child care output multipliers tend to appear in states with higher child care wages, lower unemployment, and higher percentage of children under six living with two parents in the labor force. However, these coefficients are small, indicating weak substantive significance of these variables despite the statistical significance found in the regression model. In Model 3, where median output multiplier is dropped, we find only percent urban, federal CCDF funds and percent children under six with two parents in labor force are significant. The adjusted R^2 drops by almost half compared to Model 2 – a reflection of the importance of the median output multiplier variable. In Model 4 where only the IMPLAN-generated variables are included, we see the model performance is almost the same as the full model (Model 1). Results from Model 4 show that most of the variation in child care output multipliers is explained by the IMPLAN variables: median output multipliers, the gross absorption coefficient for child care, and the proportion of child care purchases from the Services sector that are made locally (adjusted R^2 = 0.952).

Table 8 presents results from the regression analysis on child care Type II employment multipliers.

Table 8. Coefficients from regression on child care Type II employment multipliers

	Model 1	Model 2	Model 3	Model 4
	Coefficients	**Coefficients**	**Coefficients**	**Coefficients**
(Constant)	1.637	0.89	0.853	0.442
Median employment multipliers (Type II)	0.27 (***)	0.431(***)		0.193 (***)
RPC of child care	0.031	0.161 (**)	0.176 (*)	0.051
Percent of urban population	8.23E-05	0.001	0.002 (*)	
Land area in square miles	7.27E-08	3.41E-08	2.46E-08	
Median family income in 1999	-3.05E-06 (***)	-3.75E-06(**)	-5.68E-06 (**)	
Percent of children under 6 in paid care	-0.001 (*)	-0.003 (**)	-0.004 (*)	
Center as percent of total: licensed or regulated	-0.001 (**)	-0.001 (***)	-0.001 (**)	
Average annual wage for child care workers	-1.05E-05 (**)	6.51E-06	4.40E-06	
Reimbursement rate 75th percentile as of March 2000 (monthly – in dollars)	-1.70E-05	8.95E-05	7.96E-06	
Percent of eligible children receiving federal child-care subsidies in FY 1999	0.001	0.002	0.001	
Total Federal Funds (CCB 1999) logged	-0.014 (*)	-0.034 (***)	0.018 (*)	
Percent of Non-white population	0	0.001	0.000	
Unemployment rate	0.007	0.024 (**)	0.012	
Percent of children under 6 living with two parents (both in labor force)	0.004 (**)	0.006 (**)	0.009 (***)	
CC Gross Absorption Coefficient	-0.008 (***)			0.005 (***)
CC purchases from the services sectors (spent locally)	0.003 (***)			0.004 (***)
R square	0.922	0.77	0.499	0.757
Adjusted R Square	0.884	0.678	0.318	0.735

Notes: Dependent Variable: Employment multipliers (Type II) for the child care sector, IMPLAN 2000.
(***) Variable significant at 0.01 level; (**) Variable significant at 0.05 level; (*) Variable significant at 0.10 level.

Again, most of the cross-state variation in employment multipliers is due to the overall inter-industry linkage in the total economy (median employment multiplier), the gross absorption coefficient for child care, and the proportion of child care Services sector purchases spent locally (see Model 4 in Table 8, adjusted R^2 = 0.735). More exogenous variables are significant in regression models for employment multipliers than is the case for output multipliers, and the adjusted R^2 of Model 1 (0.884) is larger than that of Model 4 with only IMPLAN-generated variables (0.735). Two variables reflecting possible leakages – median family income and percentage of children under six in paid care – are significant and the coefficients are negative as expected. We see that higher employment multipliers for child care are related to a higher proportion of children under six with two parents in the labor force, higher unemployment rate, and lower median family income, similar to regression results for output multipliers (see Model 2 in table 8). Ironically, percent of children in paid care and center-based care as a percent of total licensed care are negatively related to child care employment multipliers, contrary to our hypotheses. Among all variables related to induced effects, only total Federal CCDF funding is significant, and the coefficient is negative in Model 1 and 2. Recall that the employment multiplier measures the extent of employment linkages generated by increased demand for child care. This suggests that investments in labor intensive sectors such as child care will absorb most of the impact of increased final demand directly, and linkage effects will be small since the sector is linked to sectors that are relatively less labor intensive. Important differences are found between Model 2 and Model 3. Exclusion of the median employment multiplier allows Model 3 to show the importance of urban complexity and federal CCDF funds on child care linkage effects. As in the output models, we see that Model 2 has twice the explanatory power of Model 3, reflecting the importance of the median multiplier of the overall state economy in explaining geographic differences in child care multipliers.

5. Discussion: policy and methodological implications

The IMPLAN input-output model system has been widely used in regional economic analysis of the child care sector. Our analysis shows how IMPLAN, as a standardized modeling system, is based on its own set of assumptions and methods for estimating the production functions for regional economic sectors. Subnational input-output analysts using IMPLAN should be aware of the difficulty that IMPLAN faces when collecting all necessary data at the state and local levels. Despite these limitations, IMPLAN provides a useful basis for comparison between the child care sector and other sectors in terms of their linkage effects in the regional economy. The internal consistency of IMPLAN's modeling assumptions and data sources across all economic sectors and states makes it possible to bring a comparative analysis to the economic importance of child care in the state economy.

Correlation analysis shows strong correlation between child care multipliers and key policy variables. Low child-staff ratios, higher child care worker wages, higher subsidy reimbursement rates, and higher government investment in child care overall are positively correlated with higher child care output multipliers. This suggests that investment in child care can have a positive short term effect on the overall state economy, as well as a positive long term effect on the child care industry by increasing effective demand and promoting quality services. However our regression analysis demonstrates the strong relation between child care multipliers and IMPLAN structural modeling features such as state-specific gross absorption coefficient of child care and child care purchases from the Services sector made locally. Not surprisingly, state differences in multipliers are closely linked to state-specific child care production functions estimated by IMPLAN. Nonetheless, it is state median multipliers – a proxy for the complexity of the state economy – that shows the highest explanatory power on cross-state variance in child care multipliers. Other measures of economic integration (percent urban), child care demand and policy variables are of less importance when IMPLAN structural variables are included. Given that the structural variables are more important, future modelers may wish to give attention to adjusting these variables with better state level data. In fact, the IMPLAN program provides flexibility to modify the default production function developed for state and local models to better reflect the reality of the sector.

For the child care sector, the most important area for improvement may be in the valued added elements, particularly labor (employee compensation). IMPLAN relies on BLS data for employment which significantly undercounts the self-employment (family child care) component of the child care industry. Much of the informal sector of child care services is also uncounted. Nearly 90% of child care purchases from value added sectors are employee compensation, while almost zero proportion of child care expenditure is from Proprietary Income. Family providers (self employed) can account for more than half of all market based child care in some states (Choi et al., 2009, Warner, 2006, 2007). Although IMPLAN adjusts for self employment, the adjustment for child care still misses a very large portion of employees (more than half of the total in the New York case). The percentage of child care expenditure on employment compensation (about 30-40%, varied across states) is also relatively low compared to industry budget estimates which find that centers typically report 75-80% of costs are labor (Copeland, 1991). Both problems are related to the source of labor and business data that IMPLAN uses to measure the child care sector which primarily counts center-based care. Thus, modifying the child care production function with data from state administrative sources may better reflect the economic structure of child care in the state and yield better estimates of multipliers from the IMPLAN model (see Choi et al., 2009, for an example). Furthermore, IMPLAN allows only one production function for each of the 528 sectors in the state economy. Yet, each sector consists of different types of businesses which may have very distinctive purchase patterns, i.e., in child care, center care versus family care. Thus adjusting the state-level production functions to reflect differences in sector composition could be integrated into the IMPLAN I-O models to better reflect the actual structure of child care in a particular state.

6. Conclusion

Many scholars have argued that child care – as a local service sector – has important short-term economic impact in the regional economy in addition to its long-term importance for human development. Bringing child care into regional economic modeling has raised important methodological challenges in demonstrating the economic significance of local service sectors in their own right (Pratt and Kay, 2006; Pratt, Kay and Warner, 2007; Warner, 2006). Child care is an emerging market sector, and standard economic data sources undercount the many small centers and self employed providers that comprise the sector. Most of the state teams which conducted child care regional economic I-O studies adjusted the labor and gross receipts measures with data from state licensing records. These data typically revealed a child care sector twice as large as that captured in BLS establishment data on which IMPLAN is based. This is particularly because employment in the family child care sector is not counted in BLS data. However, no study adjusted the structural IMPLAN variables related to the production function for child care inside the IMPLAN model. Our analysis has unpacked the structure of the IMPLAN production function for child care and shown this is another important arena for improved modeling work. By looking across states and comparing other economic, demographic and policy variables with IMPLAN structural variables, we are able to show the importance of those structural variables. Future modeling work should give more attention to the structure of the IMPLAN-derived production functions.

Acknowledgements

This research was conducted as part of the larger Cornell University Linking Economic Development and Child Care Research Project supported by the US Department of Health and Human Services, Administration for Children and Families, Child Care Bureau research funds. The article builds in part from prior research conducted with Rosario Ribeiro. We would also like to thank James Pratt and David Kay for earlier critiques of our work, as well as the insightful comments of three anonymous reviewers.

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