Revising Income Eligibility for the National School Lunch Program: Analyzing Indifference Scales in Households with Children

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Abstract

The National School Lunch Program (NSLP), the largest child nutrition initiative in the United States, provides free or reduced-price lunches to low-income children, enhancing health outcomes and educational performance. However, the current eligibility criteria based on Federal poverty guidelines assume equal resource distribution among household members and do not differentiate between adults and children, potentially causing bias that does not adequately protect children in need. This study develops a new eligibility criterion tailored specifically for children and considers intra-household resource share. Using the indifference scale and data from the U.S. Consumer Expenditure Survey (CES), we provide the first estimates of the resource share allocated to each child and economies of scale for the most common household types in the U.S. Our findings suggest that the eligibility threshold for two-child households requires a minor adjustment, while thresholds for households with three and four children need significant increases, specifically from $65,000 to $73,125 and from $74,518 to $85,543, respectively.

1. Introduction

The National School Lunch Program (NSLP), the largest child nutrition initiative in the U.S., provides free or reduced-price lunches to low-income children. Studies show that participation in the NSLP enhances health outcomes (Gundersen et al., 2012) and improves educational performance (Hinrichs, 2010). Participants typically consume more essential vitamins and minerals, maintaining a balanced diet with higher dietary fat and lower added sugars compared to nonparticipants (Gleason & Suitor, 2003). Recent findings also indicate the NSLP's effectiveness in reducing food insecurity among households with kindergarten-aged children (Arteaga & Heflin, 2014). Eligibility for the NSLP is based on the Federal poverty guidelines published annually by the United States Department of Health and Human Services. Specifically, households with incomes at or below 130 percent of the Federal poverty level qualify for free meals, while those with incomes between 130 and 185 percent qualify for reduced-price meals.

There are two primary concerns with the eligibility criteria being tied to the federal poverty line for the NSLP program. First, they are derived from an equivalence scale, which accounts for economies of scale but assumes equal distribution of resources among household members, such as in a household of one child and two adults where each is presumed to receive one-third of the resources. Numerous studies, including Calvi et al. (2023), indicate that children often receive less than their expected share—for example, less than one-third in a three-person household for many households. This leads to situations where children in households with incomes above the poverty line still lack resources sufficient to meet daily needs. Consequently, these impoverished children within wealthier households miss out on safety net programs when the eligibility criteria are set at a standard that does not account for intrahousehold distribution within the household.

Second, the Federal poverty line adjusts for household size but does not account for whether the additional members are adults or children. For example, in 2023, the poverty line is set at $24,860 for a three-person household and increases to $30,000[5] for a four-person household. The additional $5,140 is consistent whether the new household member is an adult or a child. However, this uniform figure from the Federal poverty line fails to account for the unique needs and differences in resource distribution when a child is added to a household, rendering it unsuitable for use in the NSLP program.

To address these issues, this study develops a new eligibility criterion for the NSLP program that considers intra-household resource distribution and is specifically tailored for children. A child's welfare within a household is influenced by two crucial factors: *resource share*, which determines the portion of household resources allocated to the child, and *economies of scale*, which affect the overall living cost for all household members. Empirically, these factors are challenging to assess due to two main sources. First, consumption datasets typically record data at the household aggregate level and do not detail how resources are distributed among individual members, especially in shared expense categories like food and housing. Thus, it is challenging to calculate the resource share for each household member directly. Second, even with detailed data, empirically comparing utility levels among individuals is challenging due to the requirement of utility cardinalization. This method is typically avoided in empirical research due to its complexity and theoretical constraints.

To address this complexity, we used a concept called the indifference scale (Browning et al., 2013), which quantifies the portion of household expenditure required to maintain equivalent

[5] https://www.govinfo.gov/content/pkg/FR-2023-02-09/pdf/2023-02739.pdf

welfare levels for *the same* child across different household compositions. We then applied this model using household expenditure data from the U.S. Consumer Expenditure Survey (CES), to empirically estimate the resource share allocated to each child and the economies of scale for various household types, including couples with 1, 2, 3, and 4 children. Our findings indicate that our estimated indifference scale, particularly when averaging the indifference scales for fathers, mothers, and children, aligns with the indifference scales set by the current eligibility criteria of the NSLP. Yet, when focusing solely on the indifference scale for children, adjustments are necessary. The eligibility threshold for two-child households should be slightly reduced from $55,500 to $52,935. In contrast, the thresholds for households with three and four children need significant increases, moving from $65,000 to $73,125 for three children, and from $74,518 to $85,543 for four children. Under the current NSLP criteria, larger households, particularly those with three or four children, are not adequately protected.

Our study makes two key contributions. First, it provides the first estimates of indifference scales for households with children in the United States. This offers novel insights into how resources are distributed among household members and how economies of scale vary with household composition. Second, our analysis has important policy implications for the National School Lunch Program (NSLP). Based on our findings, we recommend revising the eligibility criteria specifically for households with three and four children to better account for the relationship between household composition and program eligibility.

The rest of the paper is organized as follows: Section 2 discusses the modeling framework, Section 3 presents the estimation results, Section 4 explores the policy impacts, and Section 5 concludes with a discussion of the findings.

2. Theoretical model

This section will illustrate how to identify household members' resource allocations, household economies of scale, and indifference scales using solely household expenditure data. Our methodology draws from previous studies by Browning et al. (2013), Dunbar et al. (2013), and Calvi et al. (2023), which demonstrated that, with a minimal level of assumptions, it's possible to identify the above-unobserved components by comparing household budget share functions for private assignable goods across various household types. The underlying idea of this approach is that holding household total expenditures to be the same and assuming household members' preferences for specific private assignable goods remain constant regardless of their household type, any changes in household members' consumption behavior can be attributed to alterations in resource allocation and economies of scale. These changes are modeled as two defaltors that scale down or up total household expenditures, which can be derived by simultaneously estimating all household budget share functions. Below, we outline a model to describe household consumption behaviors across different household sizes and then demonstrate how to identify resource shares and economies of scale based on household expenditure patterns.

In this paper, we consider four types of households: couples with one, two, three, and four ($n = 1, 2, 3, 4$) children. Throughout the analysis, n is also used to denote the household type. To determine the allocation of resources and economies of scale within households, we adopt the collective household perspective introduced by Browning et al. (2013) (henceforth BCL). This model views households as collections of individuals ($i = m, w, c,$ representing man, woman, and child, respectively) collectively make decisions regarding the purchase and consumption of a bundle of goods $k = (1,2, \dots K)$. The number of women, men, and children is denoted by $m_{i,n}$. Household consumption is subject to the constraints of the household budget $\exp(x)$ and market prices $p = (p^1, p^2, \dots, p^K)$. Each household member can receive a respective share of resources $\eta_{i,n}\exp(x)$ and benefit from the economies of scale of living together. Although BCL has been widely recognized as a seminal work, it has the limitation of not being able to identify the resource share of children as there is no reference individual. That is, we need to compare the well-being of children who live with a family with that of children who live alone, which rarely exists. Moreover, the BCL model is not able to identify the exacet economies of scale of each household. To overcome this limitation, this study employs the identification strategy proposed by Calvi et al. (2023), which allows for the identification of both adult and children's intrahousehold resource shares and household economies of scale. The model shows the identification could be realized based on comparing the Engel curves of private assignable goods.

The model describes household consumption by three important parts: resource share function, economic of scale function, and individual's utility function. The first one captures how resources are distributed within the household based on each household member's bargaining power. The second one reflects how much household members could benefit from living together. The two functions together could be used to compare the household members' material well-being when they live in different types of households. For example, a female living with her patterner may receive less resource share compared to living alone, but she may share some expenses with her patterner, like rent and gas. Thus, purely using resource share or economy of scale to infer one's living situation is clearly not inclusive. Third, the model requires the preference of each household member to be represented by a well-behaved (monotonic, strictly quasi-concave, and three times continuously differentiable) indirect utility function.

Resource share function. The resource share function is justified by the efficiency assumption in the collective household model. That is, for any (p, x), there exists a differentiable, zero-homogeneous resource share function $\eta(p,x)$ to make the outcome of the household decision process is Pareto efficient. The parameter η could also be interpretated as "bargaining power". Thus, η may also depend on other factors, such as the household members' relative education level, relative income level, and other factors of the household living status. In previous literature, these factors are usually called distribution factors. Here we note them as $z_{i,n}$. Each household member i living in a collective household receive a certain share $\eta_{i,n}(p,x,z_{i,n})$ of resource. The resource share $\eta_{i,n}(p,x,z_{i,n})$ is between zero and one and sum up to one. If $\eta_{i,n}=1$ then the household behaves as individual i is the effective dictator. Further, following Lewbel and Pendakur (2008), we need the following assumption:

Assumption 1. The resource share function is independent of household total expenditure e^x, that is, $\eta_{i,n}\left(p,x,z_{i,n}\right)=\eta_{i,n}(p,z_{i,n})$.

This assumption highly simplifies the model and the identification process. Recently, several empirical results supported this assumption. Menon et al. (2012) shows that for Italian households, resource shares do not exhibit much dependence on household expenditure. Cherchye et al. (2015) and Bargain et al.(2018) also find similar results using data of Dutch and Bangladesh. Bargain and Donni (2012) show that the identification results of indifference scale still hold when the sharing functions depend on total expenditure. Thus, in this paper, we will drop household total expenditure e^x from the resource share function.

Economies of scale function. The economies of scale for individual living in a collective household comes from the publicness of some goods. Suppose we observed a collective household purchased a bundle of goods $Q_n=(Q_n^1 \dots Q_n^K)$ with market price p, and the quantity of goods that each member in this household consumed is $q_{i,n}=\left(q_{i,n}^1 \dots q_{i,n}^K\right)$. For purely private goods, the household consumption equals to the sum of all household members consumption. For public goods, the household consumption is smaller than sum of all household members consumption. In Calvi et al. (2023), they used Barten scales to indicate to what extent the sum of household members consumption exceeds the household purchased quantity. The Barten scales can be summarized by a vector $\alpha_n = (\alpha_n^1 \ldots \alpha_n^K)$, such that $Q_n^k = \alpha_n^k \sum_i q_{i,n}^k$. In another point of view, the Barten scales could be used as price-deflators, which indicate to what extend the shadow price of each good to household members is cheaper than market price. The shadow price of each good $\alpha_n^k p^k$ is identical to all household members, and it only depends on the publicness of good k. If good k is a private good, then $\alpha_n^k = 1$, the shadow price of good k equals to market price. If good k is shared among household members, then $\alpha_n^k < 1$ and the shadow price is lower than the market price.

Individual's and household's indirect utility function. In the previous two sections, we showed how resource is allocated to each household member and how household members benefit from living together. Given the resource share and shadow price of each good. The household member's indirect utility function could be note as $v_{i,n}(\alpha_n p, x + \ln \eta_{i,n}(p, \alpha_n, z_{i,n}), z_{i,n})$. For simplicity, we will omit demographic vector in the following equations. Hence, the budget share of individual i spending in good k could be written as:

$$w_{i,n}^k = w_{i,n}^k(\alpha_n p, x + \ln \eta_{i,n}(p, \alpha_n)) \tag{1}$$

Thus, the household-level budget share of good k take the following form:

$$W_n^k(p^k, x, \alpha_n) = \sum_i m_{i,n} \eta_{i,n}(\boldsymbol{p}, \alpha_n) w_{i,n}^k(\alpha_n p, x + \ln \eta_{i,n}(\boldsymbol{p}, \alpha_n)) \tag{2}$$

In the case of good k is private and assignable good, which means that good k is exclusively consumed by a certain household member i, the household-level budget share function becomes:

$$W_n^k(p^k, x, \alpha_n) = m_{i,n}\eta_{i,n}(p, \alpha_n)w_{i,n}^k(\alpha_n p, x + \ln \eta_{i,n}(p, \alpha_n)) \quad (3)$$

Indifference scale of household member. In order to compare each household members' material well-being within different household sizes, we need take both resource share and economies of scale into account. Thus, this paper uses the concept of indifference scale to cover the two aspects to cover the two aspects (Browning et al., 2013). The indifference scale defines as the income adjustment applied to a person living in a household of a particular type to be just as well off as if they were living in another type of household. Suppose a person i receives $\eta_{i,n}$ resource share and faces Barten scale α_n when her/she lives in household of type n. The indifference scale $I_{i,n,n'}$ for the person living in another household of type n' relative to household of type n is given by:

$$v_i\left(\alpha_{n'} p, x + \ln \eta_{i,n'}(p, \alpha_{n'}) - \ln I_{i,n,n'}\right) = v_i(\alpha_n p, x + \ln \eta_{i,n}(p, \alpha_n)) \quad (4)$$

The indifference scale indicates that for person i living in household type of n', he/she needs to receive $\eta_{i,n'}e^x/I_{i,n,n'}$ amount of income to buy as much as goods as her/she living in another household type of n with same total budget constraint e^x, so that he/she could lie on the same indifference curve. In the case of $I_{i,n,n'} = 1$, it means there is no difference for person i living in household type of n' or n. The resource reduction due to live in a larger household is covered by the economies of scale. If $I_{i,n,n'}$ is lower than one, it means the person i's living status is worse off when he /she lives in household type of n'. Thus, her/his income need to be scaled up, vice versa.

However, in the above discussion, the economies of scale is interpreted as the deflator to market price. It is hard to derive the indifference scale when the economies of scale presented in this form since shadow prices for different types of households are different. Thus, we need to summarize the Bartan scale into a more general form:

Assumption 2. There exists a scalar-valued, differentiable function $s_{i,n}(\alpha_n, p)$, such that the following equality holds:

$$v_{i,n}\left(\alpha_n p, x + \ln\eta_{i,n}(p, \alpha_n)\right) = v_{i,n}\left(p, x + \ln\eta_{i,n}(p, \alpha_n) - \ln s_{i,n}(\alpha_n, p)\right) \quad (5)$$

The function $s_{i,n}(\alpha_n, p)$ transforms shadow price into a general cost saving form. It indicates how much living-cost the person i could save when he/she living in household instead himself/herself due to economies of scale. The value of $s_{i,n}(\alpha_n, p)$ is between $\eta_{i,n}$ and 1. In the case of all goods consumed by person i are private goods, $s_{i,n}(\alpha_n, p) = 1$, the person couldn't benefit from living with other household members. In the case of all goods consumed by household members are public goods, $s_{i,n}(\alpha_n, p) = \eta_{i,n}$. Thus, the range of intermediate values indicates the situation of partly shared consumption.

Note that there are some important features of the deflator $s_{i,n}(\alpha_n, p)$. First, it is price-dependent and the sign of derivatives of $s_{i,n}(\alpha_n, p)$ with respect of prices depend on the publicness of goods. A price increase in private good will increase the economies of scale and decrease $s_{i,n}(\alpha_n, p)$, like food price. A price increase in public good will decrease the economies of scale and increase $s_{i,n}(\alpha_n, p)$. For instance, an increase in household expenses or rent will reduce consumption quantity, thereby diminishing the economies of scale. Second, the economies of scale may be different among household members. The public goods may account for different share in each person's consumption bundle. For example, for a person always works outside may not use the air conditioning as much as his/her partner does. Thus, his/her economies of scale may lower than his/her partner. Third, the economies of scale is independent of log household expenditure x. Given the scalar-valued function $s_{i,n}(\alpha_n, p)$ and the Assumption 1 and Assumption 2 hold, the equation which used to derive $I_{i,n,n'}$ could be written as:

$$\begin{aligned} & v_i\big(p, x + \ln \eta_{i,n'}(p, \alpha_{n'}) - \ln s_{i,n'}(\alpha_{n'}, p) - \ln I_{i,n,n'}\big) \\ & = v_i\left(p, x + \ln \eta_{i,n}(p, \alpha_n) - \ln s_{i,n}(\alpha_n, p)\right) \end{aligned} \tag{6}$$

Thus, the indifference scale for a person i living in a household of type n' compared to a household of type n is given by:

$$I_{i,n,n'} = \frac{\eta_{i,n'}(p,\alpha_{n'})}{s_{i,n'}(\alpha_{n'},p)} \frac{s_{i,n}(\alpha_n,p)}{\eta_{i,n}(p,\alpha_n)} \tag{7}$$

3. Structural Identification

To achieve the goal of identifying each household member's resource share through household consumption data, we employ the Quadratic Almost Ideal Demand System (QUAIDS) (Banks et al., 1997), a commonly used demand system that satisfies PIGLOG preference. By applying Roy's identity, each household member's budget share functions for private assignable goods are in the form of:

$$w_{i,n} = a_{i,n}(p) + b_{i,n}(p)x + c_{i,n}(p)x^2 \tag{8}$$

Substituting these personal budget share functions into household's budget share function on private goods results in:

$$W_{i,n}(x) = m_{i,n}(\eta_{i,n}\alpha_{i,n} + \eta_{i,n}\beta_{i,n}x + \eta_{i,n}c_{i,n}x^2) \tag{9}$$

Where $\alpha_{i,n} = a_{i,n} + b_{i,n}(\eta_{i,n} - s_{i,n}) + c_{i,n}(\eta_{i,n} - s_{i,n})^2$, and $\beta_{i,n} = b_{i,n} + 2c_{i,n}(\eta_{i,n} - s_{i,n})$. These household Engel curves are linear in x and x^2. The corresponding coefficients can be retrieved by applying linear regressions with household budget shares $W_{i,n}(x)$ as dependent variables and x, x^2 as explanatory variables. However, the preference parameters $\beta_{i,n}$ and $c_{i,n}$ are unknown since we do not rely on data from single-person households. Moreover, it's hard to find out children who live alone. Thus, SAP and SAT assumptions are needed to retrieve resource shares from these budget share functions since the unknowns is more than equations for each type of houusehold. The SAP refers to household members' preferences over a certain type of product being similar, whereas SAT assumes people's consumption preference is similar when they live in different types of households, such that the first derivates and the second derivates are identical among household members and household types. Thus, the identification of resource shares for each type of household is achieved by using second-order derivatives of the household Engel curves with respect to x. The coefficients of second-order derivatives of the Engel curves are proportional to the unknown resource shares, $\eta_{i,n}$, which must sum to one. Therefore, the resource shares for each household member can be determined by utilizing the four equations in four unknowns, as outlined in the household's Engel curves for the respective private assignable goods. With the resource shares been determinded, the economies of scale can be achieved by using first-order of the Engel curves, which contains two unknowns and three equations.

4. Empirical application

4.1 Data

We analyzed data gathered from the U.S. Consumer Expenditure Survey (CES) spanning the period from the first quarter of 2015 to the first quarter of 2022 to explore spending patterns within households. The CES, administered by the U.S. Census Bureau for the Bureau of Labor Statistics (BLS) every quarter, offers insights into consumer expenditures, income levels, and demographic profiles across the United States. Approximately 10,000 addresses are surveyed each calendar quarter, with around 6,000 interviews conducted. The survey follows a rotating panel structure, with one-quarter of addresses being replaced with new ones each quarter. Once a housing unit has been surveyed for four consecutive quarters, it is replaced by a new address. To ensure the survey's accuracy in representing the population, each interview is weighted and considered statistically independent. Therefore, we treated quarterly data independently and considered households appearing in different quarters as distinct observations.

Our sample consists of 14,010 households selected based on specific criteria, including households consisting solely of parents and children, households containing between one and four children under 16 years old, and those with non-zero quarterly household expenditure. To mitigate outliers, households with total expenditure exceeding three standard deviations from the mean are excluded. The final sample comprises 4,961 one-child households, 6,118 two-child households, 2216 three-child households, and 715 four-child households. Since CES does not gather data on total assignable consumption, we designate men's, women's, and children's clothing as representative of private assignable goods. By using a distinctive dataset detailing total private expenditure for each household member, Bargain et al. (2022) demonstrate a remarkable alignment between resource shares estimated using clothing budget shares and observed resource shares. This finding indirectly validates the utilization of clothing as a proxy for assignable goods.

Table 1 presents descriptive statistics for various variables related to household demographics and financial aspects of the estimation sample.

Table 1. Descriptive statistics

Variable	Value	Mean	Std. Dev.
Children number		1.906	0.842
Household annual income		101,148	65,817
Quarterly expenditure		9,934	9,139
Men's clothing budget share		0.002	0.008
Women's clothing budget share		0.003	0.009
Children's clothing budget share		0.008	0.017
Living area	1=Urban 0=Rural	0.939	0.240
Men's education	1= Bachelor's degree and above 0 = Otherwise	0.458	0.498
Men's annual income		80,090	76,701
Men's race	1=Black 0=Other	0.062	0.241
Men's age		39.26	8.15
Women's education	1= Bachelor's degree and above 0 = Otherwise	0.510	0.500
Women's annual income		38,796	51,461
Women's race	1=Black 0=Other	0.053	0.224

Women's age	37.03	7.377
Average children's age	6.861	4.233
N	14,010	

4.2 Empirical model

We apply QUAIDS to describe individuals' expenditure patterns on clothing since Banks et al. (1997) show that Engel curves of some goods require quadratic terms in the logarithm of expenditure, such as clothing. Adding demographic variables and error terms to the household budget shares equations on members yields:

$$W_{m,n,h}(x) = \eta_{m,n}(z_n, z_h)[\alpha_{m,n}(z_n, z_h) + \beta(z_h)x_h + c(z_h)x_h^2] + \varepsilon_{n,h} \quad (10)$$

$$W_{w,n,h}(x) = \eta_{w,n}(z_n, z_h)[\alpha_{w,n}(z_n, z_h) + \beta(z_h)x_h + c(z_h)x_h^2] + \varepsilon_{n,h} \quad (11)$$

$$W_{c,n,h}(x) = m_{c,n}\eta_{c,n}(z_n, z_h)[\alpha_{c,n}(z_n, z_h) + \beta(z_h)x_h + c(z_h)x_h^2] + \varepsilon_{n,h} \quad (12)$$

where $W_{i,n,h}(x)$ indicate the percentage of budget spent on member i's clothing in household h. x_h indicates household-level log expenditure. z_n are household composition variables consisting of four dummies that indicate the children's number in this household. z_h represent household and household members' characters, as listed in Table 1. Following Calvi et al. (2023), this paper allows household composition variables and household characters to influence both resource allocation and personal consumption preference. Moreover, we assume preference parameters are similar across people and types. Thus, β and c do not vary across household members and household types. However, $\alpha_{i,s}$ may vary freely.

We model resource share $\eta_{i,n}$ as linear functions of household composition variables z_n and household and household members' characters z_h, and $\eta_{i,n}$ must sum to one. The preference parameters β and c are modeled as linear functions of z_h, and $\alpha_{i,n}$ are linear to z_n and z_h. Since the error term may be correlated across these equations, we applied a non-linear Seemingly Unrelated Regression (NLSUR) to jointly estimate the Engel curves system. The NLSUR fits a system of non-linear equations by feasible generalized non-linear least squares (Poi, 2008). Thus, it is popular in demand-system estimation.

4.3 Results

Table 2 below presents selected summary statistics for the estimated each child's, women's and men's resources shares as well as economies of scale for full sample. It is worth noting that our results are predicated upon a diverse array of household compositions and individual demographic variables. Hence resource allocation and economies of scale may differ according to household characteristics. The results presented in panel (A) suggest that, on average, male household heads consume a greater proportion of resources (32%) compared to female household heads (28%), who, in turn, consume more than children (23%). These results indicate that fathers in households have more bargaining power than mothers and children. The results also align with Li and Dorfman (2021), who report that in households with two adults and no children in the U.S., fathers hold 52% of all resources while mothers hold 48%.

Table 2. Estimated resource shares and scale economies

		Mean	**Median**	**Std. Dev.**
(A) Resource share	Men	0.323	0.319	0.062
	Women	0.279	0.266	0.055
	Child	0.230	0.224	0.063
(B) Economies of scale		0.813	0.785	0.284

Panel (B) in Table 2 presents the summary statistics of estimated economies of scale of non-reference households. The results show that the average economies of scale in non-reference households is 0.813. Recall that the economies of scale describe the cost saving when individuals live in larger households. Thus, the result implies that, on average, individuals living in non-reference households could save about 18.7% on living costs compared to the reference household.

It's important to note that our estimates of joint consumption are measured relative to a reference household containing three individuals and do not precisely reflect the absolute level of joint consumption. Incorporating households with more members into the analysis and designating them as the reference household would likely result in greater economies of scale in consumption. Alternatively, our estimates can be interpreted as mean estimates of the true degree of joint consumption in households with 2-4 children.

Table 3 below provides key statistics for estimated resource shares of children, women, and men, along with economies of scale and indifference scales. These estimates are based on observable household characteristics (including 1-4 children) and composition variables. We also include estimates for resource shares and scale economies in a typical non-reference household (see Table 3 for a list of these values), defined as one with median values for all factors and household type variables. The small standard errors associated with these estimates suggest that the parameters of interest are reliably estimated.

Table 3. Estimated resource shares, economies of scale, and indifference scales in different household types

		1-Child	2-Child	3-Child	4-Child
	N	4961	6118	2255	715
(A) Resource share	Men	0.377	0.302	0.291	0.224
		(0.050)	(0.042)	(0.039)	(0.036)
	Women	0.340	0.251	0.237	0.226
		(0.033)	(0.028)	(0.028)	(0.024)
	Child	0.283	0.224	0.157	0.137
		(0.064)	(0.025)	(0.015)	(0.010)
(B) Economies of scale		1	0.819	0.798	0.802
		(0.344)	(0.293)	(0.299)	(0.287)
(C) Indifference scales	Men	-	0.812	0.806	0.594
	Women	-	0.738	0.712	0.654
	Child	-	0.869	0.630	0.538

Note: The indifference scales are calculated as $I_{i,1,n} = \frac{E(\hat{\eta}_{i,n})}{E(\hat{s}_{i,n})} \frac{E(\hat{s}_{i,1})}{E(\hat{\eta}_{i,1})}$.

Estimates by Household Type. Table 3 presents an analysis of the distribution of estimated resource shares for children, women, and men across all households in the CES samples, along with scale economies and indifference scales for nuclear households with multiple children compared to those with one child. We proceed to examine how these estimates vary according to household size.

Three main features emerge from Table 3, which displays the average estimated $\hat{\eta}_{j,n}$, $\hat{s}_n$ and $\hat{I}_{j,n}$ by household size. First, resource sharing, the allocation of resources to each child, woman, or man decreases with household size, as resources must be divided among more individuals in larger families. Specifically, our estimates indicate that child in families with one child receive approximately 28.3% of the household's resources, on average. As the family size increases, this percentage decreases: for families with two children, it's around 22.4%; for three children, it's about 15.7%; and for four children, it's roughly 13.7%. The decline in children's share from CES is steeper than that for men and women, suggesting that resource allocation among children is more inequitable in larger households, on average.

Second, economies of Scale. Panel (B) of Table 3 shows that the estimated economies of scale in households other than the reference households are less than one. We normalize the economies of scale of one-child households to one and adjust the economies of scale of non-reference households accordingly, focusing on the relative standards between reference and non-reference households. The findings suggest that individuals in larger households benefit more from sharing public goods. However, the relationship between economies of scale and household size is not straightforward. We estimate a non-monotonic relationship between scale economies and household size in CES families. In our study, we found that households with two, three, and four children show economies of scale values of 0.819, 0.798, and 0.802 respectively, compared to those with one child. Normally, adding more members to a household is expected to increase economies of scale because resources like space and utilities are shared more efficiently. However, our findings do not align with this expectation. The reason may lie in the composition of household consumption. As families grow, they might spend relatively more on private goods, which are consumed individually, rather than on goods shared among all members. This increase in private consumption reduces the overall benefits of sharing resources. Therefore, as more children are added, the proportional benefit from shared resources remains consistent, rather than increasing, leading to stable but not improving economies of scale in larger households.

Third, on average, we estimate indifference scales that are less than one. Based on the estimated resource share and economies of scale, we calculate the indifference scale for each category of household member in different household types. Remember that the 1-Child household serves as the reference household. Thus, the indifference scale implies that an individual's expenditure needs to be scaled up or scaled down to $\frac{\eta_{i,n} exp(x)}{I_{i,1,n}}$ to make the individual living in a non-reference household maintain the same utility level as he/she living in the reference household. The results show that the indifference scales of all household members in the non-reference households are below one, which means that for households that have the same total expenditure, the material well-being of household members decreases as the household size increases.

While the estimated indifference scales in CES are below one across all household sizes, children's indifference scale drops significantly compared with male and female household heads. For children living in 3-Child and 4-Child, their expenditure would need to be scaled up to about 160% and 185% to be just as well off as if they were living in a reference household with the same household expenditure level. This indicates that for children in CES families, particularly those in households with three or four children, the impact of scale economies on their consumption level is outweighed by the necessity of sharing resources with more individuals as the household size increases. Therefore, their expenditure would need to be scaled up to maintain the same standard of living as if they were living in a nuclear household with one child and the same household expenditure level.

5. Policy implication

The National School Lunch Program (NSLP) is a federally supported initiative operating within educational and childcare settings, where eligibility for the program is linked to the adjusted federal poverty threshold based on household size. NSLP sets the eligibility ceiling at 185% of the federal poverty threshold, thereby directly influencing the eligibility criteria for millions of American children in need of food assistance.

The 2023 poverty thresholds established by the US Census Bureau indicate that a one-child household with an annual income of $24,860 and a three-child household with an annual income of $35,140 imply an inverse indifference scale of 70% ($\frac{\$24,860}{\$35,140} \times 100\% = 70\%$. This number is consistent with our estimation, which is close to the average of the father's (0.806), mother's (0.712), and child's (0.630) indifference scales. However, our analysis suggests a general increase in the poverty threshold for three-child households to $39,527 ($24,860×1.59 = $39,527) based on the specific indifference scale for children. This represents a 12.5% ($\frac{\$39,527-\$35,140}{\$35,140} \times 100\% = 12.5\%$) increase over the current threshold provided by the US Census Bureau. These findings highlight significant discrepancies between the current eligibility thresholds and the implied thresholds for households when specifically considering children. For instance, the current National School Lunch Program (NSLP) threshold for a reduced-price meal in a four-child household is $74,518, but our analysis suggests it should be increased to over $85,543—a 14.8% difference. This substantial discrepancy indicates that a significant number of children in households with three or four children might not be receiving adequate assistance under existing NSLP income criteria. Although precise estimations are challenging due to the lack of detailed income distribution data, the considerable gap of $8,000 to $11,000 underscores the potential for revising the poverty threshold to extend food assistance to several million additional individuals nationwide.

6. Conclusion

This study presents the first estimates of indifference scales for households with children in the U.S., revealing significant discrepancies within the National School Lunch Program (NSLP) eligibility criteria, particularly for households with multiple children. Our analysis indicates that the current NSLP threshold for a four-child household, set at $74,518, should be increased to over $85,543 — a 14.8% adjustment. Similarly, the threshold for three-child households should rise from $65,000 to $73,125 — a 12.5% adjustment, reflecting the need for revised poverty thresholds that more accurately represent the economic realities the children face in those large households.

By providing these initial estimates, our research underscores the necessity of adjusting NSLP eligibility criteria to ensure a fairer distribution of benefits aligned with actual household needs. Our recommended adjustments aim to enhance the program's effectiveness and extend essential nutritional support to millions of underserved American children. This analysis provides a compelling case for policymakers to reevaluate and potentially increase the income thresholds for NSLP eligibility, facilitating improved food security and health outcomes for children in larger households across the nation.

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