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9 Measurement of Output and Quality Adjustment in the Day-Care Industry

Swati Mukerjee and Ann Dryden Witte

This paper studies a growing component of child-care arrangements and focuses on various measures of output and of quality of output of day-care centers.[1] A methodology for adjusting output measures for changes in quality is developed by the construction of a quality index. This route for measuring quality changes is suggested as an alternative when traditional hedonic techniques are difficult to implement. One such specific case is the day-care market, where defining a market price is both conceptually and empirically difficult. To illustrate the construction, interpretation, and use of the quality-index approach, we utilize both state (Massachusetts) and national (U.S.) data. Because of the unavailability of data at the national level, estimates from state data had to be employed to illustrate the proposed method of quality adjustments. Caution is required in interpreting our quality-adjusted output for the United States for at least two reasons. First, our estimates of the cost of quality improvements are obtained using data for a single state. Second, our measure of quality, although consistent with the literature, is open to question.

We present two measures of the output of the day care industry: The first measure is a physical measure of output—the number of children in care. The second is a real dollar measure of output provided to us by Robert Parker of

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1. According to Sandra Hofferth's statement at the hearing before the Select Committee on Children, Youth, and Families, from the mid 1960s to the mid-1980s, there was a substantial rise in care at a day-care center or nursery school relative to other forms of care.

the Bureau of Economic Analysis (BEA). Regardless of the measure considered, the output of the child-care industry, when not adjusted for quality, grew rapidly during the 1970s and 1980s. (See fig. 9.1) The growth rate of output depends critically on the way in which one measures output, with physical output showing a higher rate of growth than constant-dollar measures of output. Adjustments of either measure of output for quality alter both the levels and rates of growth given by either measure.

There have been extensive discussions and several studies regarding ways to measure quality of child care. The federal government and the states have sought to regulate the quality of day care. More recently the National Association for the Education of Young Children (NAEYC) has sought to develop standards for the accreditation of child-care programs. The discussions and professional studies on the measurement of the quality of care have yet to be reflected in research seeking to measure the output of child care. In this paper, we seek to combine the work on output measurement in day care with current research on the measurement of quality. We measure quality in a way consistent with state and federal regulations and estimate the valuation of quality using cost functions. We adjust the output of child care to reflect the decline in quality experienced in the 1970s and 1980s. The result is a change in both the level and the growth rate of output, suggesting that adjustment for quality lowers the level of output. This suggests that current national data, at least on children, may overstate both the level and the growth rate of output and highlights the need for some adjustment of the national figures.

The structure of the paper is as follows: In section 9.1, we discuss current methods of measuring output in the day-care industry. Availability of data and the construction of a consistent output and employment series at the national level are dealt with in section 9.2. Issues related to the measurement of the quality of care are discussed in section 9.3. In sections 9.4 and 9.5, the methodology for constructing a quality index is developed and applied to adjust national data for quality changes. The final section contains our summary and conclusions.

9.1 Output Measurement

One way in which service output may be measured is by examining the value of the inputs. This approach is commonly used in the national accounts to measure government output. However, as more sophisticated approaches become available this methodology is being replaced.[2] Two other methods of measuring the output of service industries are discussed in the literature.[3] Output may be measured as either *D*-output or *C*-output (using the terminology of Bradford, Malt, and Oates 1969). *D*-output consists of direct services pro-

2. E.g., BLS has adopted the alternative transactions approach to measuring banking output in lieu of the liquidity approach. See Kendrick (1985), 116.

3. See Searle and Waite (1980), Ross and Burkhead (1974), and Bradford, Malt, and Oates (1969).

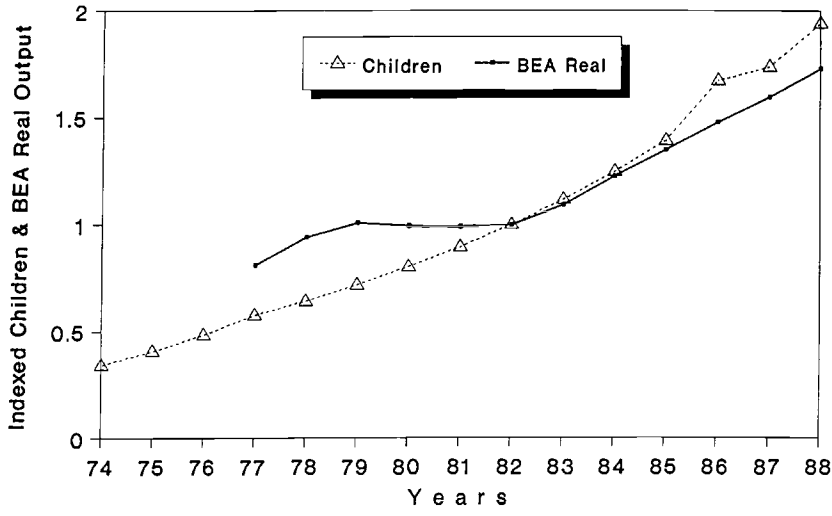

Fig. 9.1 Comparison of children and BEA real dollar output over time in United States (1982 = 100)

duced (e.g., the number of hours a child is cared for). *C*-output measures the consequences (e.g., the cognitive ability of the child cared for). The latter measure creates the difficulty of not differentiating the output from its consequences (e.g., a child's cognitive ability is also a function of the home environment).[4] Measuring *D*-output, on the other hand, has the advantage of separating the output from an evaluation of its effectiveness.

D-output, the direct services produced, has been measured for many service industries. For example, the output of hospitals can be measured as the number of patient days in the hospital, with the caveat that the product has to be a function of the diseases treated. See Newhouse (1970).[5] When a firm such as a hospital produces different types of output, an aggregation problem is inevitable. Day-care centers are like hospitals in that both the type of child cared for and the quality of care provided can differ widely.

The ultimate output (*C*-output) of day care has an effect on both the children and the parents. High-quality day care may increase the productivity of parents as they are freed of concern for the welfare of their children.[6] The effect

4. See Searle and Waite (1980), 336.

5. In the case of symphony orchestras (Lange et al. 1985), output measures have been the number of concerts performed or the concert attendance. However, in a study of the sports industry, particularly for cricket, team victories are often used as the measure of output (Schofield 1988).

6. This was suggested informally at the conference by Robert M. Coen of Northwestern University, who was concerned that all current studies focused on the output of day care too narrowly and that the broader perspective was ignored. We agree.

In this context Klerman and Leibowitz (1989) have found that higher cost of child care slows the process of women's returning to work.

of day care on children has been measured through test scores and such direct measures as the Prescott/SRI Child Observation System. (Stallings and Wilcox 1978). This paper, although recognizing the desirability of measuring the ultimate effect of day care, focuses on the direct output of day-care centers. Our contribution lies in providing and contrasting two different measures of output (dollar and physical) and adjusting the physical measure for changes in the quality of care.

Attempts to provide distinct measures of output for the day-care industry began in the mid-1970s. As far as we know, the first attempt to discern the number of children in day care occurred in 1974 (U.S. Department of Commerce 1976). As part of the current population survey, the Census Bureau asked mothers questions concerning day-care arrangements.

The census of services reports information for child day-care services beginning in 1977. Prior to 1977, information on day care was incorporated in social service (SIC 83) and could not be examined separately. The census of services distinguishes between for-profit (taxable) and not-for-profit (tax exempt) establishments. According to the 1987 census of services, day-care services are provided in approximately equal amounts by the for-profit and the not-for-profit sectors. The distinction between for-profit and not-for-profit establishments has been dealt with in various ways by researchers.[7]

Basing its work on the census of services, BEA began producing estimates of the dollar personal consumption expenditures on day care in 1977. In accordance with its standard practice for services, BEA used weekly dollar receipts as its measure of output for profit-making organizations (PMOs) and weekly expenditures as its measure of output for not-for-profit organizations (NPOs).

Physical measures of output have been used by researchers studying the nature of production in day-care centers. For example, Ruopp et al. (1979) use the number of full-time equivalent children enrolled at the center.[8] Mukerjee, Witte, and Hollowell (1990) use the number of hours of child care provided.

There is substantial controversy whether the physical or dollar measure pro-

7. The distinction between PMOs and NPOs has been dealt with in various ways by researchers analyzing the cost of day care. They have categorized centers in various ways. E.g., in Hall's estimated revenue function (1978), he includes a binary indicating whether a center operates for-profit or as a not-for-profit establishment and another binary indicating whether the center was run by a public or private organization. Ruopp et al. (1979) estimate separate average cost functions for parent-fee and publicly funded centers. In a recent paper, Mukerjee, Witte, and Hollowell (1990) estimate separate cost functions for not-for-profit and for-profit day care centers in Massachusetts. For consistency with current work, we treat PMOs and NPOs as separate entities. To obtain aggregate measures, we simply sum the aggregate level of output for the two types of entities.

8. Hall (1978) claims to estimate cost equations for the day-care centers utilized by participants in the Seattle and Denver income maintenance experiments. His dependent variable is the charge for a 40-hour week of care. Assuming that the relationship between the charge and the quantity of care is proportional, he includes no measure of output among his explanatory variables.

vides a superior measure of output. For example, see articles in Inman (1985). The real issue is whether these two measures have different implications regarding the level and growth of output. We will compare the implications of these two measures of output using aggregate data for the United States and a unique data set recently collected in Massachusetts. These data contain detailed information on a random sample of day-care centers. (See app. 2 for a detailed description of the data.)

For the Massachusetts sample, physical and dollar measures of output were highly correlated (.80) for PMOs; for NPOs the correlation between physical and dollar measures was substantially lower (.59). These results suggest that particularly for the large NPO sector the choice of output measure is important and deserves careful consideration.

9.2 The Availability of Data

At the national level, it is difficult to obtain a physical measure of output of day care during the 1970s and 1980s. Using a wide range of data sources and extrapolation, we obtain physical measures of output for 1977–87. We use BEA's measure of real expenditures as our dollar measure of output. (See table 9.1.) As noted earlier, the two series, physical and dollar, show different rates of growth.

As far as we are aware, there has been no previous attempt to obtain a national time series of the physical output level of day-care centers. We attempted to obtain child-care hours, our preferred measure, provided by all day-care centers in the United States but were unable to find the necessary data. We were able to find measures of the number of children in care for selected years from current population survey (CPS) and survey of income and program participation (SIPP) data.

There were several obstacles to compiling a consistent series on the number of children in care. The data were drawn from different sources, years, and universes. In 1974 and 1977 the CPS collected the data. In 1974, the data covered all mothers and the three youngest children ages 3–13. In 1977, the gathered data pertained to the two youngest children under five years of employed mothers. Data were available for 1976 from an Abt study of licensed centers (Ruopp et al. 1979), but the adjustments in the final estimates were too numerous for us to make the data comparable. In 1985 and 1986, the data collected by SIPP covered the three youngest children (younger than 15 years) of employed mothers. Adjustments were made to make the universes as comparable as possible. These adjustments are detailed in appendix A. The resulting data points for these years were used to extrapolate for intervening years and to extend the series to include 1987 and 1988. Extrapolation, using the average annual compound rate of growth, yielded the series on children as given in table 9.1. The series is reasonably consistent with other available data on day care.

Table 9.1 **Aggregate Time Series for Day-Care Centers in United States (1974–1988)**

Year	BEA Output (in millions of $)*	Children (in thousands)	Annual Average Employment		Staff-Child Ratio		Marginal Valuation		Quality Valuation	
			Upper (in thousands)†	Lower (in thousands)‡	Upper	Lower	Upper	Lower	Upper	Lower
1974	. . .	386	104	71	0.270	0.184	2,934	3,652	791	672
1975	. . .	459	113	77	0.246	0.168	3,091	3,848	761	646
1976	. . .	546	123	84	0.225	0.153	3,257	4,054	732	622
1977	3,436	649	135	92	0.209	0.142	3,400	4,232	709	602
1978	3,986	725	159	108	0.219	0.149	3,305	4,117	724	615
1979	4,270	810	177	121	0.219	0.149	3,309	4,120	723	614
1980	4,211	904	187	128	0.207	0.141	3,413	4,250	707	600
1981	4,200	1,010	194	133	0.193	0.131	3,559	4,432	685	582
1982	4,242	1,128	200	137	0.178	0.121	3,727	4,640	662	562
1983	4,633	1,260	216	148	0.172	0.117	3,800	4,732	652	554
1984	5,203	1,407	241	165	0.171	0.117	3,803	4,736	652	554
1985	5,724	1,571	261	176	0.166	0.112	3,702	4,659	615	521
1986	6,272	1,889	280	190	0.148	0.101	3,977	4,985	590	501
1987	6,767	1,959	303	206	0.155	0.105	3,805	4,771	589	501
1988	7,339	2,188	329	225	0.150	0.103	3,949	4,924	593	506

*Nominal figures deflated by price deflator (1982 = 100) obtained from BEA.

†SIC 835, includes day-care centers, nursery schools, and some Head Start programs.

‡Day-care centers.

Hofferth (1987) reports that the total capacity of *licensed* day-care centers was 1.01 million children in 1976 and 2.1 million in 1986.[9] The spaces available in licensed day-care centers approximately doubled over the ten-year period. Our estimates of the number of children in care is below capacity as would be expected (.55 million in 1976 and 1.89 million in 1986). It is interesting that our estimates of the number of children in care is below capacity in both 1976 and 1986, given the prevalence of articles in the press regarding nonavailability of child care. To the extent these are references to day-care centers (as opposed to several other forms of care, e.g., family day care) a possible reason may be a mismatch between the location of available slots and the location of families with child-care needs. Note also that the gap between capacity and the number of children in care narrowed markedly between 1976 and 1986. This could have also contributed to the refrain, "I can't find day care." Another reason lends credence to the number of children in care being lower than capacity. Conversations with directors of day-care centers indicate that it is common practice for day-care centers to obtain a license for as high a capacity as possible. Many centers actually choose to run below capacity for professional and other reasons. For example, one center director with whom we spoke had a licensed capacity of 101 and actual enrollments of only between 80 and 90. Most centers we talked with run at about 80 percent of their capacity. This is in line with our estimates, which indicate that in the ten years from 1976 to 1986, capacity utilization has increased from 54 percent to about 90 percent. Our estimates of the number of children in care imply a 246 percent increase in the number of children in care. This may overestimate the rate of increase in the number of children in care, and we suspect that the number of children in care increased by between 100 percent and 246 percent.[10]

Now we turn to the data on employment in day-care centers. The employment numbers are the annual average employment figures taken from Bureau of Labor Statistics (BLS) publication, *Employment and Wages, Annual Averages*, of various years. Employees of day care centers are included in the SIC code 8351, child day-care services. This SIC code contains nursery schools, preschools, and some Head Start centers as well as day-care centers. These employment data cover employees subject to state unemployment insurance (UI) laws and also those subject to unemployment compensation for federal employees (UCFE) program. Use of these data to obtain a series for employment in day-care centers may result in either an over or under estimate of the number of employees in day-care centers. The source of overestimation is clear as these data reflect employment in nursery schools, preschools, and some Head Start centers.

9. The 1976 data were taken from the NDCS, which reported on licensed day-care centers. The 1986 figures come from a survey of each state's licensing office done by the NAEYC. See Hofferth (1987), 565.

10. A recent report on child care by the U.S. Department of Labor (1988) estimates that the number of children in care increased by 77 percent between 1977 and 1985.

However, three sources of underestimation must be set against this source of employment overestimation. SIC 835 excludes employer supported programs, as long as workers are on the employers' payroll. Hofferth and Phillips (1987) conclude that "employers would not appear to be a major source of expanded child care." Even among employers that do provide care, the most common way is to help families find and pay for such care. Hofferth and Phillips estimate that in 1985, "120 corporations and 400 hospitals provided child care at or near the work place." These centers cannot be assumed to be run by the employers. Many lease out to chains like Kinder Care or Bright Horizons as, for example, Beth Israel Hospital in Boston is currently planning to do. Hence this source of bias may not be significant. Secondly, SIC 835 excludes church-supported day-care centers. We may note, however, that "under a 1981 Supreme Court ruling, church-chartered schools are not required to be covered under the system. However, many of these schools continue to cover their employees on a voluntary basis."[11] This second source of underestimation therefore appears to be relatively small. The third source of downward bias is the inclusion in SIC 835 of only paid employees, to the exclusion of proprietors and partners who might also actively provide care.[12] As centers get larger, it is likely that this source of bias would be weakened. However, we have no information on which to judge the actual level of bias.

In view of the above, we believe that use of BLS employment figures for SIC 8351 probably results in an overestimate of employment in day-care centers. To adjust for this, we multiply employment in SIC 8351 by the ratio of output of day-care centers to the combined output of day-care centers and nursery schools, that was obtained from the BEA. This establishes a lower bound on the employment numbers. The upper bound would be the unadjusted figures (table 9.1).

9.3 The Quality of Output

As in the case of most other service industries, the output of day-care centers is not homogeneous. Thus, to measure output adequately, it is essential to adjust simple dollar or physical output measures for differences in quality. How does one measure the quality that day-care services provide? The concept of quality is a difficult one to define and to reduce to measurable indices. Historically, the concept of what constitutes quality shifted from post–World War II to the present times. Earlier, the nurturing aspect of care was emphasized to calm prevalent fears regarding perceived social and emotional ill effects of institutional care. In the 1960s, the emphasis shifted to an interest in the development of cognitive skills of children, triggering the beginning of Head Start and similar programs. In the 1970s, the emphasis was placed on a more balanced approach to developing both cognitive and social skills, thus

11. U.S. Department of Labor, (various years), sec. on "Characteristics and Uses of the Data."
12. Manser (1990), preliminary comments.

enhancing both physical and emotional development.[13] Today, the balanced approach prevails, as can be seen in the varying approaches to quality in accreditation criteria, in federal and state regulations, and in other studies.[14]

Today, the NAEYC,[15] which accredits child-care programs, defines a high-quality early childhood program "as one that meets the needs of and promotes the physical, social, emotional, and cognitive development of the children and adults—parents, staff, and administrators—who are involved in the program. Each day of a child's life is viewed as leading toward the growth and development of a healthy, intelligent, and contributing member of society." (NAEYC 1989, 7). Among the integral criteria in the establishment of a high-quality early childhood program, as cited by the NAEYC, are the following components: interactions among staff and children, a well-rounded and developmental curriculum, frequent staff-parent interaction, effective administration, sufficient and highly qualified staffing, a nurturing and spacious physical environment, a high degree of health and safety, a well-balanced nutrition and food service program, and continual evaluation of the program to assess its strengths and weaknesses.

U.S. day-care centers have been regulated by federal, state, and local bodies. These regulations relate to enrollment policies, staff quality, group size and staff-child ratios.[16] With the suspension of the federal interagency day-care requirements (FIDCR) in 1981, the regulation of child-care services is under the jurisdiction of individual states.[17] In spite of a gradual tightening of regulations by the states since the mid-1970s, individual state regulations can and do vary a great deal. In addition, the existence of these regulations does not necessarily imply that they are actually followed or enforced, because monitoring is poor.[18] An important component, nevertheless, in both federal and state regulations has been the staff-child ratio, the requirements of which usually vary with the age of the child.

Measures like the staff-child ratio, however, can only be an indication of

13. This discussion is taken from Stallings and Wilcox (1978), 103–4.

14. A thorough and up-to-date discussion on research and professional practice regarding the quality of care is given in Hayes, Palmer, and Zaslow (1990), chap. 4, and app. B. The appendix compares the main features of the major sets of standards that have existed and do exist in programs covering early childhood care. These are six in all, two being federal standards; the remaining four are standards set by professional bodies. The Head Start program still exists; the FIDCR was suspended in 1981. The remaining four sets of standards have been developed for voluntary compliance when applicable. These are (1) the accreditation criteria developed by the NAEYC; (2) guidelines developed by the NBCDI (National Black Child Development Institute); (3) standards of the ECERS (Early Childhood Environment Rating Scale), developed by child development scholars at the University of North Carolina; and (4) standards of the CWLA (Child Welfare League of America).

15. According to the GAO report, the NAEYC, "a membership organization of more than 70,000 professionals in the field of child development and early childhood education, provides the only national voluntary accreditation system exclusively for all types of early childhood centers and schools" (GAO 1990, 61).

16. See Ruopp et al. (1979), 229.

17. See Hayes, Palmer, and Zaslow (1990), chap. 6, and app. A.

18. See Hayes, Palmer, and Zaslow (1990), chap. 4, sec. on regulations.

quality and not be quality per se as considered by the comprehensive national day-care supply study (NDCS). This study's measures of quality were based on a dual observation system, where daily behavior of both children and care givers was observed in detail. This dual approach was supplemented by several standardized tests. The NDCS study then correlated measurable characteristics of day-care centers, like staff-child ratio and group size, with their observations and test measures of quality. Their conclusion was that out of the measurable characteristics, group size, and caregiver-child ratio were very important, especially for infants and toddlers.[19] This finding is corroborated in subsequent research.[20]

More recently, a Department of Labor report (U.S. Department of Labor 1988) cited a reader survey from *Working Mother* magazine (March 1988) indicating that parents feel that "warmth, frequency, and kind of interaction" between child and care giver is important, imparting values consistent with their own. Other quality factors mentioned in the report were the training level of the staff, wages, and stability of staff. Table 9.2 lists various measures of the quality of child care that have been suggested.[21] Clearly, the quality of child care is best measured by a vector of attributes.[22]

Combining insights from all the above sources, it seems that an important, if not the most important, element in the measurement of the quality of care provided by centers is the interaction between the staff and children.[23] The measure of quality that is most often used is the staff-child ratio. However, this ratio captures the interaction only to a limited extent. Because group size also proved important, we used a ratio that reflects more closely this interaction and the group size. We take into account the fact that interaction occurs only when the staff is in contact with the children and that children of different ages require different levels of attention. For example, it requires far more time to provide necessary care for an infant than to provide necessary care for a preschooler. We therefore use weighted children instead of the simple number of children. The ratio we use is the number of staff-class hours divided by a weighted index of the number of children.[24] This is our preferred measure

19. Findings for infants and toddlers (6 weeks–3 years) showed both group size and care giver–child ratio strongly correlated with quality. In the case of preschoolers, the results were somewhat different. In their case, a smaller group size led to better quality and this result was both "strong and consistent." However, the relationship of quality to care giver–child ratio was "slight." Ruopp et al. (1979, xxxvii).

20. See Hayes, Palmer, and Zaslow (1990), 88.

21. We thank Marilyn Manser for use of this table from her preliminary comments to this paper.

22. This is no different from what the literature has discussed (e.g., in the case of hospitals). See Newhouse (1970).

23. A way of reducing the large number of quality characteristics would be to use a factor-analysis approach. However, there are well-known problems of interpretation. In this study, on the basis of the existing work done, we formed a judgment on what would be most important in measuring quality.

24. A better measure would be the staff-class hours divided by a weighted average of the number of child-care hours provided. The weights would reflect the differential time requirements of children of different ages.

Table 9.2 Definitions of Quality of Child Care

Viewpoint	Definitions or Measures
Parents	Warmth, frequency, and kind of interaction between the child and the provider
	Values imparted consistent with those of their own family
Professional associations	Presence of a program of developmentally appropriate activities
	Degree of parental involvement
	Training and knowledge of staff about child development
	Ratio of children to providers
	Size of groups in which children receive care
	Nutritional value of the meals provided
	Safety of the physical environment
	Other policies and practices affecting the health of the children, such as staff hygiene and the handling of medications
Other	Stable staff

Source: U.S. Department of Labor (1988).
Note: Adapted from Manser (1990).

of quality and is available from our Massachusetts data. The staff-child ratio and our preferred measure of quality provide quite different results for the centers in our Massachusetts data. The staff-child ratio (QUAL2) consistently indicates higher levels of quality, particularly for larger centers, than does the ratio of staff class hours to the weighted number of children (QUAL1). This may reflect an increase in the size of administrative staff as centers become larger. Clearly, these two measures of quality produced different results. Specifically, the staff-child ratio indicates that larger centers produce much higher quality care than the ratio of staff-class hours to the weighted number of children would indicate.

Turning from the Massachusetts data to the national data, we are unable to obtain our preferred measure of quality, because there is no national information on the number of hours that children are spending at day-care centers. This is a serious gap in the national data. We are left with the staff-child ratio to measure the trends in the quality of care in the United States.

We estimate that in 1976, staff-child ratio was between 0.23 to 0.15 or 4.4 to 6.5 children per care giver.[25] By 1986, we estimate that the staff-child ratio had declined so that there were between 6.8 and 9.9 children per care giver. These numbers are well within reasonable bounds, given federal and state regulations. However, they suggest a decline in quality that is worrisome.[26]

25. The reciprocals have been calculated for figures correct to 3 decimal places as taken from table 9.1.

26. Because ages of children could not be controlled for, one explanation could be a very high increase in the proportion of older children in day-care centers over the years. This appears unlikely given the increasing labor force participation of women with children younger than five years old.

In the next section, we use U.S. staff-child ratios as the only measure of quality available at the national level and adjust national level output for quality changes by using a quality index. We carry out adjustments for output measured in physical as well as in dollar terms.

9.4 Valuing Quality

Quality changes may be handled in a variety of ways. (See Armknecht and Ginsberg, chap. 3, this vol.) In the literature, hedonics has usually been the preferred route, where price is regressed on each of the characteristics of the product. The regression parameters then provide implicit prices for characteristics and enable calculation of the value of quality changes. An important prerequisite to using traditional hedonic analysis is the availability of an appropriate price. In the day-care case, it is difficult to decide which price to use. Parents pay one price (often subsidized), and the actual cost of care is quite different, as centers receive various private, state, and federal subsidies. Hedonic analysis relies on a market clearing price that reflects both marginal costs and marginal utilities. Such a price is not often observed for day care. An alternative way of adjusting for quality is based on costs. Armknecht and Ginsberg observe, "When market information is not available, we could ask the provider of the service to estimate the value of the change from their cost data. Changes in provider's costs could be adjusted for normal profit margins and marked up to the retail level. The resulting price change serves as a proxy for consumer's valuation of the quality change which cannot be observed directly in the market place. This approach is used most frequently for commodities in the CPI, particularly for new vehicles."

Our approach is in some ways consistent with Armknecht and Ginsberg's suggestion. We estimate a cost function using accounting data and calculate the marginal cost of quality using the parameter estimates that result. For PMOs it seems reasonable to assume that this marginal cost is a reasonable proxy for consumer valuation. For NPOs this marginal cost may not provide a good proxy for consumer valuation. However, it does provide an estimate of the cost of producing higher quality, and this can be seen as a useful first step toward producing valuations for quality.

Conceptually, $C = C(\mathbf{Z}, \mathbf{Q})$, where $\mathbf{Z}$ is the vector of explanatory variables, and $\mathbf{Q}$ is the vector of the quality variables. Then the partial derivatives dC/dQ would give, under the assumptions of equilibrium, competition, and no externalities in the day-care market, the vector of the marginal valuations of quality in day care with respect to each quality variable. These marginal valuations can then be used to construct a quality index with which to adjust output.[27]

27. Regarding the measurement of quality, the controversy of price-versus-cost approach can be seen in earlier works (e.g., Nicholson 1967 and Gilbert 1961). As Newhouse says, "J. L. Nicholson has criticized Milton Gilbert for using cost rather than price to measure the contribution

At the national level, we lack the data needed to construct cost functions, and, therefore, we construct a quality index using parameter estimates from cost functions estimated using Massachusetts data sample.[28] In an earlier paper (Mukerjee, Witte, and Hollowell 1990) separate cost functions were estimated for PMOs and NPOs assuming a generalized homothetic Cobb-Douglas production technology (Zellner and Revankar 1969)[29] and our preferred quality measure. This technology has the advantage of allowing returns to scale to vary with output. Table 9.3 contains a definition of all variables included in the cost functions[30] and descriptive statistics for these and some additional variables. The empirical results for the cost functions using the preferred quality measure appear quite reasonable[31] with increases in the price of inputs increasing costs. Furthermore, the production technology utilized by for-profit and not-for-profit centers are significantly different. For the purposes of the present study, cost functions were reestimated separately for PMOs and NPOs using staff-child ratios. (See results in table 9.4.)

From the perspective of quality valuation, we are primarily interested in the coefficient on the quality measure, in this case the staff-child ratio. The coefficient on these variables always have *t*-ratios greater than two—the quality of output consistently has a significant effect on the total costs of operating a day-

to welfare of a change in quality. Since cost equals price in our model, this criticism presents no problem to it; one could merely say that the assumptions imply that an increase in quality, quantity held constant, implies an equal increase in both cost and price. Our analysis is really in the same spirit as Nicholson's by proposing a criterion which relates to the consumer's preferences as revealed in the market-place; that is, that the decision maker is in equilibrium at the quality level which maximizes quantity bought at a given price . . ." (67).

28. There are two reasons why using estimates from Massachusetts data may overstate the national valuation. First, incomes are in general higher in Massachusetts, people there tend to hold liberal views, and there is a long tradition of concern with social welfare. This is likely to lead to a higher than average valuation to quality, overstating the coefficient on quality thereby. Second, average costs may be higher because Massachusetts is generally acknowledged to be a high-wage state. We suspect that using Massachusetts data to get the marginal cost of quality overstates the national valuation.

29. The theoretical reasons we did not choose a more flexible form like the translog are outlined in Mukerjee, Witte, and Hollowell (1990). The first difficulty is that the large number of parameters to be estimated in a flexible form call into question the precision of estimates in a reasonably sized data set. The second problem is that, in the presence of a large range of observations in the data set, flexible forms may fail to fulfill certain restrictions such as diminishing marginal physical product. These considerations led us to consider the class of homothetic functions as good candidates for selection. However, it is interesting that Kremp and Mairesse (chap. 2, this vol.) reject the null hypothesis that elasticity of substitution is equal to one. In future work we will be using more general forms.

An alternative method of estimating the cost function would be to assume a multiproduct production function. This would greatly increase the number of right-hand variables and collinearity. We decided to use a single output production function and adjust the output for quality.

30. Note that in table 9.4 LN before a variable name indicates that a natural logarithm of the variable was included in the cost function.

31. The GAO report (1990) for Congress deliberations on the "Smart Start" bill used a Cobb-Douglas production function and obtained cost estimates with quality measures like the staff-child ratio. However, their results are not comparable with ours as they take into consideration only accredited centers (high quality).

Table 9.3 **Descriptive Statistics for Day-Care Centers in Massachusetts**

	PMO Sample		NPO Sample			
Variable	Mean	Standard Deviation	Mean	Standard Deviation	*t*-Statistic*	Variable Definition
TOTEXP	1,583.690	1,425.190	3,684.320	5,603.870	0.360	Total weekly expenditure ($)
CHRS	1,689.510	5,174.700	1,347.780	1,486.670	0.410	Total no. of hours children are cared for in a week
LAB	6.350	2.760	9.740	8.130	3.220	Hourly price of labor
PCAP	337.970	364.200	243.740	553.770	1.080	Monthly price of capital (per room)
PMAT	55.900	250.710	18.400	18.070	0.960	Monthly price of material (per child)
QUAL1	0.570	0.520	0.750	0.540	1.730	Ratio of paid staff classroom hours/weighted children
QUAL2	0.140	0.110	0.200	0.160	2.700	Staff/child ratio
QUALED	4.380	1.160	4.440	1.150	0.110	Average education of staff
QUALEX	7.330	2.700	6.180	2.630	2.200	Average experience of staff
SUB1DUM	0.460	0.500	0.570	0.500	. . .	Dummy variable = 1 if time donated by volunteers/ parents
SUB2DUM	0.150	0.360	0.440	0.500	. . .	Dummy variable = 1 if received state/private funding
INF	0.829	2.418	2.694	6.090	2.300	Total no. of infants
TOD	7.732	9.841	8.319	16.583	0.236	Total no. of toddlers ages 1–2
PRE	36.415	20.434	38.764	33.496	0.463	Total no. of preschoolers
KIN	2.878	8.487	3.846	0.552	0.730	Total no. of kindergartners
SCH	2.659	8.478	8.778	25.490	1.864	Total no. of school-age children
TOTCHLD	50.512	25.899	62.403	53.325	1.592	Total enrollment
NFT	4.195	4.589	8.653	13.652	2.530	Total no. of full-time staff
NPT	2.439	2.530	2.972	4.135	0.850	Total no. of part-time staff
PSCLHRS	158.683	181.874	321.931	513.440	2.442	Total hours staff spend in classroom per week
PSOTHRS	19.488	23.201	37.889	52.176	11.264	Total hours staff spend in other duties per week
PSHRS	178.512	199.177	360.486	553.604	2.518	Total hours of all staff per week

*t-statistic for test of difference in means.

Table 9.4 **Cost Function Estimates for Day-Care Centers in Massachusetts (using preferred measure of quality)**

	PMO Sample		NPO Sample		
Variable	Coefficient Estimates	t^*	Coefficient Estimates	t^*	t-Value†
Constant	9.3990	4.2110	4.7430	4.9720	1.918
CHRS	0.0008	2.6090	0.0002	2.7680	2.000
LNCHRS	−0.5020	1.7980	0.2270	1.9110	0.908
LNPLAB	0.7980	4.2310	0.2520	2.4360	2.516
LNPCAP	0.2160	2.1400	0.0750	1.4020	1.240
LNPMAT	0.1540	1.8950	0.1800	1.8010	0.200
LNQUALI	0.3260	2.1780	0.2520	2.2600	3.895
LNQUALED	−0.9290	2.7560	0.0330	0.1250	2.253
LNQUALEX	−0.6090	2.7590	−0.2900	1.6570	1.130
SUB1DUM	−0.1630	0.9370	0.2700	1.9630	1.959
SUB2DUM	0.1010	0.3740	0.1870	1.1340	0.273
R^2	0.8204		0.7954		
Adjusted R^2	0.7585		0.7499		
F	13.2500		17.4920		
Probability>F	0.0001		0.0001		
N	40		56		

*Absolute values.

†t-value for test of difference of estimates.

care center.[32] Further, the coefficients on the quality measures are insignificantly different for PMOs and NPOs.

To obtain a marginal valuation for quality, we take the derivative of total cost with respect to the measure of quality (QUAL). Given our homothetic Cobb-Douglas cost function the derivative is

$$(1) \qquad \frac{\delta E(TC)}{\delta QUAL} = e^{\beta_0} e^{\beta_1 Q} Q^{\beta_2} \beta_3 QUAL^{\beta_3 - 1} X^{\beta_4} = \beta_3 \, (TC/QUAL),$$

where QUAL in this case is measured as the ratio of the number of staff to the number of children, e is the base of natural logarithms, Q is our measure of output (the total number of hours children are cared for at the center, or child hours, CHRS), and X is a vector of all other explanatory variables, listed in table 9.4.

This derivative is the marginal cost of providing higher staff-child ratios. If we assume equilibrium, competition, and no externalities in the day-care mar-

32. As has been pointed out by Zvi Griliches, ed. of this vol., it is possible that our measure of quality is endogenous and that the significance of the quality measure stems from its correlation with the error term.

ket,[33] this marginal cost is equal to the marginal social valuation of increases in the staff-child ratio, the measure of the quality of day care available at the national level.

Recall that at the national level we were able to construct a time series for the staff-child ratio for the 1974–88 time period. It was not possible to construct a separate time series for the PMOs and NPOs. Because the Chow test indicated that the PMOs and NPOs have significantly different technologies, two sets of marginal valuations, one using PMO coefficient estimates and means and the other using NPO coefficient estimates and means, were estimated separately using the U.S. staff-child ratios. To determine the U.S. marginal valuation, the marginal valuations for PMOs and NPOs were weighted by the estimated proportion of the two types of centers.[34]

Our marginal valuations of quality are open to a number of questions and are, perhaps, best considered illustrative of a methodology rather than policy relevant. The first difficulty is that we use data for a single state to estimate the cost functions. Clearly, it would be better to estimate these functions using data that are nationally representative. The second difficulty is our simplistic measure of quality. Clearly, the quality of day care is best measured using a vector of attributes rather than a single proxy measure as we have done. Finally, it is possible that our measure of quality is endogenous. If an appropriate instrument were available, we could adjust for this potential problem. Unfortunately, there was no reasonable instrument in our data set.

9.5 The Adjustment of Output for Quality

Taking the weighted marginal valuations for the United States, calculated as described above, we multiplied this marginal valuation by the level of quality (i.e., staff-child ratio) in the United States in each year from 1974 to 1988. This is the quality value that we used to construct an index of quality valuation.

We adjusted our physical measure of output by multiplying the output by its index for the value of quality actually attained in that year. Figure 9.2 compares the quality-adjusted physical measure with its unadjusted counterpart, the number of children. Notice that adjusting for quality has lowered the rate of growth. Quality-adjusted physical output is below the unadjusted out-

33. These conditions are more likely to hold for profit-making firms rather than nonprofit ones. Thus, we have far more confidence in the case of PMOs rather than NPOs that the marginal cost we calculated are reasonable proxies for marginal valuations. However, we believe that the calculation of marginal cost for NPOs is a useful step on the road to obtaining good proxies for quality valuation.

34. The weights were the proportion of the receipts and revenues of PMOs and NPOs to the total receipts and revenues of all centers. The receipts and revenues for 1977, 1982, 1985, 1986, 1987, and 1988 were obtained from the various censuses and the *Service Annual Surveys*. Receipts and revenues for the years in between were obtained by extrapolating using the assumption that they grew proportionally to the employment in day-care centers. In our case, we used the lower-bound employment numbers.

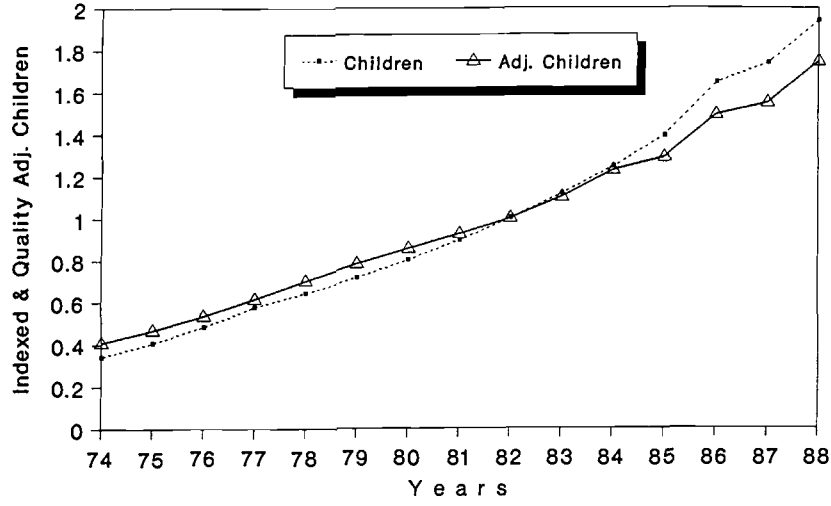

Fig. 9.2 Growth of children and quality-adjusted children over time in United States (1982 = 100)

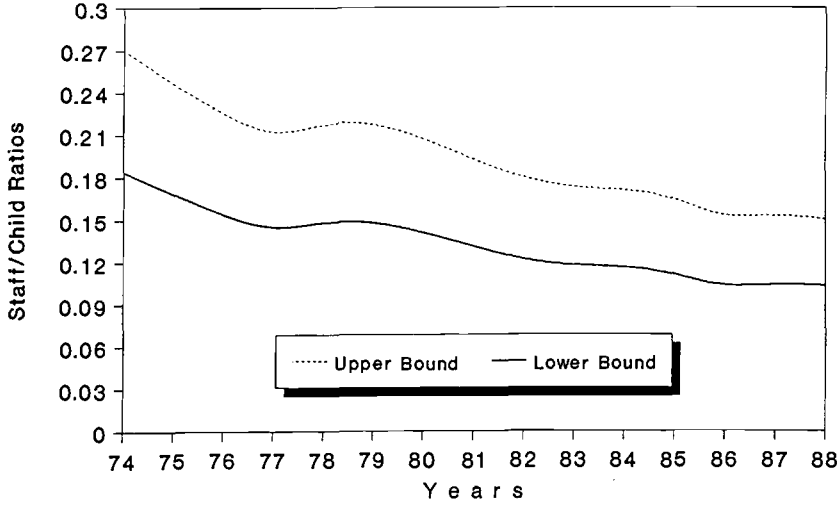

Fig. 9.3 Movement of staff-child ratios over time in United States

put measure after 1982 because of the decline in the staff-child ratio (fig. 9.3). The decline in quality, as measured by staff-child ratios over time, has led to an increasing marginal valuation of quality. (See table 9.1.) This is consistent with the increasing national concern over the quality of day care. Griliches, editor of this volume, has pointed out that we may be overadjusting for quality when we adjust real dollar measures of output using our methodology. This

may be true because the real price of day care already reflects changes in quality. To check on this possibility, we correlated the real price index for day care with our quality index.[35] The correlation was high, at 0.92. Note both a decline in the estimated real price of day care and the decline in the estimated staff-child ratio indicate a decline in the quality of care at day-care centers. We also compared quality-adjusted children with the unadjusted real dollar value of output (see table 9.5). The two measures were highly correlated at 0.98. Figure 9.4 compares the movements of the quality-adjusted physical measure and the unadjusted real dollar measure over time. The figure indicates that, after 1982, both the real dollar output used by the BEA and the quality-adjusted children measures move fairly closely. This underscores the necessity of adjusting the physical measure for quality changes, bringing it in line with the BEA real dollar measure of output.

9.6 Summary and Conclusions

The twin objectives of this paper were, first, to study different available output measures of day-care centers and, second, to propose a methodology for adjusting a given output measure for quality changes. To develop a national measure of quality-adjusted output, we carefully considered the measurement of both output and quality. Output may be measured either in physical or in dollar terms. At the national level, the two measures indicate different rates of growth over time with the difference between the measures increasing over time. To measure the output of day care in physical terms, we suggested the use of the number of hours of child care provided rather than a simple count of the number of children in care. An even better measure of output, we felt, would be the number of hours of care weighted by the age of children in care. However, at the present time, data on the suggested physical measure of output are not available. What is available is information on the number of children in care, but only for selected years. The problem is made more complex by the fact that the survey questions used to obtain information on the number of children in care are not comparable over different years. We had no alternative but to use various adjustments and interpolation and extrapolation to construct a time series for children. This series was compared with the available alternative dollar measure of output: BEA's series on the real dollar value of day-care expenditures.

The most widely used traditional measure of the quality of day care has been the staff-child ratio. We suggest that the ratio of the number of staff-class hours to the age-adjusted number of children is a superior measure of quality because it better proxies staff-child interaction. In the absence of national data

35. Real price is defined as price that has been adjusted for inflation. At the national level, we obtained this in two stages. First we multiplied the number of children by the average number of hours from Massachusetts. The next stage consists of dividing the constant-dollar measure of output by the estimated child hours for the United States.

Table 9.5 **Comparison of Quality-Adjusted Physical Output Measure with BEA Real Output (1974–1988)**

Year	Real BEA Output (in millions of $)	Children Adjusted (in thousands) Upper Bound*	Children Adjusted (in thousands) Lower Bound†
1974	. . .	462	461
1975	. . .	528	528
1976	. . .	604	604
1977	3,436	695	695
1978	3,986	793	793
1979	4,270	885	885
1980	4,211	966	965
1981	4,200	1,045	1,045
1982	4,242	1,128	1,128
1983	4,633	1,242	1,242
1984	5,203	1,386	1,386
1985	5,724	1,459	1,455
1986	6,272	1,684	1,684
1987	6,767	1,744	1,747
1988	7,339	1,961	1,968

*Refers to the upper bound of the staff-child ratio.

†Refers to the lower bound of the staff-child ratio.

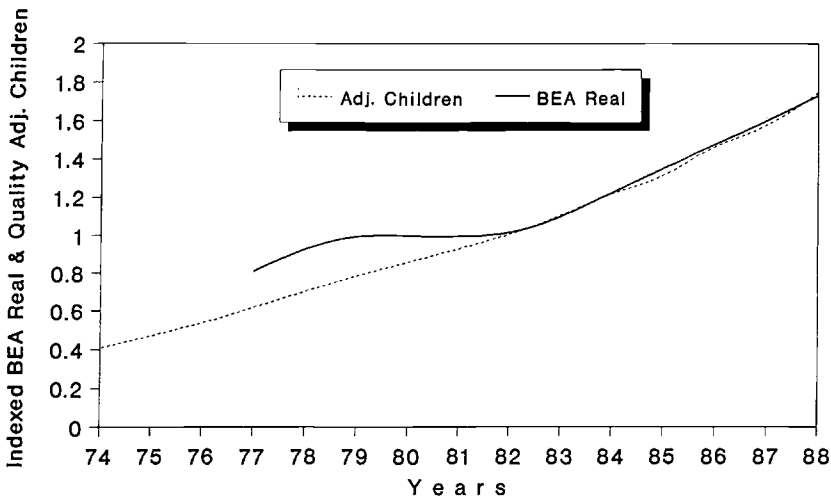

Fig. 9.4 Growth of unadjusted BEA output and quality-adjusted children over time in United States (1982 = 100)

on the preferred measure of quality, we constructed a series on the traditional measure of quality for the United States. This required statistics on employment in day-care centers, and we obtained these by adjusting the numbers given in the employment and wages (U.S. Department of Labor) of various years. Dividing the number of children in care by the number of employees, we obtain estimated staff-child ratios for 1974–88. The estimated staff-child ratio declined throughout the period studied. This suggests that there has been a decline in the quality of care provided by day-care centers in the United States during the period considered.

To fulfill our second objective, we illustrated a method for adjusting day-care output (whether measured in physical or dollar terms) by any given quality measure. The need for this method grew out of the difficulty of applying traditional hedonic methods because of the presence of both supply- and demand-side subsidies that made the definition of a single price difficult.[36] An alternative to the traditional route, the proposed methodology utilizes cost functions to estimate a marginal cost of quality. Under equilibrium and competitive conditions this marginal cost is the same as the marginal valuation of quality by the consumer. In the not-for-profit sector, however, these conditions may not hold, and, in such instances, these valuations simply give the marginal cost of quality. Separate marginal costs of quality were obtained for not-for-profit and for-profit day-care centers in the state of Massachusetts, these estimates being used to illustrate the methodology. To obtain a marginal valuation of quality for the United States, a weighted average of the separate marginal valuations was obtained with the weights being the proportions of each type of center as reflected in the BEA data for the United States. The national marginal valuation was multiplied by the estimated staff-child ratios in the United States and then indexed to obtain a quality index. To illustrate our methodology, we proceeded to use the quality index to adjust both the simple physical and dollar measures of output in the United States in the 1974–88 time period. The decline in the staff-child ratio during the 1970s means that the quality-adjusted output shows lower rates of growth than the simple output measures. Unadjusted output may overstate both the level and the growth rate of output during our study period. It is possible, however, that the real dollar measure of output may already incorporate a quality adjustment, and so our quality measure may be overadjusting in such a case. Indeed, the quality-adjusted children and the real dollar measure of output are highly correlated, suggesting that both methods of quality adjustment (using real prices to obtain a dollar measure of output or adjusting physical output using a marginal valuation of quality) give similar results. Clearly, additional work in quality adjustment is called for. This is apart from the fact that quality itself

36. Griliches, ed. of this vol., has pointed out that the existence of subsidies may cause difficulties for cost-function estimation. This is certainly true and suggests that an essential next step is to develop models that better reflect the unusual environment of day care.

may be more appropriately measured as a vector: the staff-child measure may be challenged as being too naive or too crude. Furthermore, because national data were not available for the estimation of cost functions at the national level, cost functions were obtained using a Massachusetts data set. We are aware that Massachusetts cannot be regarded as typical of the United States. Nevertheless, it serves to illustrate a methodology that may be useful in the future when national level data are available. It also supplies an alternative to traditional hedonics and may be applicable to cases other than the day-care industry.

Appendix A

In this appendix, we describe the way in which we obtain the aggregate time-series data on day care reported in table 9.1. The main problems in constructing this time-series data are the unavailability of data for several years, changes in the definition of variables, and changes in the source of the data. We describe the sources of data and the definition of variables that underlie the data. We also explain the adjustments made to make the available data comparable for different years. Finally, we explain how we interpolated and extrapolated to obtain estimates for years when no primary data were available.

Number of Children

Sources

1974–75. The data for 1974 and 1975 were obtained from the *Current Population Reports,* series P-20, no. 298, October 1976.

1976. Data for 1976 were taken from a random sample of day-care centers that are open at least 25 hours per week, have a capacity for 13 or more children, operate at least nine months per year, and have a majority of enrollment that is nonhandicapped. The survey was conducted by Abt Associates and is reported in Coelen, Glantz, and Calore (1979). Because of difficulties in making appropriate adjustments, this source was not used. This source is also supply based, whereas CPS and SIPP data are all demand based.

1977. Data for 1977 were from *Current Population Reports,* Special studies, P-23, no. 117, June 1982, Bureau of the Census, U.S. Department of Commerce.

1985. The data for 1985 were from the *Current Population Reports,* Household economic studies, series P-70, no. 9, Bureau of the Census, U.S. Department of Commerce.

1986. The data for 1986 were obtained from a press release, U.S. Department of Commerce News, Washington, D.C., Thursday, July 27, 1989, no. CB 89–119.

Adjustments Made to Make Data Comparable

Source of the 1974 Data

As far as we know, data for the number of children in nonparental care was first collected as a supplement to the CPS in October 1974 and February 1975. The 1974 survey obtained information on care arrangements for children 7–13 years old. The 1975 survey included questions for children 3–6 years old.

Adjustments to 1974 Data

The children included in the two CPS surveys were between 3 and 13 years old, whereas in later years, with the establishment of the SIPP, coverage was extended to include all children younger than 15 years. We expanded the 1974–75 data to include children younger than 3 by using the ratio of infants and toddlers to the total number of children obtained from the Massachusetts data. This may provide an overestimate of the number of children in care during the early years if we consider the implication of Hofferth's findings (1987): "The most striking trend is the substantial growth in use of group care programs from 1965 to 1982. This growth was steady for children of full-time employed mothers. It was equally dramatic for children under age 3 and for preschoolers ages 3 and 4. Among children of part-time employed mothers, use of centers for both age groups rose substantially between 1965 and 1977, and then declined somewhat between 1977 and 1982" (562).

We verified from the Bureau that the coverage has always included the three youngest children and has been the same through succeeding CPSs and SIPPs. Hence, no adjustments were necessary regarding this aspect.

Day-care centers were defined by respondents in the CPS and SIPP questionnaire separating nursery schools and preschools from other types of day-care centers. We use the number of children reported by the respondent to be that enrolled in day/group care.

The 1974–75 survey reflects child-care arrangements for all mothers, whether or not they participated in the labor force, either on a full-time or a part-time basis. Subsequent SIPP surveys include only employed mothers.

Adjustments to 1977 Data

The children included were the two youngest children (younger than five years) of employed mothers. We adjusted the number of children to account for the children of mothers who are unemployed and for those not in the labor force by using the 1974–75 CPS data described above. These data give the

day-care arrangements for mothers working, unemployed, or not in the labor force.

We then adjusted the number of children to include those who were 5 and older by utilizing corresponding ratios from the Massachusetts data sample and by inflating the data accordingly.

Adjustments for 1985–86

Beginning in 1985, a special module on child-care arrangements was included as part of the SIPP program. SIPP obtains information on child-care arrangements for the three youngest children (younger than 15) of working parents or guardians. SIPP data are currently available for 1985 and 1986.

We adjusted the number of children to account for the children of mothers who are unemployed and for those not in the labor force by utilizing the 1974–75 CPS data described above. These data give the day-care arrangements for mothers working, unemployed, or not in the labor force.

Data are currently available from the SIPP child-care module administered in January–April 1985 and September–November 1986. (See app. B of U.S. Department of Commerce 1987; and U.S. Department of Commerce 1990) We used the January–April, 1985 results as the basis for obtaining the number of children in day-care centers in 1985 and the September–November 1986 results to estimate the number of children in day-care centers in 1986.

Methods of Interpolation and Extrapolation

Using all data currently available, we were able, even after the extensive adjustments described above, to obtain estimates of the number of children attending day-care centers for only 1974, 1977, 1985, and 1986. We obtained estimates of the number of children in care for all other years by interpolation and extrapolation. Specifically, our estimates of the number of children in day care in 1975 and 1976 were obtained by using the average annual compound rate of growth between 1974 and 1977. Our estimates of the number of children in care for 1978 through 1984 were obtained by using the average annual compound rate of growth between 1976 and 1985. Our estimates of the number of children in care for 1987 and 1988 were obtained by using the average annual compound rate of growth as reflected in the SIPP data for 1977 and 1985.

Number of Employees

Source. U.S. Department of Labor (various years).

Because SIC 835 included nursery schools, preschools, and some types of Head Start centers, we adjusted the data downward by utilizing unpublished

data on output of day-care centers and nursery schools given to us by Robert Parker of BEA.

BEA's Dollar Measure of Output

These data were obtained from Robert Parker of the BEA and are unpublished. The estimate of the nominal dollar value of the day-care centers' output aggregates the receipts of PMOs and the expenditures of NPOs. The data have been adjusted by BEA for misreporting on the tax returns and other coverage errors. The real output was obtained by using the implicit price deflator for day care as developed by BEA. As we understand from Parker of the BEA, this deflator is a composite of input prices assembled by the BEA, being a weighted average of the index of average earnings and the producer price index for industrial commodities less final and related products and power. The actual weights themselves are derived from the 1977 input-output table.

Quality Adjustments on Aggregate Data

To obtain a quality index for aggregate data, the marginal valuation of quality was calculated for various staff-child ratios at the national level, using the estimates with QUAL2 for all centers in Massachusetts (i.e., combining PMOs and NPOs). These marginal valuations were multiplied by the actual staff-child ratios to yield a value of quality that was utilized in obtaining a quality index. This index was then used to adjust the quantitative measure of output (children).

Appendix B

The data are obtained from a random sample of day-care centers in Massachusetts.[37] The dependent variable, total costs, is the annual expenditure of each center summing all labor, capital, supplies, food, transportation, utilities, phone, liability insurance, and other costs. The independent variables are discussed below.

The price of labor is the personnel costs, fringe benefits, and payroll taxes divided by total paid staff hours. To arrive at the total capital cost for a center,

37. The data set contains information for centers selected from two sampling frames. The first sampling frame was the licensing lists of the Massachusetts Office for Children. The data for 86 centers from this sampling frame are used. The second frame was the centers used by a random sample of Massachusetts families with children under the age of 13. The data for 27 centers were selected from this sampling frame. The addition of the second set of centers in February 1988 tends to overcome deficiencies in the licensing-list sampling frames (e.g., incomplete and out-of-date lists). See the affordability report (Marshall et al. 1987) for details.

we sum rent or mortgage payments, utilities, maintenance, and repair costs. This figure is divided by the total number of rooms to yield the price of capital. Summing the costs of supplies, equipment, food, phone services, and transportation and then dividing by the number of children gives us the price of material.

Day-care centers receive a range of subsidies: state food-program allocations, donations, funds from endowments, supplies brought in by parents, volunteer hours, and Department of Social Services (DSS) funding.[38] Because these subsidies fall naturally into two groups, two subsidy variables were created. Subsidy 1 is a binary variable equal to one if the center used volunteer hours and zero if the center did not. Subsidy 2 is a binary variable equal to one if the center received state funding items (state food and DSS), financial subsidies such as endowments and loans, or funding from private organizations or the United Way. These subsidies may be expected to lower costs for PMOs, but prima facie it is not possible to say how they may affect NPOs. In the latter case the use of subsidies may actually increase costs—for example, they may be used for staff perquisites. Costs may also rise because of unmeasured improvements in quality. For instance, better and more varied play equipment may be purchased.

The quality variables used have been discussed in section 9.3. The next two variables relate to education and experience. To reflect the diverse educational levels of the staff in any day-care center, we construct a variable that indicates the average education of the staff. The experience variable is created by taking the weighted average of the total years of experience possessed by the staff. This reduces the range of staff experience in any one center to a scalar. It is unclear how parameter estimates on these two variables should be interpreted. They may be reflecting technology embodied in labor. In that case, there is the possibility that, as more technology is incorporated into labor, certain aspects of quality, for example, the fostering of creativity in children, may be enhanced. Alternatively, this labor embodied technology may lower costs. The coefficients on these variables may also measure marginal productivity not included in labor price. To the extent these two variables measure quality, we would expect a positive relationship to costs. However, to the degree they reflect cost-reducing technological change or differences in marginal productivity not reflected in labor price, we would expect negative coefficients.

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