Chapter 3

Rothbarth Scales for Families with Children

This chapter focuses on the estimation of the cost of children, the size of associated equivalence scales, and the influence of household characteristics on the cost of children. The employed method was first suggested by Rothbarth (1943) who pointed out that adult equivalence scales can be derived from the observation of adult goods: it is assumed that the adults in two households with the same number of adults are equally well off if both households spend the same amount of money on adult goods Drawing on this idea and the works of Gronau (1988, 1991) and Lazear and Michael (1988), an economic model of household behaviour is derived, which can be used to estimate the intra-household distribution of income and related equivalence scales.

Extending on the exposition in section 2.2.4, the method is presented in the first part of the chapter together with possible problems associated with the model. In particular identifying assumptions, possibilities of testing those assumptions and related literature will be discussed. In the second part, the theoretical model is established, while the empirical part focuses on three questions: (1) the determinants of the distribution between parents and children, (2) the actual size of equivalence scales, and (3) the question, if scales depend on the level of utility.

3.1 Rothbarth Equivalence Scales and the Distribution Between Parents and Children

When consumption of adult specific goods, for example clothing, tobacco or alcohol, can be observed directly, expenditures on these goods can be used as an indicator of parents' welfare. The central idea is that two otherwise identical couples with a different number of children are assumed to be equally well off, if they spend the same amount of money on adult specific goods. E.g. a childless couple r with an income of $\mu^r = 2000$ € spends $q_A^r = 40$ € on some adult good A, say alcohol. When an otherwise identical couple s with two children and an income of $\mu^s = 2500$ € is also observed spending $q_A^s = 40$ € on alcohol, then these two couples share the same level of welfare. An equivalence scale m can easily be calculated by dividing the incomes or total expenditures of both couples ($m = 1.25$ in the example):[1]

$$m = \mu^s/\mu^r \tag{3.1}$$

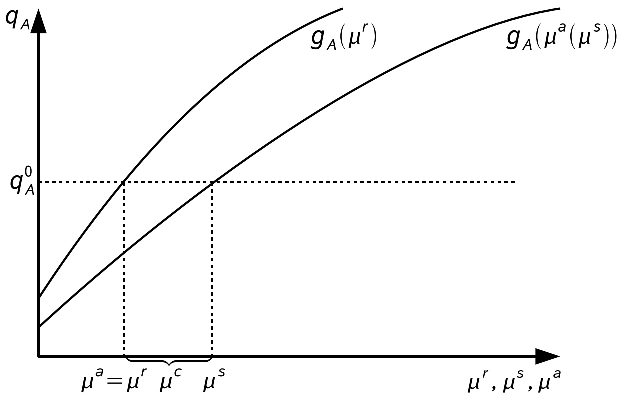

Figure 3.1: *Demand for adult good and income distribution in household s.*

Alternatively, the Rothbarth methodology can be used to address intra-household distribution and the cost of children. The cost (or income share) of children μ^c is then equal to the total income of the couple with children μ^s minus the income μ^a which goes to the parents and which is assumed to be equal to the income μ^r of the equivalent childless couple, so that $\mu^a = \mu^r$ (Figure 3.1). If demand g_A for some adult good A is observed, then this

[1] In principle, the method can also be applied to the cost of children to single parents, which might be different to the cost of children to couples. However, the underlying assumptions (separability and constant preferences) are even more critical in the case of single parents. This will become apparent in the further discussion of the model.

demand depends only on that part of income μ^a that is allocated to the parents. The cost of children μ^c can be calculated by comparing the demands of couples with children and without children. The identifying assumption is that for childless on some adult good A, say couples the share of income that is allotted to both partners is exactly equal to total income and therefore observable. If household type $\boldsymbol{s}$ with children spends an amount, say q_A, on the adult good at income level μ^s, then the parents' share is equal to μ^a, which is equal to the income μ^r at which a childless couple spends the same amount q_A on the good, and the cost of children is:

$$\mu^c = \mu^s - \mu^a. \tag{3.2}$$

3.2 The Formal Model

Deaton and Muellbauer (1986), Gronau (1988) and Lazear and Michael (1988) show that a theoretical basis of the Rothbarth methodology can be founded on the assumption of separability and constant preferences. A childless couple derives utility from all the goods it consumes, maximizing its utility by choosing the optimal consumption bundle. In addition to their own consumption, parents also care for their children, taking themselves pleasure in their children's well-being. The material well-being of children is determined by the children's own consumption bundle. To infer the changes in purely material well-being of a couple when it is having children, it is assumed that parents have a utility function which is *separable* in utility from their own consumption and in their children's utility:

$$U = \tilde{U}(U^a, U^c) \tag{3.3}$$

with the subutility functions

$$\begin{aligned} U^a &= U^a(\boldsymbol{q}^a) \qquad \text{and} \\ U^c &= U^c(\boldsymbol{q}^c, k), \end{aligned} \tag{3.4}$$

where $\boldsymbol{q}^a$ and $\boldsymbol{q}^c$ are the quantities consumed by parents and children, and k is the number of children. All utility functions have the usual properties with respect to consumed quantities, being increasing and quasi-concave in $\boldsymbol{q}^a$ and $\boldsymbol{q}^c$; U^c is also not increasing in the number of children k.

Separability implies that the parents' consumption subutility function $U^a(\cdot)$ is not influenced by their children's consumption. Because of separability, children affect their parents' consumption only through income effects, while the marginal rate of substitution for parents stays the same: two bottles of champagne are as good as a night at the theatre, no matter if a couple has children or not.

For childless couples the functions $U^c(.)$ and $\tilde{U}(.)$ are not defined; instead, they maximize the function of their material utility $U^a(.)$ directly. The parents' material well-being U^a is the reference for the calculation of equivalence scales, thus deliberately leaving out of the discussion the children's welfare level as well as parents' utility derived from their children.

For U^a of couples with and without children to be comparable, it is necessary that tastes for the partners' own consumption do not change when they are having children. This does not rule out that parents care for their children. As Gronau (1988) puts it: "...the assumption is consistent with parents' stuffing their children with spinach but is inconsistent with their starting to eat spinach themselves to set a personal example. More seriously, it is inconsistent with children's affecting their parents' pleasure from watching television, going to the ball game, or listening to a Bartok quartet."

Parents maximize utility according to the budget constraint:

$$\boldsymbol{p}'(\boldsymbol{q}^a + \boldsymbol{q}^c) = \mu^a + \mu^c = \mu \ . \tag{3.5}$$

There are no public goods in the household, which could be shared between parents and children. This leads, together with the separability of the subutility functions to two stage budgeting (see Deaton and Muellbauer, 1980, Chapter 5). The budget is first divided between parents and children into μ^a and μ^c and then spent according to the respective demands of parents and children. Two stage budgeting does not mean that children spend their share themselves – the parents taking the larger part of consumption decisions for their children is well consistent with it. It rather means that parents behave *as if* they were first dividing the budget and then spending the individual budgets. Children have no substitution effects on their parent's consumption. As a result the parents' personal budget is the total budget minus the children's budget, where $\varrho(.)$ is the distribution rule that determines the children's budget:

$$\mu^a = \mu - \varrho(\mu, \boldsymbol{p}, k) \tag{3.6}$$

Separability also leads to separate demand functions for parents and children which are not directly observable:

$$q_i^t = g_i^t(\mu^t, \boldsymbol{p}), \qquad t = \{a, c\} \tag{3.7}$$

Only total household consumption q_i can be observed:

$$q_i = q_i^a + q_i^c = g_i^a[\mu - \varrho(.), \boldsymbol{p}] + g_i^c[\varrho(.), \boldsymbol{p}] \tag{3.8}$$

However, if there is a good A that is consumed only by parents, household consumption for this particular good is equal to parents' consumption $q_A^a = q_A$. The parents' demand function $g_A^a(\mu^a, \boldsymbol{p})$ for this good can be determined from a sample of childless couples. The distribution rule $\varrho(.)$ can be identified implicitly by equating demand functions for good A from couples with and without children. Because of separability, both functions are identical and depend only on the parents' budget μ^a, which is known for the childless couple and unknown for the couple with children:

$$q_A^a(\mu^a, \boldsymbol{p}) = q_A^a(\mu - \varrho(.), \boldsymbol{p}) \tag{3.9}$$

The equivalence scale then evaluates to:

$$m(\mu) = \frac{\mu}{\mu^a} = \frac{\mu}{\mu - \varrho(.)} \tag{3.10}$$

3.3 Constant Preferences

The discussion of the falling incidence of smoking among couples with children in chapter 4 (p. 102) gives an impression of how sizable the effect of children on their parents' consumption pattern can be for some goods. Smoking is an extreme case, because of negative externalities. For many goods and for larger commodity groups in particular, the direct effect of having children on parents preferences will probably be rather small. The effect of between-group consumption shifts (e.g. between food and transportation) is probably of less importance than the effect of intra-group shifts (e.g. the father replacing the three-seater sports car with a fast family van), which remain hidden when only larger aggregates are observed.

A more serious reservation that can be raised against the model is the assumption of identical preferences between parents and couples without children. First of all couples with children and couples without children usually differ in their age structure. This can easily be handled if age is controlled for. In the present study for example, the age of adults has been restricted to be between 30 and 50. More serious is the question if family composition is indicative for special preferences. If couples who have a preference for having children have different preferences regarding adult goods, then it is likely that there is a selectivity bias.

Gronau (1991) suggests to test for a selectivity bias by estimating the "taste" for children from the sample as the probability of having children dependent on different demographic variables of the parents. The residual of the regression can then be used as an independent variable in the regression of adult goods for the childless subsample. If there is no significant relation between the residual and adult goods, then this is evidence that there is no connection between the preference for children and adult goods. On the other hand, if the residual has an effect in the subsample with children then this is an indicator that liking children more leads to more resources being diverted towards children. This is indeed confirmed in Gronau's work.

3.4 Separability

Two-stage budgeting permits to identify parents' and children's income shares. Separability of preferences alone does not lead to two-stage budgeting. It is also necessary, that all goods in the household are private. However, if there are economies of scale in consumption or "family goods" that are consumed jointly by all household members, then the presence of children in the household can influence parents' demands in an indirect way, even if preferences are separable.

Family goods are public goods consumed by the family, e.g. the living room, some appliances or the fixed costs of a car. The consumption of parents and children can also interact because of increasing returns to scale in the flow of services or in home production when goods are consumed jointly. As Gronau's spinach example continues: "...parents may switch from lettuce to spinach not because they feel they should set a personal example but because it is 'cheaper' to prepare one big bowl of spinach salad than two separate salads." In all cases, the presence of children can affect parents' consumption, because an additional unit of a jointly consumed good affects both arguments of the household utility function U, U^a and U^c, while an additional unit of a private good affects only one of the arguments, either U^a or U^c.

This interaction affects the implicit prices of goods. The problem is alleviated when economies of scale are distributed evenly among different goods. In this case relative implicit prices do not change and economies of scale have only an income effect that reduces the cost of children to parents and that is correctly measured with the Rothbarth method. Studies on economies of scale by Lazear and Michael (1980) and Nelson (1988), as well as results presented in chapter 5 of this work show, however, that economies of scale are distributed rather unevenly between goods, with shelter showing markedly higher economies of scale than clothing or transportation. Changing relations of implicit prices would lead to substitution effects that are not consistent with the separability assumption. The results of both studies cannot be applied directly to families with children, as they do not distinguish between adults and children (Nelson only studies one and two person adult households, the same applies to the model in Chapter 5)[2], but a good that is private in a two person household (such as clothing) should also be private in a family, while a good that shows high economies of scale in a smaller household (such as housing) will retain this property in a larger household, if only to a different degree.

Economies of scale in household production *between* parents[3] are perfectly compatible with separability, because they affect only adult consumption and

[2] When children have different needs from parents, the differences in needs cannot be distinguished from economies of scale.

[3] This topic is discussed and a model of economies of scale for two-person households is developed in chapter 5.

do not depend on the number of children. The same applies to possible economies of scale in child rearing, as goods are shared between children. These savings affect only children's consumption directly, while under separability, they have only income effects on parents consumption.

How Do Economies of Scale Affect Equivalence Scale Estimates?

Following Nelson (1992), the impact of disregarded economies of scale on the Rothbarth equivalence scale estimate can be illustrated with a simple model. Assume that there are only two goods consumed by parents and children: a family good F, that is consumed jointly and without congestion by parents and children, so that $q_F = q_F^a = q_F^c$, and a private good P, some of which is consumed by parents and some by children, so that $q_P = q_P^a + q_P^c$. The household maximizes the separable utility function $\tilde{U}(U^a(q_P^a, q_F), U^c(q_P^c, q_F))$ subject to the budget constraint $p_P(q_P^a + q_P^c) + p_F q_F = \mu$. It is easily shown that while the parents alone would set the marginal rate of substitution between goods P and F equal to p_F/p_P, they will set the rate equal to $p_F/p_P - (\partial U^c/\partial q_F)/(\partial U^c/\partial q_P)$ when children are present, where $(\partial U^c/\partial q_F)/(\partial U^c/\partial q_P)$ is the children's marginal rate of substitution between P and F.[4] This is equivalent to a price reduction of the family good. An additional unit of the private good adds utility to its consumer, either the parents or the children, while each additional unit of the family good adds to the utility of all family members, making the family good relatively more valuable.

While the household utility function itself is separable in its arguments of parents' and children's utility, the maximization problem is not, because the presence of a pure public good in the household leads not only to income effects but also to price effects. The effect on the equivalence scale estimate is shown in Figure 3.2. Let line AA' be the budget constraint of a childless couple. Obviously, the couple maximizes its utility with the consumption bundle in a. If the presence of children has only income effects on parents' consumption, then equivalent parents would reach the same budget constraint AA' with their income share μ^a. But the presence of the public good leads to a flatter budget constraint, line BB' for instance. Actually, equivalent parents consume less of P and more of F. According to the Rothbarth method, parents consuming bundle c at utility level U_1^a would be equally well off as the reference childless couple, but this is wrong. Rothbarth compensation is

[4] Parents use the following maximization program: $\max_{q_P^a, q_P^c, q_F} \tilde{U}$ s.t.$p_F(q_F^a + q_F^c) + p_F q_F = \mu$, the solution of which leads to the condition $\frac{\partial U^a/\partial q_F}{\partial U^a/\partial q_P^a} = \frac{p_F}{P_P} - \frac{\partial U^c/\partial q_F}{\partial U^c/\partial q_P^c}$ or $MRS^a = \frac{p_F}{P_P} - MRS^c$.

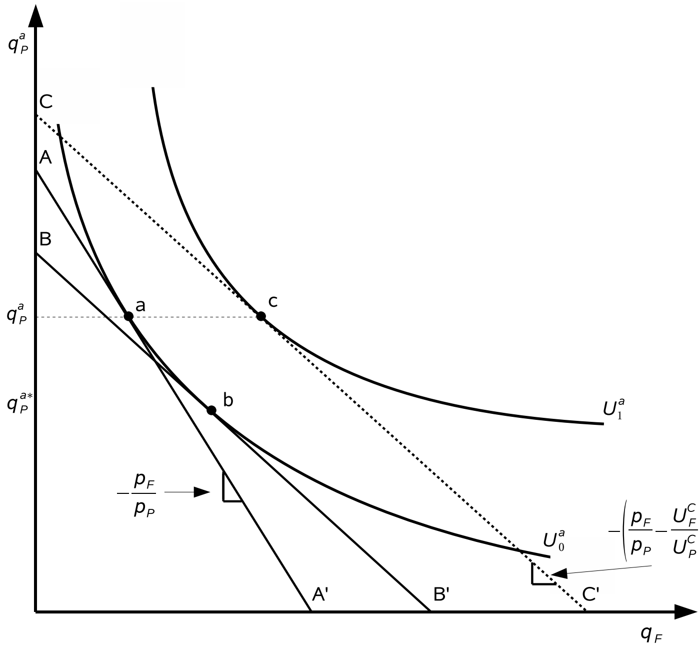

Figure 3.2: *Bias in the estimate of the equivalent adult income μ^a when a family good is consumed jointly by parents and children. Source:Nelson (1992), with modifications.*

too high, provided the identifying adult good is a normal good. The reverse is true, if the identifying adult good is a family good.[5]

[5]Deaton and Muellbauer (1986) give a slightly different interpretation of the bias of the Rothbarth scale: they assume that a Gorman model is the "true" equivalence scale. But preferences in the Gorman model are not separable. Quite the opposite: in this model demands are determined by a household utility function and a household consumption technology that is represented by scale factors that encompass the needs of children as well as economies of scale. As a consequence, parents substitute away from child intensive goods and towards less child intensive goods, where a child intensive good is a good with a high share of its consumption going to children. This can be expressed in terms of a high Barten scale factor, see Section 2.2.5 and Chapter 4.

If this logic is applied to Nelson's family/private good example, the bias would have the same direction in both models: the family good is not child intensive at all, while the private good is also consumed by children. Thus households substitute towards the family good. Clothing is an example of a private good where adult consumption can be identified, but that is also consumed by children.

However, if the identifying adult good is less child intensive (as is a plausible assumption for alcohol and tobacco), then an equivalent household would consume more of the good than the reference household, and the Rothbarth compensation were too low. So in Nelson's case, the private nature of the identifying adult good is the cause for the bias in the Rothbarth scale, while Deaton and Muellbauer's explanation is based on child intensity.

Nelson notes that in general, the direction of the bias is ambiguous, because the adult good could be a complement to a family good. However, with wide enough commodity groups this special case is not probable. A test that examines cross-price elasticities would be straightforward, but would require data with sufficient observed price variation. This was not available for this work. Still, the view that the direction of the bias predicted by Nelson's model is correct is supported by evidence found in the applied work in Sections 3.7 and 3.8: in a comparison of equivalence scale estimates for private adult goods and for a family good, the family good generates lower values than the private goods.

Gronau establishes that the assumption of separability can be maintained when parents' preferences for private and family goods are separable and equivalence scales are redefined to reflect only the welfare generated by parents' consumption of private goods. As Nelson (1992) points out, this is somewhat unsatisfactory, because the goods that exhibit considerable economies of scale and therefore fall largely into the category of family goods (shelter, transportation, recreation, household furnishings, and fuel and utilities) take a share of more than fifty percent of the family budget.

Another interpretation is possible, one that allows for family goods while maintaining the separability assumption. This has not been discussed in the literature before. Again, assume that there are private goods and family goods, that are purely public, so that children do not affect parents' consumption through congestion. Children consume a vector of private children's goods $\boldsymbol{q}_P^c$ and a vector of family goods $\boldsymbol{q}_F$. Assume further, that the needs of children for family goods are small compared to the needs of their parents, so that the utility function of children is in a region of satiation for family goods. Then the amount of family goods consumed is determined by the parents. The children's utility function takes the form $U^c = min(U_P^c(\boldsymbol{q}_P), U_F^c(\boldsymbol{q}_F))$ and utility is determined by utility from private goods U_P^c, because utility from family goods U_F^c is always larger than U_P^c. As a consequence, the children's marginal rate of substitution between private and family goods is zero, and – following the discussion above – the choice of the marginal rate of substitution of parents would not be affected by their children. This is an elegant way of avoiding the the problems generated by family goods in the model. The assumption is not entirely implausible when one thinks of the small child in the large house. However, this hypothesis would be very difficult to test, because children's preferences are even more difficult to recover than parents', as they are never observed living alone.

This is not always the same, because child intensity is the result of a combination of children's needs and economies of scale.

The results in this work rather favour Nelson's explanation, because Rothbarth scales that are based on private adult goods are higher than other estimates.

Tests of Separability

The method has drawn some attention on its theoretical basis and on empirical tests of its validity, and of the separability assumption in particular. In turn, both Deaton et al. (1989) and Nelson (1992) test separability.

Deaton et al. (1989) suggest a test of the separability assumption which rests on the observation of several adult goods. Separability implies that any demographic change from which the adult goods are separable has only an income effect on the good and no substitution effect. For any good g in the set of adult goods G to be separable from a demographic change s_d it is required that:

$$\frac{\partial q_g}{\partial s_d} = \theta_d \frac{\partial q_g}{\partial \mu} \tag{3.11}$$

If separability holds, the factor θ_d is independent of the good g. Only the derivatives in Equation 3.11 are directly observable, but when several adult goods are observed, the separability assumption can be tested by examining equality of the respective calculated θ_d.

Deaton et al. note that – even if separability is not rejected – this procedure cannot distinguish between the case that parents' consumption is separable from children's consumption and the case that adult goods are separable from the rest of consumption goods as a whole. Suppose there are three groups of commodities represented as vectors: adult goods $\boldsymbol{q}_G$, other goods consumed only by adults $\bar{\boldsymbol{q}}_A$ and other goods consumed only by children $\bar{\boldsymbol{q}}_C$. Let $\boldsymbol{p}$ and $\boldsymbol{p}_G$ be the price vectors of other goods and adult goods respectively. Then $\mu^a = \boldsymbol{p}_G{}'\boldsymbol{q}_G + \boldsymbol{p}'\bar{\boldsymbol{q}}_A$ and $\mu^c = \boldsymbol{p}'\bar{\boldsymbol{q}}_C$.

The Rothbarth method assumes that the household utility function is separable in $(\bar{\boldsymbol{q}}_A, \boldsymbol{q}_G)$ and $\bar{\boldsymbol{q}}_C$:

$$U = U[\upsilon(\bar{\boldsymbol{q}}_A, \boldsymbol{q}_G), \bar{\boldsymbol{q}}_C] \tag{3.12}$$

but the same test applies if the utility function is separable in $\boldsymbol{q}_G$ and $(\bar{\boldsymbol{q}}_A, \bar{\boldsymbol{q}}_C)$:

$$U = U[\boldsymbol{q}_G, \upsilon(\bar{\boldsymbol{q}}_A, \bar{\boldsymbol{q}}_C)]. \tag{3.13}$$

But this is not the end. In general, the assumption of separability is applied to commodity groups of common affinity, e.g. goods and leisure, or present and future consumption. There is nothing in terms of preferences that binds adult clothing and tobacco or alcohol consumption. The only thing they have in common is that they are rarely used by children. Separability implies that the elasticity of substitution between any good of the separable group and any good outside it is the same. Therefore the two utility functions 3.12 and 3.13 can be distinguished, if there are data with price variation. Then the elasticity of substitution for different pairs of goods can be estimated and compared.

In a comparative work, Nelson (1992) tests plausibility of the Rothbarth method by calculating children's expenditures $p_i q_i^c = p_i q_i - p_i q_i^a$ using Gronau's (1991) specification with adult clothing and Deaton and Muellbauer's (1986) specification with adult clothing and adult goods (clothing, tobacco and alcohol) as identifying adult good. In all three models, Nelson finds significantly negative children's expenditures q_i^c for health insurance, personal care, dry cleaning and laundry and public education. She also finds positive children's expenditures on tobacco and alcohol of around ten percent. If one is willing to accept that these results are not due to a misspecification of the model, they do shed some doubt on the separability assumption. On the other hand, together these goods make up only about five percent of total household expenditures. It could be argued that the deviation from full separability is small enough for the resulting bias to be not severe.

3.5 Further Literature

Despite the simplicity of the estimation procedure, the number of applications is rather limited, probably due to the difficulty of finding appropriate adult goods, and because of doubts over the theoretical feasibility of the method. In their evaluations of the method, both Gronau (1988, 1991) and Nelson (1992) stop short of reporting actual equivalence scales. In another evaluation, Deaton and Muellbauer (1986) apply the method to poor countries (Sri Lanka and Indonesia), taking all non-food expenditures as a proxy for adult goods expenditures. The resulting scales are rather low, because even at the very low income levels in these countries, non-foods are not a pure adult good. Deaton and Muellbauer argue, that with child intensive food expenditures and less child-intensive non-foods the Rothbarth scale is biased downwards (see Footnote 5, p.57). A correction procedure is suggested, but the authors note that the method cannot be applied to more developed countries, where children take a much higher share of non-food expenditures.

Gronau (1991) also tests the sensitivity of results to the functional form of the employed Engel curves. In particular, usually linear Engel curves are employed, and Gronau includes a quadratic term. He notes that a linear model implies a sharing rule which is linear in income, while a sharing rule of a higher order can only be accomplished with higher order Engel curves. However, the results do not change with functional form.

In an application for Germany, Faik (1995) in his general survey on equivalence scales estimates Rothbarth scales from expenditure data on alcohol and tobacco found in the 1969 German income and expenditure survey. In the application of the method, Faik assumes fixed cost for children. Tobacco does not lead to sensible estimates, because of its low income elasticity, but estimates for alcohol are quoted in table 2.1. Apart from calculating scales, Faik does not pay much attention to the method.

Further applications of the method are found in Blaylock (1990), who compares subjective scales and Rothbarth scales, Tsakloglou (1991) with an application to data from Cyprus, and in Lazear and Michael (1988). Lazear and Michael are mainly concerned with intra-household distribution between parents and children, not with equivalence scales. They do calculate an equivalence scale from intra-household distribution: with expenditure on children being on average 38% of the expenditure on adults, the equivalence scale would be about 1.2 for a couple with one child. The work is of particular interest here, because Lazear and Michael investigate into the effects of various household characteristics on intra-household distribution between parents and children. As distribution can also be interpreted in terms of equivalence scales, I will refer to these results in Section 3.8, where the effects of demographic characteristics on equivalence scales are examined.

3.6 The Adult Good

To estimate equivalence scales with the Rothbarth method, goods have to be observed, which are – either by definition or by custom – used exclusively by adults. The usual suspects for adult goods are adult clothing, alcohol and tobacco.[6] Jewelry is also a possible adult good, if the age of children is restricted. Deaton et al. (1989) examined the possibility of expanding the adult goods category by including adult education, entertainment, health, meals out, personal care, and transport and got mixed results. They recognize that with the exception of adult education, children share in all these activities and may affect the time cost of some (e.g. meals out and entertainment), whereas adult education may be regarded rather as an investment than as consumption.

Tsakloglou (1991) also pays attention to the correct identification of the adult good. He regresses expenditures on various goods on total adult expenditures and on the number of children. Tsakloglou claims that a good can be assumed to be a pure adult good, if the effect of children on expenditures on the good is not significant. Using this test, meals out, alcohol, tobacco, adult clothing and footwear, and entertainment are classified as adult goods while medical care, personal care, transport and other goods[7] are excluded.

That a good is consumed only by adults is not sufficient for estimation, it is also important that there are no substitution and taste change effects on the demand for this good stemming from the presence of children. One important effect of children on their parents' demand will work through a change in the

[6] The sum of expenditures on these three goods is used for example by Lazear and Michael (1988) and Gronau (1991), who also uses adult cothing alone.

[7] The 'Other goods' group includes: coffee, newspapers, magazines, pipes, lighters, legal expenses, gambling, insurance, membership fees and subscriptions, and payments for financial and personal services.

value of time. Therefore, time intensive goods like theatre tickets or food away from home are not good candidates. The preference for tobacco might be influenced by the presence of children as well. The problem of changing preferences can be avoided in part if it is assumed that there are no economies of scale in child costs. In this case every child has the same weight and the intra-household distribution of income and respective equivalence scales can be derived from a sample of couples with differing numbers of children alone. When adults' preferences are affected by the presence of children in the household (compared to a childless household), but not by the *number* of children present, then consumption can be separable between parents and children for households with differing numbers of children even if it is not separable when households with and without children are compared: Parents of three children would consume the same quantity and quality of wine as equivalent parents of a single child, even if they both consume less (or more) than an equivalent childless couple.

In addition to the separability requirement, for estimation errors to be small, the income elasticity of the demand for the adult good has to be sufficiently high (See Figure 2.4). To find a unique solution, demands also have to be monotonous, otherwise two different incomes might generate the same demand q_A. This makes tobacco and alcohol bad candidates for the adult good: the demand for tobacco is very income inelastic in developed countries, rendering an estimation of scales impossible, while the demand of alcohol is not always monotonously increasing over the full income range. In addition, tobacco and alcohol take only a small part of the budget, which complicates estimation and can lead to high standard errors of estimated equivalence scales. For equivalence scale estimation in developing countries, Deaton and Muellbauer (1986) suggest to use all non-foods as a proxy for adult goods, which is highly income elastic and represents a (very) large budget share. However, this is certainly not appropriate for developed countries, where children consume a high share of non-foods.

I prefer adult clothing as adult good for three reasons: First, it has a high income elasticity close to one, which reduces standard errors of the estimated equivalence scales. Second, adult clothing takes a budget share for a childless couple of about 10 percent, thus representing an important share of adult expenditure. And third, the demand for adult clothing is probably less influenced by the presence of children than the demand for tobacco or alcohol. In datasets with a short time horizon surveyed, clothing often has the problem of bulk purchases, and average consumption is not appropriately described. This is not a serious problem in the 1993 German Income and Expenditure Survey, because the survey length was a year, leading to almost no observations with zero clothing purchases. It can be assumed that the demand for clothing is sufficiently independent of the increased time use of children. However, the demand for clothing depends on many household characteristics: working women for example increase their expenditures on clothing (this is not the case for men). Therefore, household characteristics that do not depend on children have to be controlled for.

Two further values that are observed in the German Income and Expenditure Survey and that can be used to define another adult good are total floor space of the apartment and the floor space of children's rooms (in square meters). Assuming that public rooms (kitchen, bathroom, living room) can be shared with children at no additional cost (i.e. there is no congestion), then the difference between children's and total square meters is equal to total parents' consumption of living space, public and private. Even though no pure adult good, non-child floor space, or the respective share of rent expenditures, represents *adult* housing consumption and can therefore be used to calculate Rothbarth equivalence scales.

If the assumption of no congestion does not hold, actual adult housing consumption would be lower than non-child floor space. This would lead to a downward bias of the estimated Rothbarth scale, because a household with children and the same adult housing consumption would report higher non-child floor space than a childless household with the same adult housing consumption. A Rothbarth scale that is based on identical values of non-child floor space would be lower than a scale that is based on identical values of the true adult housing consumption, leading to a downward bias, provided separability holds.

The discussion in Section 3.4 has shown, that Rothbarth scales can also be biased, if the separability assumption is violated. There is an upward bias, when the adult good is more private and a downward bias when it is more public. Adult clothing is a private good and would lead to scales that are biased upwards. Non-child floor space is a more public good, that would generate equivalence scale estimates that are biased downwards. This downward bias is added to the above-mentioned possible bias from congestion. Rothbarth scales based on non-child floor space are therefore useful as a counterpart to private adult goods such as adult clothing, to find a lower and an upper bound for the "true" equivalence scale.

In this work, Rothbarth equivalence scales are estimated for adult clothing, men's and women's clothing separately, alcohol, jewelry, total adult consumption of these goods ("adult goods"), as well as non-child floor space.

3.7 Estimation of a Linear Model

Assume a linear Engel curve for the adult good.

$$q_A = \alpha_0 + \alpha_1 \mu^a \ , \tag{3.14}$$

where α_0 and α_1 are parameters and μ^a is the parents budget, which is equal to the total budget μ minus the children's budget μ^c.

A linear specification of the children's budget with $\mu^c = k\gamma\mu$, where k is the number of children and γ is the relative cost of a single child, is less than ideal. Given a certain income μ, an additional child has the same per capita expenditures as the other children, while parents' expenditures are reduced. This problem can be solved by letting children's expenditures depend on parents' expenditures instead of total expenditures ($\mu^c = k\gamma\mu^a$), but then the demand equation for the adult good becomes nonlinear and standard linear regression cannot be applied. In an alternative specification, the total cost of children can depend on the logarithm of the number of children plus one, so that the value of μ^c for a childless couple is zero:

$$\mu^c = \gamma\mu \ln(k+1) \tag{3.15}$$

This specification leads to slight economies of scale in child rearing. As an alternative, different, separate gammas γ_k can be estimated for each number of children, so that a household with k children and total income μ has child cost

$$\mu^c_k = \gamma_k \mu \; . \tag{3.16}$$

This specification allows for an investigation into the economies of scale that are connected with having more than one child, but it comes at the cost of an increased number of parameters, leading to high standard errors, in particular in the demographically diverse model that will be estimated in section 3.8.

The logarithmic specification (3.15) of child cost leads to the following structural demand equation for the adult good:

$$q_A(\mu, k) = \alpha_0 + \alpha_1(1 - \gamma \ln(k+1))\mu \tag{3.17}$$

Two households s and r with a number of children of k^s and k^r and with total expenditures $\mu^s = \mu^a + \mu^c$ and μ^r are equally well off, when expenditures on the adult good are equal: $q_A(\mu^s, k^s) = q_A(\mu^r, k^r)$. Substitution of equation (3.17) and transformation gives an equivalence scale that is independent of total expenditures:

$$m^s_r = \frac{\mu^s}{\mu^r} = \frac{1 - \gamma \ln(k^r + 1)}{1 - \gamma \ln(k^s + 1)} \tag{3.18}$$

For a childless reference household child cost are zero ($k^r = 0$ and $\ln(k^r + 1) = 0$) and total expenditures are equal to the adult expenditures of the compared household ($\mu^r = \mu^a$). The scale reduces to:

$$m^s = \frac{\mu^s}{\mu^a} = \frac{1}{1 - \gamma \ln(k^s + 1)} \tag{3.19}$$

To reduce heteroskedasticity, demand for the adult good is transformed into a share equation. The following specification is estimated:

$$w_{At} = \theta_0 \mu_t^{-1} + \theta_1 + \theta_2 \ln(k_t + 1) + u_t \tag{3.20}$$

where w_{At} is the budget share of the adult good in the t^{th} household, μ_t is total expenditure, k_t is the number of children and u_t is the equation error term. The equivalence scale for household s with k^s children relative to a childless couple reference household is:

$$\hat{m}^s = \frac{1}{1 + \theta_2/\theta_1 \ln(k^s + 1)} \ . \tag{3.21}$$

For the specification of child cost with separate gammas (Equation 3.16), the estimation equation changes to:

$$w_{At} = \theta_0 \mu_t^{-1} + \theta_1 + \theta_{21}\tau(k_t, 1) + \theta_{22}\tau(k_t, 2) + \ldots + \theta_{2\kappa}\tau(k_t, \kappa) + u_t \ , \tag{3.22}$$

where $\tau(k_t, k)$ is an indicator function that is one if the number of children is equal to k and zero otherwise, and κ is the number of children in the largest household that was considered. Then the equivalence scale for a household s with k^s children becomes:

$$\hat{m}^s = \frac{1}{1 + \theta_{2k^s}/\theta_1} \ . \tag{3.23}$$

Estimates

Included in the regression are 6173 West German and 1187 East German households with a man and a woman present. Adults are of the age between 30 and 50 and children under the age of 13. Because of the long accounting period, only 11 households do not report any expenditure on adult clothing. This number is negligible, and no Heckman-style correction (Heckman (1980)) of a censored sample is necessary. The observations are left in the sample. Removing them has no noticeable effect on the result. Results are reported for household types AAC, AACC and AACCC consisting of two adults (signified by AA) and one, two and three children (signified by C, CC and CCC).

For estimation, the logarithmic child cost model (equation 3.15) is used. Table 3.1 shows equivalence scales and the child cost parameter γ for West and East Germany, estimated for five different types of adult goods, the aggregate of these goods and non-child floor space. For the income variable μ, total private consumption ("Privater Verbrauch") is used.

As expected, scales calculated for non-child floor space are slightly lower than other scales for East and West Germany, because larger households substitute away from more private goods (clothing, alcohol, jewelry) and towards more public goods (housing), leading to an upward bias on scales calculated

	West Germany				East Germany			
	Family Type				Family Type			
Adult good	AAC	AACC	AACCC	γ	AAC	AACC	AACCC	γ
Adult clothing	1.22 (0.01)	1.41 (0.02)	1.58 (0.03)	0.264 (0.009)	1.22 (0.02)	1.40 (0.05)	1.56 (0.07)	0.260 (0.022)
Women's clothing	1.25 (0.01)	1.46 (0.02)	1.65 (0.04)	0.285 (0.010)	1.21 (0.02)	1.38 (0.05)	1.54 (0.08)	0.251 (0.024)
Men's clothing	1.19 (0.01)	1.34 (0.02)	1.46 (0.03)	0.229 (0.012)	1.24 (0.03)	1.43 (0.06)	1.62 (0.10)	0.275 (0.028)
lcohol	1.19 (0.02)	1.33 (0.05)	1.46 (0.07)	0.227 (0.025)	1.24 (0.05)	1.44 (0.11)	1.63 (0.17)	0.279 (0.047)
Jewelry	1.20 (0.01)	1.36 (0.02)	1.51 (0.04)	0.243 (0.011)	1.11 (0.03)	1.19 (0.06)	1.26 (0.08)	0.148 (0.037)
Adult goods	1.21 (0.008)	1.38 (0.02)	1.53 (0.02)	0.250 (0.007)	1.18 (0.02)	1.31 (0.04)	1.43 (0.06)	0.217 (0.020)
Non-child floor space	1.16 (0.02)	1.27 (0.03)	1.37 (0.04)	0.196 (0.016)	1.17 (0.07)	1.29 (0.14)	1.40 (0.21)	0.206 (0.077)

Table 3.1: *Equivalence scales estimated with different adult goods for East and West Germany and three household types: Couples with one child (AAC), two children (AACC) and three children (AACCC). Standard errors in parentheses, EVS 1993. Scales for West Germany and Adult goods are also reported in table 2.1.*

from the former and a downward bias on scales based on the latter type of goods. It is reassuring that the effect points into the right direction. The effect is stronger for Western Germany than for Eastern Germany, probably because of different housing conditions.

When separability holds, all adult goods must lead to the same estimate for γ. This is not the case for both regions, even though differences are rather small. For East Germany only jewelry shows significantly lower scales than the other goods. The share of jewelry is high enough that it has a strong effect on equivalence scales which were estimated from the adult goods aggregate. Without jewelry, the adult goods scales are increased to 1.22, 1.41, and 1.58, respectively. These scales are not significantly different from West German scales.

In West Germany, women's clothing and adult clothing (of which women's clothing constitutes a high share) show a significantly higher γ than men's clothing, alcohol and jewelry. This can be explained by the fact that employed women have to spend more on clothing than home making women. With a higher share of women with children staying at home, the average expenditure on female clothing in childless households is higher than in with-children households, leading to an upward bias of the equivalence scale.[8]

[8]This effect is not recognizable in East German data, because under socialism em-

	Woman's Share ≤ 0.2				Woman's Share > 0.2			
	Family Type				Family Type			
Adult Good	AAC	AACC	AACCC	γ	AAC	AACC	AACCC	γ
Adult clothing	1.19 (0.01)	1.34 (0.03)	1.48 (0.04)	0.233 (0.013)	1.22 (0.02)	1.39 (0.04)	1.55 (0.06)	0.256 (0.017)
Women's clothing	1.20 (0.01)	1.37 (0.03)	1.52 (0.05)	0.245 (0.014)	1.22 (0.02)	1.40 (0.04)	1.57 (0.06)	0.261 (0.019)
Men's clothing	1.18 (0.02)	1.31 (0.03)	1.43 (0.05)	0.216 (0.016)	1.21 (0.02)	1.37 (0.05)	1.52 (0.07)	0.247 (0.022)
Alcohol	1.17 (0.03)	1.31 (0.07)	1.42 (0.10)	0.214 (0.036)	1.18 (0.04)	1.31 (0.09)	1.43 (0.13)	0.216 (0.047)
Jewelry	1.17 (0.02)	1.30 (0.03)	1.41 (0.05)	0.211 (0.017)	1.23 (0.02)	1.42 (0.05)	1.59 (0.08)	0.268 (0.022)
Adult goods	1.18 (0.01)	1.32 (0.02)	1.44 (0.03)	0.220 (0.011)	1.22 (0.01)	1.40 (0.03)	1.56 (0.05)	0.258 (0.014)
Non-child floor space	1.12 (0.01)	1.21 (0.03)	1.28 (0.04)	0.159 (0.017)	1.20 (0.03)	1.36 (0.06)	1.50 (0.10)	0.240 (0.032)

Table 3.2: *Equivalence scales estimated with different adult goods for West Germany. Households separated into two groups depending on the personal share of the woman of gross income. Standard errors in parentheses.*

To investigate this, the West German sample is divided into two groups: households, where the woman's share in gross earned income is lower than or equal to 20% and households where the share is higher (Table 3.2). This reduces the difference between women's clothes and the other goods for both groups. Scales for households with a higher share of income for the mother have slightly, but significantly higher equivalence scales, probably due to higher child care cost and the cost of time saving commodities, like prepared or out of house food.

A comparison of the Engel curve parameters α_0 and α_1 reveals that demands of households with a higher woman's share differ only with respect to woman's clothing and to a lesser extend jewelry (Table 3.3). This can be either necessary expenditures because work clothes are more expensive for women or it can be an intra household distribution effect. A higher share of earned income of the woman leads to more spending power and a higher expenditures of typical women's goods. Distribution effects would also explain why the calculated equivalence scales for typical women's goods are higher: This could be the cause of a redistribution from the mother to the child. The mother gives up some additional part of her personal income to spend more on her children.[9]

ployment among women was very high. High employment among women still prevailed in 1993.

[9]Lundberg et al. (1997) show that a shift of intra household distribution towards the

	Woman's Share ≤ 0.2		Woman's Share > 0.2	
Adult Good	α_0	$\alpha_1 \cdot 100$	α_0	$\alpha_1 \cdot 100$
Adult clothing	−147	5.02	−221	5.74
	(50)	(0.15)	(77)	(0.17)
Women's clothing	−63	2.94	−149	3.61
	(32)	(0.09)	(52)	(0.11)
Men's clothing	−84	2.08	−72	2.14
	(25)	(0.07)	(37)	(0.08)
Alcohol	9	0.12	6	0.13
	(3)	(0.01)	(4)	(0.01)
Jewelry	−954	6.41	−1021	7.12
	(78)	(0.23)	(120)	(0.26)
Adult goods	−998	12.92	−1167	14.47
	(105)	(0.31)	(156)	(0.34)

Table 3.3: *Demand parmeters for different adult goods, West Germany. Households separated into two groups depending on the personal share of the woman of gross income. Standard errors in parentheses.*

With the cost of children possibly depending on household characteristics a more detailed model is needed to separate the effect of parents characteristics on expenditures on their children. In addition the scales that were estimated in this section do not depend on income by construction. Even though it has some arguments in its favour (see the discussion of independent of a base (IB) equivalence scales in the introduction), it is unnecessarily restrictive. Therefore a more detailed model will be developed in the next section.

3.8 Estimation of a Demographically Diverse Model

A straightforward method to include more detailed demographic effects into the model is by including translation parameters, i.e. fixed cost of characteristics. Let $\boldsymbol{z}$ be the n-vector of *adult* characteristics and $\boldsymbol{\zeta}$ a n-vector of parameters. The demand of the adult good changes to:

$$q_A = \alpha_0 + \alpha_1 \mu^a + \boldsymbol{\zeta}'\boldsymbol{z} \tag{3.24}$$

Child expenditures can depend on the m-vector of distribution characteristics $\boldsymbol{s}$. These can include children's characteristics like age and sex as well as parents' characteristics, like education or age. Some of the characteristics in $\boldsymbol{s}$ can coincide with characteristics in $\boldsymbol{z}$. $\boldsymbol{s}$ also includes unity to reflect a

mother has a positive effect on expenditures on typical children's goods. To prove this, a more detailed model of the household is necessary. In chapter 5 a model of equivalence scales that includes intra household distribution is explored.

reference level of the fixed cost of each child. With the m-vector of parameters σ, the child cost equation becomes:

$$\mu^c = k\boldsymbol{\sigma}'\boldsymbol{s} + \gamma\mu\ln(1+k) \ , \tag{3.25}$$

and adult income is:

$$\mu^a = \mu(1 - \gamma\ln(1+k)) - k\boldsymbol{\sigma}'\boldsymbol{s} \tag{3.26}$$

Substitution of (3.26) into (3.24) gives the linear demand equation for the adult good:

$$q_A = \alpha_0 + \alpha_1\mu(1 - \gamma\ln(1+k)) - \alpha_1 k\boldsymbol{\sigma}'\boldsymbol{s} + \boldsymbol{\zeta}'\boldsymbol{z} \tag{3.27}$$

Transformation into share form and addition of an error term gives the estimated equation:

$$w_{At} = \theta_0\mu_t^{-1} + \theta_1 + \theta_2\ln(1+k_t) + \frac{k_t\boldsymbol{\theta}_s'\boldsymbol{s}_t}{\mu_t} + \frac{\boldsymbol{\theta}_z'\boldsymbol{z}_t}{\mu_t} + u_t \ , \tag{3.28}$$

where u_t is an error term. Setting prices to unity, one gets: $\hat{\alpha}_0 = \theta_0$, $\hat{\alpha}_1 = \theta_1$, $\hat{\gamma} = -\theta_2/\theta_1$, $\hat{\boldsymbol{\sigma}} = -{\theta_1}^{-1}\boldsymbol{\theta}_s$ and $\hat{\boldsymbol{\zeta}} = \boldsymbol{\theta}_z$.

From the estimated parameters of the demand equation, an equivalence scale can be calculated:

$$m^s(\mu^a, \boldsymbol{s}) = \frac{\mu^s}{\mu^a} = \frac{1 + \frac{k\boldsymbol{\sigma}'\boldsymbol{s}}{\mu^a}}{1 - \gamma\ln(1+k)} \tag{3.29}$$

This scale is income dependent with a child cost component that is relative to household income ($\gamma\ln(1+k)$) and a fixed component ($k\boldsymbol{\sigma}'\boldsymbol{s}$). The influence of the fixed component decreases with rising income, and the equivalence scale converges to $1/(1 - \gamma\ln(1+k))$.

In the estimated models, the following demographic variables are influencing the demand of adult goods: the woman's share of earned income and woman's share squared, woman's education, woman's age, a dummy for the man's social status being a worker and a dummy for the man's social status being not working. The reference social status is being self-employed, a civil servant or a salaried employee. All variables have a significant influence on demand in West German data.

Two models were estimated: model F with only a fixed cost term for children, and model V where the wife's share of earned income, wife's share of earned income share squared, age of youngest child and mean age of children were allowed to influence the fixed cost of children in addition to the fixed cost term.

Table 3.4 shows the results of model F, while the results of model V are

	West Germany					East Germany				
Adult good	AAC	AACC	AACCC	γ	σ_0	AAC	AACC	AACCC	γ	σ_0
Adult clothing	1.23	1.41	1.57	0.297	−1439	1.28	1.53	1.77	0.314	14
	(0.01)	(0.03)	(0.04)	(0.023)	(645)	(0.04)	(0.08)	(0.14)	(0.066)	(1481)
Women's clothing	1.24	1.44	1.62	0.322	−1849	1.27	1.51	1.75	0.300	261
	(0.02)	(0.03)	(0.05)	(0.024)	(686)	(0.04)	(0.09)	(0.15)	(0.073)	(1625)
Men's clothing	1.20	1.35	1.49	0.257	−776	1.29	1.55	1.82	0.337	−404
	(0.02)	(0.03)	(0.05)	(0.031)	(845)	(0.05)	(0.11)	(0.20)	(0.084)	(1871)
Alcohol	1.14	1.24	1.30	0.226	−1951	1.24	1.45	1.64	0.260	655
	(0.03)	(0.06)	(0.08)	(0.065)	(1694)	(0.07)	(0.14)	(0.21)	(0.129)	(2814)
Jewelry	1.24	1.42	1.59	0.330	−2542	1.12	1.21	1.29	0.108	1243
	(0.02)	(0.04)	(0.06)	(0.027)	(760)	(0.06)	(0.10)	(0.13)	(0.143)	(2827)
Adult goods	1.22	1.40	1.54	0.306	−2049	1.21	1.38	1.53	0.228	581
	(0.01)	(0.02)	(0.03)	(0.019)	(514)	(0.03)	(0.06)	(0.09)	(0.064)	(1364)
Non-child floor space	1.13	1.22	1.29	0.179	−503					
	(0.02)	(0.04)	(0.06)	(0.050)	(1321)					

Table 3.4: *Model* F*: Equivalence scales estimated with different adult goods for West and East Germany. Standard errors in parentheses.*

a) West Germany

Adult good	Household type AAC	AACC	AACCC	γ	σ_0	*Share*	*Share*^{2}	*Young age*	*Mean age*	*Edu-cation*
Adult clothing	1.22	1.38	1.52	0.304	−3826	2426	−2665	−403	437	48
	(0.01)	(0.03)	(0.05)	(0.025)	(1484)	(3132)	(3739)	(122)	(135)	(99)
Women's clothing	1.23	1.42	1.58	0.328	−4161	2322	−2887	−360	389	60
	(0.02)	(0.03)	(0.06)	(0.026)	(1596)	(3368)	(4025)	(131)	(145)	(106)
Men's clothing	1.19	1.32	1.43	0.267	−3285	2593	−2308	−472	515	27
	(0.02)	(0.04)	(0.05)	(0.033)	(1910)	(4026)	(4802)	(157)	(174)	(127)
Alcohol	1.14	1.24	1.31	0.208	−4484	3237	−4968	17	−167	303
	(0.04)	(0.07)	(0.09)	(0.073)	(4053)	(8578)	(10267)	(336)	(372)	(274)
Jewelry	1.23	1.40	1.55	0.325	−2114	10267	−10949	−298	35	−4
	(0.02)	(0.04)	(0.06)	(0.030)	(1839)	(3952)	(4697)	(151)	(167)	(122)
Adult goods	1.21	1.37	1.51	0.304	−3038	6433	−7049	−307	173	48
	(0.01)	(0.02)	(0.04)	(0.020)	(1218)	(2593)	(3090)	(100)	(111)	(81)
Non-child floor space	1.13	1.24	1.32	0.154	4604	5294	−10247	642	−365	−349
	(0.03)	(0.05)	(0.06)	(0.057)	(3145)	(6496)	(7819)	(261)	(282)	(201)

b) East Germany

Adult good	Household type AAC	AACC	AACCC	γ	σ_0	*Share*	*Share*^{2}	*Young age*	*Mean age*	*Edu-cation*
Adult clothing	1.28	1.52	1.77	0.287	4805	10250	−9413	−23	−66	−334
	(0.04)	(0.09)	(0.14)	(0.076)	(4817)	(5328)	(5927)	(249)	(308)	(289)
Women's clothing	1.27	1.50	1.74	0.275	3797	11611	−13347	−77	2	−251
	(0.04)	(0.09)	(0.15)	(0.083)	(5228)	(5848)	(6581)	(270)	(334)	(315)
Men's clothing	1.29	1.56	1.82	0.308	6515	7944	−2742	69	−182	−475
	(0.05)	(0.12)	(0.20)	(0.095)	(6193)	(6723)	(7376)	(320)	(396)	(368)
Alcohol	1.25	1.49	1.73	0.153	1134	16155	−19160	531	−936	335
	(0.07)	(0.14)	(0.21)	(0.170)	(9574)	(11103)	(12524)	(520)	(652)	(600)
Jewelry	1.12	1.23	1.34	0.036	10255	24875	−29859	−14	−673	−294
	(0.06)	(0.10)	(0.14)	(0.174)	(9187)	(11131)	(12606)	(466)	(597)	(541)
Adult goods	1.21	1.39	1.56	0.173	6206	16607	−18546	72	−433	−209
	(0.03)	(0.06)	(0.09)	(0.077)	(4439)	(5111)	(5724)	(230)	(288)	(266)

Table 3.5: *Model* V*: Equivalence scales estimated with different adult goods for a) West and b) East Germany, and translation parameters. Equivalence scales are calculated at the median income level of the reference household; mean values were used for all demographic parameters other than income. Standard errors in parentheses.*

presented in Table 3.5. Reported scales are calculated at the median expenditure level of the reference household; DM 55,451 for West and DM 37,784 for East Germany. Model F is a useful reference, when demography does not matter, but model V yields the more interesting results

Variation among goods is higher than in the more constrained income independent model in the previous section. In particular, the relative child cost parameter γ is lower for *alcohol*, both in East and West Germany and very low for *jewelry* in East Germany. The absolute fixed cost terms σ_0 vary strongly among goods for East Germany, but are never significantly different from zero. In West Germany, all values of σ_0 are negative, but not all are significantly different from zero.

Of special interest are the scales for non-child floor space. Results for East Germany are not reported because no results could be determined that were statistically different from one. Housing was also rationed in East Germany until 1989 and administered by the state. Availability of housing was still limited in East Germany in 1993, therefore a standard preference model is not applicable. For West Germany results for non-child floor space are lower than Again these are the lowest of all for West and East Germany. East German results are rather extreme and falling with the number of children, even though standard errors are very high. This can be attributed to a rationed housing market in East Germany. Before 1989 housing was administered by the state, and it was easier for larger families to find a larger apartment. The effect of distribution policies under socialism can still be seen in the 1993 data.

Discussion of Results

What are the effects of income and demographic variables on equivalence scales? This will be discussed in the following paragraphs.

Income Dependence of Equivalence Scales

Conventional wisdom has it that equivalence scales – if they are not independent of base – are *falling* with rising income, because of increasing economies of scale and fixed cost of children (see for example Schröder, 2004). The presented estimates for West Germany are strong evidence against this presumption. Fixed cost are not significantly different from zero for East Germany, but for West Germany, all fixed cost terms both in model F and V are *negative*, and some significantly so. This does not imply, that total child cost – fixed plus relative – become negative at any income level in the observed range, but it means that estimated scales are in fact increasing with income (shown in Figure 3.3 for model V).

One possible explanation for this result could be that (young) children incur little additional cost at low income levels in rich societies. It could

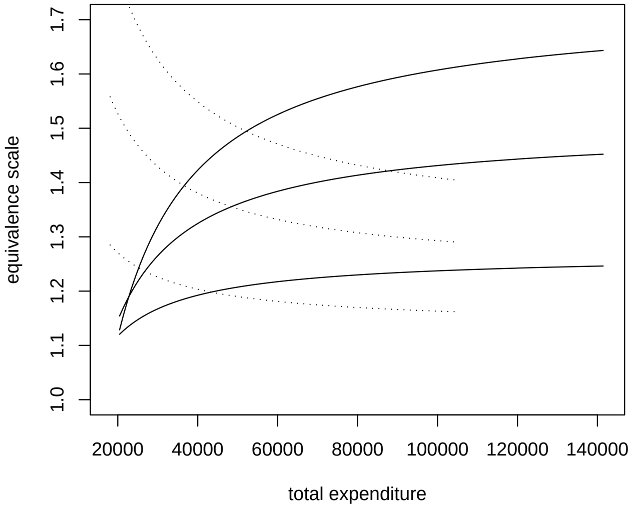

Figure 3.3: *Income dependent equivalence scales for families with one to three children for East Germany (dotted lines) and West Germany (solid lines). Note that the increase of scales with falling income for East Germany is not significant. Model* V*, mean values for all demographic parameters other than income.*

be possible in principle to have a child without having to spend much on it relative to total expenditures, so that poor parents could continue to spend almost as much on their personal goods as before. As the method only measures parents' welfare, it is impossible to say if children would "suffer" from such neglect.

A second explanation would be, that the estimation method itself is subject to a bias that varies with the income level: As outlined in Section 3.4, Rothbarth scales calculated from private goods tend to be biased upwards, because larger households do substitute away from private goods. Scales that are calculated from public goods tend to be biased downwards because larger households tend to substitute towards public goods. If poorer households have lower substitution possibilities than richer households, then the bias of the equivalence scale due to substitution is higher for the latter. As a consequence, equivalence scales for private goods are increasing and scales for public goods are falling. The bias should also be stronger for goods with higher substitution elasticities.

Figure 3.4 shows the income dependence of equivalence scales for different adult goods, for West Germany. Indeed, scales are increasing for all private adult goods, and they are falling for the more public non-child floor space. With the exception of alcohol, floor-space scales are lower than all other scales from the second to the tenth decile and scale estimates are crossing at low

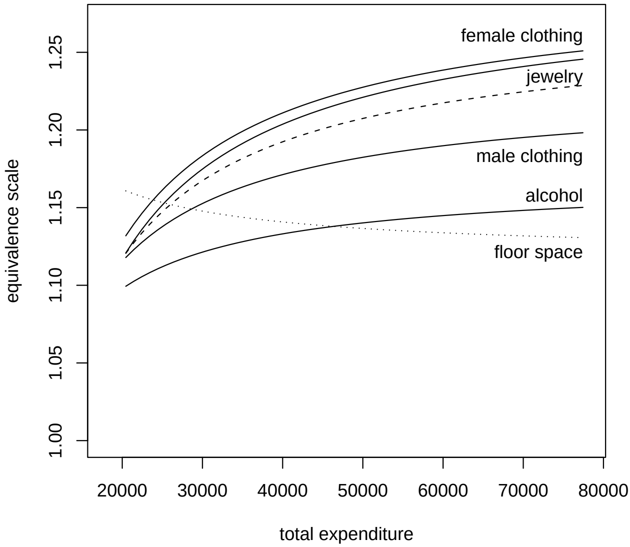

Figure 3.4: *Income dependent equivalence scales for West German families with one child and different goods. Scales based on total adult consumption are given by the dashed line. Model* V*, mean values for all demographic parameters other than income.*

incomes between DM 23,845 for female clothing and DM 28,625 for male clothing. These incomes lie in the 3rd to 5th percentile of the reference childless couples' income range.[10] The income at which equivalence scales for non-child floor space and adult goods become identical could be interpreted as a minimum income or some kind of subsistence level. Provided the interpretation is correct, scales at this income level are not biased through substitution effects.

Working Parents

Figure 3.5 shows the dependence of equivalence scales on the woman's earned income share. Equivalence scales are higher when the earned income of both partners is more equal. The result is particularly pronounced for East Germany. The earned-income share of partners is a proxy for the work hours of partners, with more equal earned-income shares indicating that both partners are more likely to work full time. Scales are lowest at the margin where one partner is not working. This result is not unexpected as there are ad-

[10] The equivalent incomes of the compared one-child family are: DM 32,892 for male clothing, DM 27,539 for female clothing, DM 29,096 for jewelry and DM 29,965 for adult goods. These values lie in the 9th, 3rd, 5th and 5th percentile of the compared households' income range.

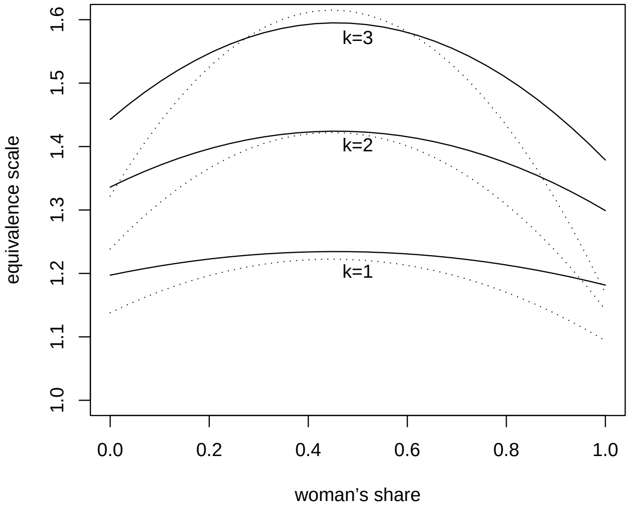

Figure 3.5: *Woman's earned income share and the level of Equivalence scales for families with one, two and three children, for East Germany (dotted lines) and West Germany (solid lines). At median expenditure level.*

ditional child care and household costs when both partners are working, but the symmetry is striking.[11]

Could the change in equivalence scales with the partner's earned income share also be an effect of intra-household distribution between partners? Probably not: Distribution effects between partners can be visible in equivalence scales only if they act differently in families with children than in childless couples. Assume that a childless woman who has a higher share of income would spend more on women's goods (like women's clothing), but a woman with children and the same income share does not spend more on these items, because of a different intra-household distribution[12]. Then an equivalence scale that is calculated from women's goods would increase with an increasing income share of the woman, because the with-children household would need a higher income to compensate the increased spending of the childless household on women's goods. The reverse is true for men's items: If an increased income share of the childless woman leads to a redistribution of expenditures towards female consumption, male consumption has to be re-

[11] Lazear and Michael (1988) included the share of employed adults in their child-cost equation. For U.S. data of the years 1972-73, they found a positive effect of parents employment on child expenditures. When two parents work instead of one, child expenditures rise by $ 5.44 per child per $ 100 spent on adults. However, when applying the same structure to data from the years 1960-61, they find a *negative* effect with a decrease of child expenditures of $ 10 per child per $ 100 spent on adults.

[12] For a detailed discussion of intra-household distribution in couples, see Chapter 5.

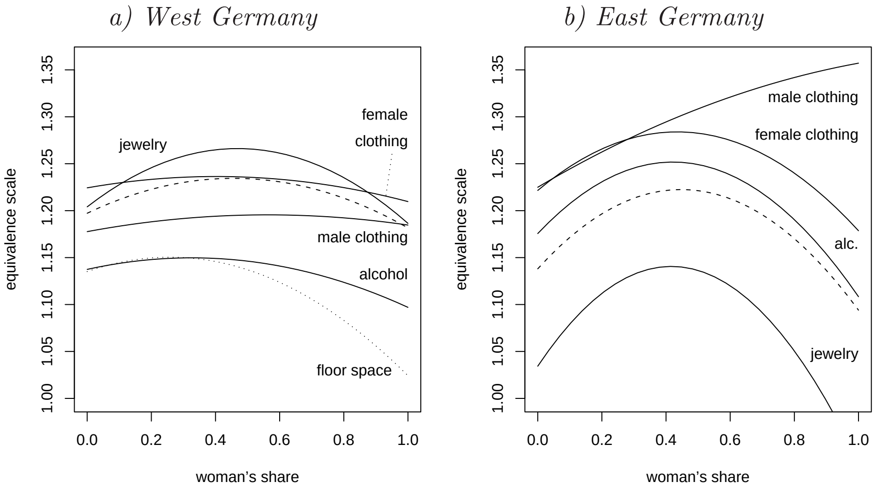

Figure 3.6: *Woman's earned income share and the level of Equivalence scales for different adult goods, for a) West Germany and b) East Germany. Dashed lines indicate the Equivalence scale for the composed adult good. At median expenditure level.*

duced, due to the budget constraint. Expenditures on men's items would fall in the childless household and equivalence scales estimated from these items would fall as well.

On the other hand, if distribution effects between partners act in the same way in childless and with-children households, then they cannot have an influence on equivalence scales. If an increased earned-income share of the woman increases her expenditures on woman's items equally for childless women and those with children, then the relative incomes at which both households spend the same amount on women's items (and thus the equivalence scale) is not affected by the income share, provided only households with identical income shares are compared. The same applies to men's items.

A redistribution between parents' and children's expenses would affect all adult goods in the same way. The direction of any effect of redistribution between parents and children on the equivalence scale estimate would not depend on the good that is used for estimation. Effects of a redistribution that is due to changing work hours of partners (for example because of higher child care costs in two-earner families) would also be symmetric, so that the equivalence scale would be highest for equal shares and lowest when the share of one partner is zero.

A look at the effect of the female income share on equivalence scales for different goods (Figure 3.6) shows that the relative effect of a changing share is varying among goods in Western Germany, but it is symmetric for all goods.

In East Germany with the exception of male clothing, equivalence scales for all goods are symmetric and changes with income share are of a similar relative size. Table 3.6 shows the calculated maximum of the equivalence scale with respect to earned income share, which is the axis of symmetry. None of the values is significantly different from 0.5. This confirms that equivalence scales are increased when both partners are working. An effect of redistribution between partners on equivalence scales for families with children is not recognizable in the data with this method.

	Women's clothing	Men's clothing	Alcohol	Jewelry	Adult goods	Non-child floor space
West Germany	0.40	0.56	0.33	0.47	0.46	0.26
	(0.22)	(0.49)	(0.35)	(0.08)	(0.08)	(0.15)
East Germany	0.43	1.45	0.42	0.42	0.45	
	(0.08)	(2.80)	(0.10)	(0.06)	(0.05)	

Table 3.6: *Axis of symmetry for equivalence scale functions with respect to earned income share. Standard errors in parentheses were estimated with delta method.*

The Age of Children

The age of the youngest child and the mean age of all children has only measurable effects in West Germany. There, a higher age of the youngest child *reduces* child cost, while a higher average age *increases* cost (except for alcohol). A possible explanation is that parents with very small children postpone expenditures on clothing and jewelry until their children get older, because shopping for these items is time consuming. This explanation is also in accordance with the observation that the age of the youngest child has no effect on alcohol consumption.

The overall age effect is quite sizeable. At the median income, a family of four with two children aged 12 and 10, has to spend 7% less than the same family with children aged 3 and 1. The effect is stronger at lower incomes and for larger families. That Rothbarth equivalence scales for families with older children are lower than those for families with younger children is somewhat counterintuitive, but it is in line with the finding in Lazear and Michael (1988) that parents spend more on younger children than on older children.

Mother's Education

The education of the mother was added to test if there is any effect of education on the cost of children. More educated parents could divert a higher share of income towards children, as an investment in their "quality" in the Beckerian (1981) sense. The model is not informative on this issue: parameter estimates for West Germany are indeed almost all positive, with the highest value for alcohol and the lowest for jewelry, but none is significant. In contrast, estimates for East Germany are all negative, with the only exception of alcohol, but again, none is significant.

3.9 Conclusion

The Rothbarth method for the estimation of equivalence scales was applied to German data in this chapter. Given data of adult goods, the method is as easy to apply as the Engel method, but without the same serious theoretical problems. The method can be explained by an assumption about the separability of children's and adults' consumption. It is not clear, though, which is the direction of the resulting bias when separability does not hold.

When several different adult goods are observed, equivalence scales can be calculated for each good separately. When separability holds, estimated scales for all goods are identical. Scales were estimated for women's clothing, men's clothing, alcohol and jewelry. Tobacco was excluded, because tobacco consumption is little affected by the presence of children. An informal test of separability was performed by comparing estimated equivalence scales for each good. It was found that separability holds, if the sample is divided into two groups according to the work status of the woman. Her share in earned income was taken as an indicator for the status, with one subsample consisting of households with a woman's earned income share of not more than 20% and the other subsample consisting of the rest.

It is a great advantage of the model, that demographic variables are easily included. A demographically more detailed model was estimated to scrutinize the effect of the income level, the woman's earned income share and children's ages on equivalence scales. It was found that scales are higher for families where both partners work the same amount of time. Income dependent equivalence scales could be calculated as well.

Surprisingly, equivalence scales for private adult goods were increasing in income in West Germany. Scales estimated with a more public good, however, were decreasing. This was explained by the greater substitution opportunities for richer households: it was shown that larger households have a tendency to substitute away from private and towards public goods. This substitution is not accounted for in the Rothbarth model, thus leading to an upward bias in estimated equivalence scales when they are calculated from private goods and a downward bias when public goods are used. The bias is amplified for richer households, if they have better substitution opportunities, leading to the observed increase of private-good scales and a decrease of public-good scales. The innovative public-good Rothbarth scales are a promising addition to the equivalence scales toolbox and should be investigated further in future research.

Variation of parameters was higher in the more detailed model. To improve estimates, the separately observed adult goods should be combined. In the traditional Rothbarth method this can be achieved only by adding them to lump adult consumption, but valuable information is lost in the process. A simultaneous estimation of a system of demand equations for adult goods, where the equivalence scale equation is a restriction over all goods could be a solution. This remains for future research.