close to zero. Invariance of $\beta$'s in Md and Cm, and clear age effects found in shares of these categories indicate that age effects in shares are captured by shifts in intercepts ($\alpha$'s). Though we do not show estimates of $\alpha$'s, recent increase in Cm shares of younger cohorts (Fig.1.8-b) are in the form of increasing $\alpha$'s and not attributed to income growth of the cohorts. By the same token, age effects of Md shares and cohort effect of Cl shares are caused by shift in $\alpha$'s.

Age effects are found in Fd, Hs, Tr, Ls, and Ot. $\beta$'s for food show some irregular pattern by age and by wave, but for age 40's and 50' the curves are continuously moving upward. They converge to -0.1 in age 60's. Upward move in food's $\beta$ for middle age indicate that food is becoming closer to luxury goods in recent years. It may be explained by recent gourmet boom in Japan and increase in health consciousness in these age groups.

Movements of housing's $\beta$ show irregular patterns. It is necessity for 20's in all waves, but they go up in 30's in various degree and irregular movements continue until 60's. We come back to discuss this point in the end of this subsection.

Transportation is luxury in 20's but from 30's it settles down to regular (neither luxury nor necessary) good. Ls and Ot have clear and distinct age profile, and they show opposite movements until 50's. For Ls, $\beta$'s show some variety in 20's but after 30's they move in the same fashions: they go down to -0.1 in 40' in all waves and gradually go up in 50' and 60's. On the other hand, $\beta$'s for other expenditure (Ot) go up in 40's and go down slightly in 50's. Explanation of these movements in Ls and Ot is simple. "When we got money, we got no time!" People in their 40's do not have enough time for leisure, because they are too busy in their work place and also busy in raising kids. When they have money to spend they use them for sending money to their kids in college[16].

$\beta$'s for education exhibit slight inverse U shape. They are low in 20's, and reaches mild plateau between 40's and 50' and goes down in 60's. In the period of plateau, kids are in schools and families spend money on education, by sending kids to private school, preparatory school, and hiring private tutors, when they can afford to. In Japan, competition in entering better schools is keen and it starts early. It is said that such tendency has been accelerated in recent years. A peak appeared in 40's in 2004 is a reflection of such trend. These patterns, found in Ls, Ot, and Ed, indicate that rich families spend more money on kids' education.[17]

After checking shift of $\beta$'s in all 11 expenditure groups, we can see that age profiles of $\beta$'s are fairly stable across all waves, except one for housing. So wave and cohort effects in $\beta$ are not strong in other 10 groups. We examine cohort and wave effects on $\beta$ in these 10 groups by checking Fig.2 in more detail. If age profile is stable, we can interpret that cohort effects are weak. From this view, cohort effects in $\beta$ are found when cohorts are in younger stage. Specifically, variations in $\beta$ are observed for food (30~40), furniture (20's), transportation (20~30's), leisure (20~30's), and other (20's) but they disappear in older ages.

Volatility of housing parameter persists until age 60's. Thus housing is affected by strong wave effects. It seems that housing's characteristic as investment good makes it more sensitive to macro economic fluctuations and change in expectations. This speculation needs farther investigation, because as mentioned earlier, housing expenditure data may contain errors.

These results and discussions are summarized in Table 2, which shows presence of wave, age, and cohort effects. Three marks, "**", "*", and "Δ" indicate effects are strong, moderate, and slight, respectively. Left half of the table is for shares (results) and the right half of the table is for effects attributable to parameter change in $\beta$'s (causes).

### 5.2 Equivalence scales

Next, we examine estimate of household equivalence scales. Table 3 reports estimate of $\delta$'s. As expected, point estimates are mostly between 0 and 1, with one exception[18]. It is hard to see discernable pattern that

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[16] A large proportion of other expenditures (Ot) is sending money to family members not living together, who is most likely to be kids in college. Other contents of Ot are hair care, cigarettes and social expenses such as ceremonial money.

[17] Sharp spike in Ed shares (Fig.1.10-a,b) cannot be explained by shifts of $\beta$ alone. Spike is caused by compound effects of shifts in both $\beta$'s and $\alpha$'s.

[18] $\delta$ estimate is negative for age in 30' s in year 1999.

change with time and age in the table, but averages of δ's within wave in the far right column, show increasing pattern. The average value is 0.245 in 1984, 0.557 in 2004, and steadily increasing. It implies that scale economy of family size is decreasing over the past 21 years. Also, we note that these figures are smaller than conventional OECD values.

Though we do not speculate on causes that lie behind this decline, it seems that family members are acting in more individualistic manner in recent years. At this stage, we cannot discuss comparison of scale economy parameter with those of other studies, because their parameter values are not derived in the same framework as ours.

The proportionality condition employed in this analysis enabled us to identify δ. Needless to say the condition is restrictive and subject to scrutiny. A more general specification is that coefficients on *lm* in share equations are not restricted to be proportional to β's. We estimated the model without proportionality condition and tested the restriction by likelihood ratio test. The results are shown in Table 3. Out of 25 cases 3 were non rejection or close to non rejection at the 1% significance level, and most of the cases were not "out of question" rejection.

To get the idea of how restricted estimates are close to (or far from) unrestricted estimates, we plot unrestricted and restricted coefficients on *lm* in Fig.3 for all waves. In Fig.3, horizontal axis is for age and vertical axis is for parameter values, and graphs are drawn for 11 expenditure groups for 5 waves. Green dots are unrestricted coefficients, and red squares are restricted estimates ($-\beta_i\delta$). A quick examination of graphs shows that though there are some discrepancies in three or four groups out of 11, restricted estimates trace profiles of unrestricted ones reasonably well. So it is not a bad idea to use our method in estimating equivalence scales.

## 6. Summary and concluding remarks

In this study we examined effects of age, cohort, and wave on Japanese household consumption. We found that fluctuation of expenditure shares on 11 broad categories cannot be explained by fluctuations in prices and income alone. We try to capture shift in taste by focusing on income parameter β in AI demand system. Main findings are

1) Age effects, in the form of shift in β, are found in discretional expenditure groups, transportation, leisure, education, and other expenditures.
2) Except housing, β's are stable for groups that relate to basic needs, namely fuel and lights, furniture, clothes, and medical care.
3) Notable cohort effects are found in communication. Shift occurred among younger generation in the last decade. Increase in shares is caused not by shift of β, but by shift of α.
4) Cohort effects in β appear to emerge in discretional expenditure groups, transportation, leisure, and other expenditures, in younger age groups, but they seem to taper off as cohorts get older.
5) Wave effects are found in housing. Age profiles and time profiles of β for housing show irregular movement.
6) β's for food seem to be moving upward with time for age group 40 to 50, except for oldest age groups.
7) Within-wave averages of household equivalence scale estimates are between 0.3 and 0.5, a slightly smaller than conventional values, and increasing with time.
8) Equivalence scale estimates do not show clear age profile.
9) Proportionality condition for equivalence scale is rejected by statistical tests, but unrestricted estimates are not far from restricted ones.

We cannot come up with convincing explanations for not all of these findings, for example 5) and 8). However, it is clear taste changes by age and cohort do exist and we found that scale economy within family is decreasing. We cannot ignore heterogeneity in taste when evaluating household's welfare level. We hope that our results will serve as basis for predicting consequence of social policies such as commodity taxation, reform in public pension, and subsidy programs targeted for specific subpopulation, e.g. elderly or family with infants.

In closing this paper, limitations of this study must be stated. First, our results are based on average shares of subgroups, thus they capture typical household behavior within subgroups. So, simple extrapolation of our results to wider income groups may be misleading. Second, family size does not give us information on family composition. Effects of family size should be different, depending on if additional family member is infant, school age kid, adult, or elderly. So their equivalence scales should be different and vary by expenditure group. Again our equivalence scale estimates are capturing averages of equivalence scales. Thirdly, data on housing may contain errors and irregularity found in housing parameter may be attributed to the data limitation. Finally, effects of regional factors are treated as random, but it may not be a realistic assumption. Consumer taste and characteristics of consumption commodities in metropolitan area may be different from those of rural district. Regional variation of tastes should be incorporated in the future study.

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## Table 1 Estimate of Beta's

| | age | 20's | | 30's | | 40's | | 50's | | 60's | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| year | group | beta | SE | beta | SE | beta | SE | beta | SE | beta | SE |
| 84 | fd | -0.1117 * | ( 0.0172 ) | -0.0921 * | ( 0.0130 ) | -0.1539 * | ( 0.0120 ) | -0.1001 * | ( 0.0172 ) | -0.1119 * | ( 0.0095 ) |
| | hs | -0.0588 * | ( 0.0261 ) | 0.1901 * | ( 0.0272 ) | 0.0683 * | ( 0.0278 ) | -0.0442 | ( 0.0261 ) | -0.1231 * | ( 0.0237 ) |
| | eg | -0.0443 * | ( 0.0066 ) | -0.0207 * | ( 0.0042 ) | -0.0243 * | ( 0.0039 ) | -0.0168 * | ( 0.0066 ) | -0.0267 * | ( 0.0039 ) |
| | fn | 0.0276 * | ( 0.0125 ) | -0.0037 | ( 0.0059 ) | 0.0048 | ( 0.0060 ) | 0.0179 | ( 0.0125 ) | 0.0087 | ( 0.0076 ) |
| | cl | 0.0195 | ( 0.0142 ) | -0.0108 * | ( 0.0053 ) | 0.0077 | ( 0.0067 ) | 0.0260 | ( 0.0142 ) | 0.0316 * | ( 0.0090 ) |
| | md | 0.0107 | ( 0.0110 ) | -0.0223 * | ( 0.0049 ) | -0.0136 * | ( 0.0026 ) | -0.0106 | ( 0.0110 ) | 0.0042 | ( 0.0056 ) |
| | tr | 0.1440 * | ( 0.0291 ) | -0.0178 | ( 0.0177 ) | 0.0001 | ( 0.0113 ) | 0.0095 | ( 0.0291 ) | 0.0147 | ( 0.0105 ) |
| | cm | -0.0216 * | ( 0.0043 ) | -0.0136 * | ( 0.0020 ) | -0.0056 * | ( 0.0017 ) | -0.0136 * | ( 0.0043 ) | -0.0075 * | ( 0.0022 ) |
| | ls | 0.0009 | ( 0.0261 ) | -0.0014 | ( 0.0121 ) | -0.0695 * | ( 0.0138 ) | 0.0347 | ( 0.0261 ) | 0.0434 * | ( 0.0114 ) |
| | ed | -0.0011 | ( 0.0096 ) | 0.0007 | ( 0.0059 ) | 0.0160 * | ( 0.0080 ) | 0.0187 | ( 0.0096 ) | -0.0083 * | ( 0.0042 ) |
| | ot | 0.0350 | ( 0.0238 ) | -0.0084 | ( 0.0185 ) | 0.1700 * | ( 0.0250 ) | 0.0786 * | ( 0.0263 ) | 0.1749 * | ( 0.0216 ) |
| 89 | fd | -0.0932 * | ( 0.0114 ) | -0.0223 | ( 0.0166 ) | -0.1174 * | ( 0.0092 ) | -0.0838 * | ( 0.0114 ) | -0.1242 * | ( 0.0078 ) |
| | hs | -0.0317 | ( 0.0205 ) | 0.0815 * | ( 0.0201 ) | -0.0054 | ( 0.0104 ) | -0.0351 | ( 0.0205 ) | -0.0477 * | ( 0.0137 ) |
| | eg | -0.0358 * | ( 0.0034 ) | -0.0177 * | ( 0.0040 ) | -0.0222 * | ( 0.0025 ) | -0.0200 * | ( 0.0034 ) | -0.0379 * | ( 0.0027 ) |
| | fn | -0.0059 | ( 0.0054 ) | -0.0106 | ( 0.0059 ) | -0.0042 | ( 0.0036 ) | 0.0069 | ( 0.0054 ) | 0.0007 | ( 0.0047 ) |
| | cl | -0.0036 | ( 0.0084 ) | -0.0001 | ( 0.0078 ) | 0.0053 | ( 0.0043 ) | 0.0238 * | ( 0.0084 ) | 0.0236 * | ( 0.0066 ) |
| | md | -0.0194 * | ( 0.0095 ) | -0.0390 * | ( 0.0058 ) | -0.0092 * | ( 0.0023 ) | -0.0141 | ( 0.0095 ) | -0.0101 | ( 0.0053 ) |
| | tr | 0.1142 * | ( 0.0261 ) | 0.0137 | ( 0.0303 ) | 0.0139 | ( 0.0134 ) | 0.0314 | ( 0.0261 ) | 0.0585 * | ( 0.0132 ) |
| | cm | -0.0125 * | ( 0.0038 ) | -0.0123 * | ( 0.0025 ) | 0.0010 | ( 0.0013 ) | -0.0147 * | ( 0.0038 ) | -0.0129 * | ( 0.0019 ) |
| | ls | -0.0398 * | ( 0.0168 ) | 0.0159 | ( 0.0139 ) | -0.0758 * | ( 0.0101 ) | 0.0171 | ( 0.0168 ) | 0.0242 * | ( 0.0091 ) |
| | ed | -0.0009 | ( 0.0046 ) | 0.0160 | ( 0.0088 ) | 0.0335 * | ( 0.0084 ) | 0.0362 * | ( 0.0046 ) | -0.0024 | ( 0.0048 ) |
| | ot | 0.1287 * | ( 0.0292 ) | -0.0250 | ( 0.0220 ) | 0.1806 * | ( 0.0197 ) | 0.0523 * | ( 0.0260 ) | 0.1283 * | ( 0.0235 ) |
| 94 | fd | -0.1253 * | ( 0.0138 ) | -0.0366 * | ( 0.0152 ) | -0.1128 * | ( 0.0064 ) | -0.0819 * | ( 0.0138 ) | -0.1048 * | ( 0.0072 ) |
| | hs | -0.0470 * | ( 0.0206 ) | 0.0735 * | ( 0.0232 ) | -0.0009 | ( 0.0124 ) | -0.0376 | ( 0.0206 ) | -0.0782 * | ( 0.0164 ) |
| | eg | -0.0480 * | ( 0.0043 ) | -0.0222 * | ( 0.0040 ) | -0.0266 * | ( 0.0027 ) | -0.0245 * | ( 0.0043 ) | -0.0456 * | ( 0.0028 ) |
| | fn | -0.0110 | ( 0.0081 ) | 0.0002 | ( 0.0057 ) | -0.0144 * | ( 0.0033 ) | -0.0092 | ( 0.0081 ) | -0.0021 | ( 0.0049 ) |
| | cl | 0.0086 | ( 0.0108 ) | -0.0070 | ( 0.0074 ) | -0.0070 | ( 0.0037 ) | -0.0140 | ( 0.0108 ) | 0.0216 * | ( 0.0058 ) |
| | md | -0.0032 | ( 0.0060 ) | -0.0378 * | ( 0.0068 ) | -0.0138 * | ( 0.0027 ) | -0.0152 * | ( 0.0060 ) | -0.0071 | ( 0.0087 ) |
| | tr | 0.1230 * | ( 0.0247 ) | 0.0226 | ( 0.0320 ) | 0.0106 | ( 0.0116 ) | 0.0201 | ( 0.0247 ) | 0.0431 * | ( 0.0116 ) |
| | cm | -0.0296 * | ( 0.0058 ) | -0.0144 * | ( 0.0025 ) | -0.0027 * | ( 0.0012 ) | -0.0106 | ( 0.0058 ) | -0.0073 * | ( 0.0020 ) |
| | ls | 0.0903 * | ( 0.0176 ) | 0.0106 | ( 0.0141 ) | -0.0940 * | ( 0.0089 ) | -0.0084 | ( 0.0176 ) | 0.0251 * | ( 0.0096 ) |
| | ed | 0.0046 | ( 0.0048 ) | 0.0137 | ( 0.0105 ) | 0.0301 * | ( 0.0104 ) | 0.0432 * | ( 0.0048 ) | -0.0041 | ( 0.0053 ) |
| | ot | 0.0374 | ( 0.0199 ) | -0.0026 | ( 0.0209 ) | 0.2315 * | ( 0.0204 ) | 0.1381 * | ( 0.0305 ) | 0.1594 * | ( 0.0210 ) |
| 99 | fd | -0.1242 * | ( 0.0138 ) | 0.0040 | ( 0.0122 ) | -0.1075 * | ( 0.0069 ) | -0.1150 * | ( 0.0138 ) | -0.1142 * | ( 0.0076 ) |
| | hs | -0.0701 * | ( 0.0264 ) | 0.0173 | ( 0.0172 ) | -0.0078 | ( 0.0125 ) | 0.0262 | ( 0.0264 ) | -0.0829 * | ( 0.0203 ) |
| | eg | -0.0523 * | ( 0.0064 ) | -0.0166 * | ( 0.0035 ) | -0.0328 * | ( 0.0025 ) | -0.0445 * | ( 0.0064 ) | -0.0480 * | ( 0.0025 ) |
| | fn | -0.0078 | ( 0.0084 ) | 0.0080 | ( 0.0053 ) | -0.0080 | ( 0.0042 ) | -0.0135 | ( 0.0084 ) | 0.0068 | ( 0.0044 ) |
| | cl | 0.0048 | ( 0.0132 ) | 0.0004 | ( 0.0050 ) | -0.0167 * | ( 0.0042 ) | -0.0114 | ( 0.0132 ) | 0.0199 * | ( 0.0043 ) |
| | md | 0.0127 | ( 0.0350 ) | -0.0129 * | ( 0.0054 ) | -0.0172 * | ( 0.0028 ) | -0.0158 | ( 0.0350 ) | -0.0080 | ( 0.0054 ) |
| | tr | 0.1444 * | ( 0.0349 ) | -0.0065 | ( 0.0228 ) | -0.0027 | ( 0.0139 ) | 0.0217 | ( 0.0349 ) | 0.0630 * | ( 0.0116 ) |
| | cm | -0.0193 * | ( 0.0078 ) | -0.0313 * | ( 0.0034 ) | -0.0022 | ( 0.0021 ) | -0.0080 | ( 0.0078 ) | -0.0068 * | ( 0.0015 ) |
| | ls | 0.0462 * | ( 0.0210 ) | 0.0248 * | ( 0.0099 ) | -0.0932 * | ( 0.0105 ) | -0.0144 | ( 0.0210 ) | 0.0606 * | ( 0.0098 ) |
| | ed | 0.0199 | ( 0.0120 ) | 0.0318 * | ( 0.0078 ) | 0.0417 * | ( 0.0117 ) | 0.0207 | ( 0.0120 ) | -0.0095 * | ( 0.0046 ) |
| | ot | 0.0459 | ( 0.0322 ) | -0.0190 | ( 0.0192 ) | 0.2464 * | ( 0.0273 ) | 0.1541 * | ( 0.0472 ) | 0.1193 * | ( 0.0173 ) |
| 4 | fd | -0.0714 * | ( 0.0190 ) | -0.0521 * | ( 0.0154 ) | -0.0681 * | ( 0.0078 ) | -0.0652 * | ( 0.0190 ) | -0.1075 * | ( 0.0084 ) |
| | hs | -0.0429 | ( 0.0256 ) | 0.0138 | ( 0.0306 ) | -0.0659 * | ( 0.0221 ) | 0.0690 * | ( 0.0256 ) | -0.0018 | ( 0.0265 ) |
| | eg | -0.0386 * | ( 0.0048 ) | -0.0364 * | ( 0.0049 ) | -0.0341 * | ( 0.0030 ) | -0.0402 * | ( 0.0048 ) | -0.0530 * | ( 0.0031 ) |
| | fn | -0.0263 * | ( 0.0090 ) | -0.0093 | ( 0.0071 ) | -0.0052 | ( 0.0028 ) | 0.0033 | ( 0.0090 ) | -0.0050 | ( 0.0048 ) |
| | cl | -0.0300 * | ( 0.0095 ) | 0.0043 | ( 0.0052 ) | -0.0018 | ( 0.0045 ) | 0.0059 | ( 0.0095 ) | 0.0110 * | ( 0.0050 ) |
| | md | -0.0178 | ( 0.0157 ) | -0.0193 * | ( 0.0081 ) | -0.0197 * | ( 0.0051 ) | -0.0004 | ( 0.0157 ) | -0.0200 * | ( 0.0085 ) |
| | tr | 0.2325 * | ( 0.0484 ) | 0.1123 * | ( 0.0352 ) | -0.0092 | ( 0.0197 ) | 0.0445 | ( 0.0484 ) | 0.0596 * | ( 0.0180 ) |
| | cm | -0.0421 * | ( 0.0064 ) | -0.0445 * | ( 0.0043 ) | -0.0008 | ( 0.0039 ) | -0.0329 * | ( 0.0064 ) | -0.0103 * | ( 0.0026 ) |
| | ls | 0.0219 | ( 0.0183 ) | 0.0603 * | ( 0.0187 ) | -0.0949 * | ( 0.0133 ) | 0.0159 | ( 0.0183 ) | 0.0528 * | ( 0.0109 ) |
| | ed | -0.0137 | ( 0.0089 ) | 0.0171 | ( 0.0116 ) | 0.0912 * | ( 0.0168 ) | -0.0611 * | ( 0.0089 ) | -0.0104 * | ( 0.0048 ) |
| | ot | 0.0284 | ( 0.0347 ) | -0.0463 * | ( 0.0205 ) | 0.2085 * | ( 0.0275 ) | 0.0611 | ( 0.0403 ) | 0.0846 * | ( 0.0240 ) |

Numbers in the parentheses are standard errors.

indicates significantly positive at the 2.5% level.

indicates significantly negative at the 2.5% level.

**Table 2 Estimates of Delta's**

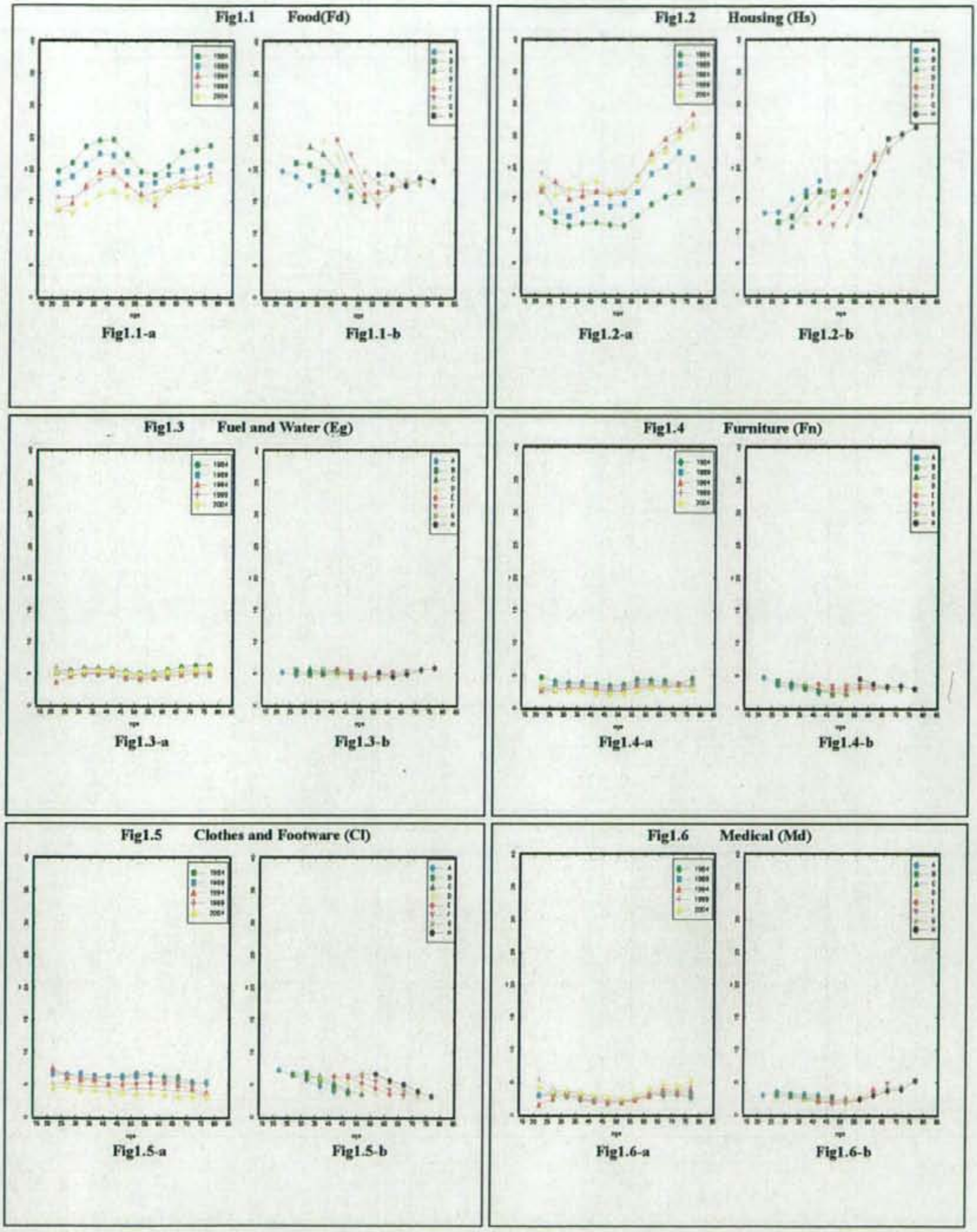
| Age | 20s | | 30s | | 40s | | 50s | | 60s | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wave | delta | SE | delta | SE | delta | SE | delta | SE | delta | SE | |
| 1984 | 0.563 | ( 0.088 ) | 0.072 | ( 0.146 ) | 0.408 | ( 0.107 ) | 0.141 | ( 0.082 ) | 0.041 | ( 0.090 ) | 0.245 |
| 1989 | 0.240 | ( 0.102 ) | 0.155 | ( 0.102 ) | 0.938 | ( 0.138 ) | 0.114 | ( 0.100 ) | 0.006 | ( 0.064 ) | 0.291 |
| 1994 | 0.293 | ( 0.123 ) | 0.230 | ( 0.091 ) | 0.671 | ( 0.098 ) | 0.265 | ( 0.089 ) | 0.379 | ( 0.057 ) | 0.368 |
| 1999 | 0.578 | ( 0.111 ) | -0.231 | ( 0.132 ) | 0.745 | ( 0.098 ) | 0.540 | ( 0.065 ) | 0.593 | ( 0.054 ) | 0.445 |
| 2004 | 0.358 | ( 0.106 ) | 0.179 | ( 0.068 ) | 0.609 | ( 0.092 ) | 0.908 | ( 0.105 ) | 0.730 | ( 0.072 ) | 0.557 |
| Average | 0.406 | | 0.081 | | 0.674 | | 0.394 | | 0.350 | | |

**Table 3 Test of Proportionality**

| | Age | | | | |
|---|---|---|---|---|---|
| Wave | 20s | 30s | 40s | 50s | 60s |
| 1984 | 22.31 | 82.55 | 146.49 | 130.07 | 158.37 |
| 1989 | 80.89 | 177.27 | 87.82 | 107.56 | 164.6 |
| 1994 | 79.61 | 164.61 | 104.13 | 145.29 | 162.31 |
| 1999 | 82.08 | 199.89 | 24.47 | 105.29 | 74.24 |
| 2004 | 82.67 | 225.68 | 18.81 | 73.67 | 48.36 |

df = 9, the 5% critical val. =16.92, the 1% critical val. = 21.67 .

## Fig.1 Change in Expenditure Shares




Vertical Axis W : expenditure share (%), Horizontal Axis age : age of the household head

**Fig1.*-a**: Lines connect the shares within wave(*=1~11).

**Fig1.*-b**: Lines connect the points belong to the same (psudo) cohorts (*=1~11).

Cohorts A:household head is born after 1960, B:55~59, C:50~54, D:45~49, E:40~44, F:35~39, G:30~34, H:25~29.

## Fig.1 Change in Expenditure Shares(continue)

**Fig1.7 Transportation (Tr)**

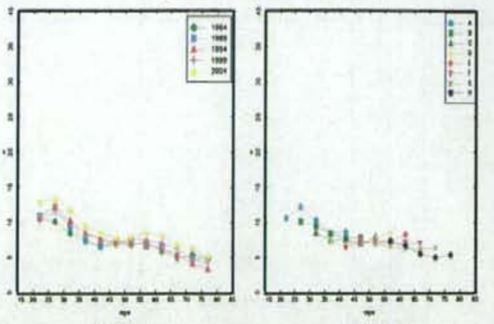


Fig1.7-a Fig1.7-b

**Fig1.8 Communication (Cm)**

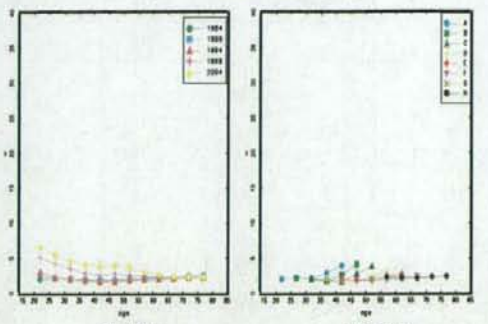


Fig1.8-a Fig1.8-b

**Fig1.9 Leisure (Ls)**

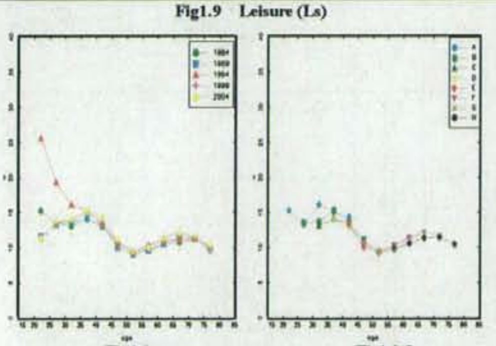


Fig1.9-a Fig1.9-b

**Fig1.10 Education (Ed)**

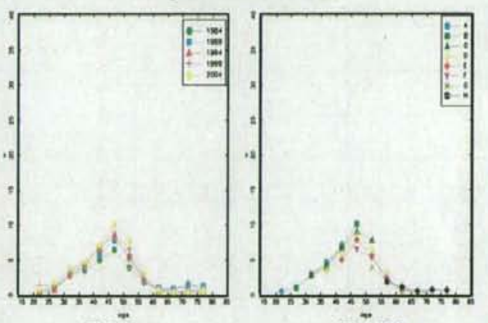


Fig1.10-a Fig1.10-b

**Fig1.11 Other (Ot)**

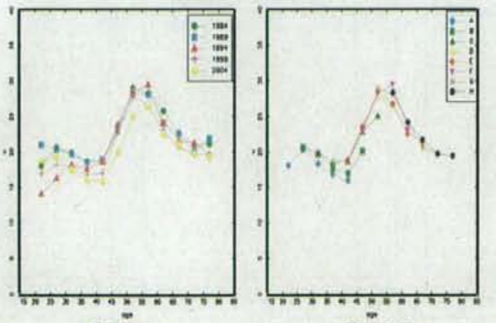


Fig1.11-a Fig1.11-b

Vertical Axis W : expenditure share (%), Horizontal Axis age : age of the household head

**Fig1.*-a**: Lines connect the shares within wave(*=1~11).

**Fig1.*-b**: Lines connect the points belong to the same (psudo) cohorts (*=1~11).

Cohorts A:household head is born after 1960, B:55~59, C:50~54, D:45~49, E:40~44, F:35~39, G:30~34, H:25~29.

**Fig. 2 Shifts in Beta's in 5 Waves**

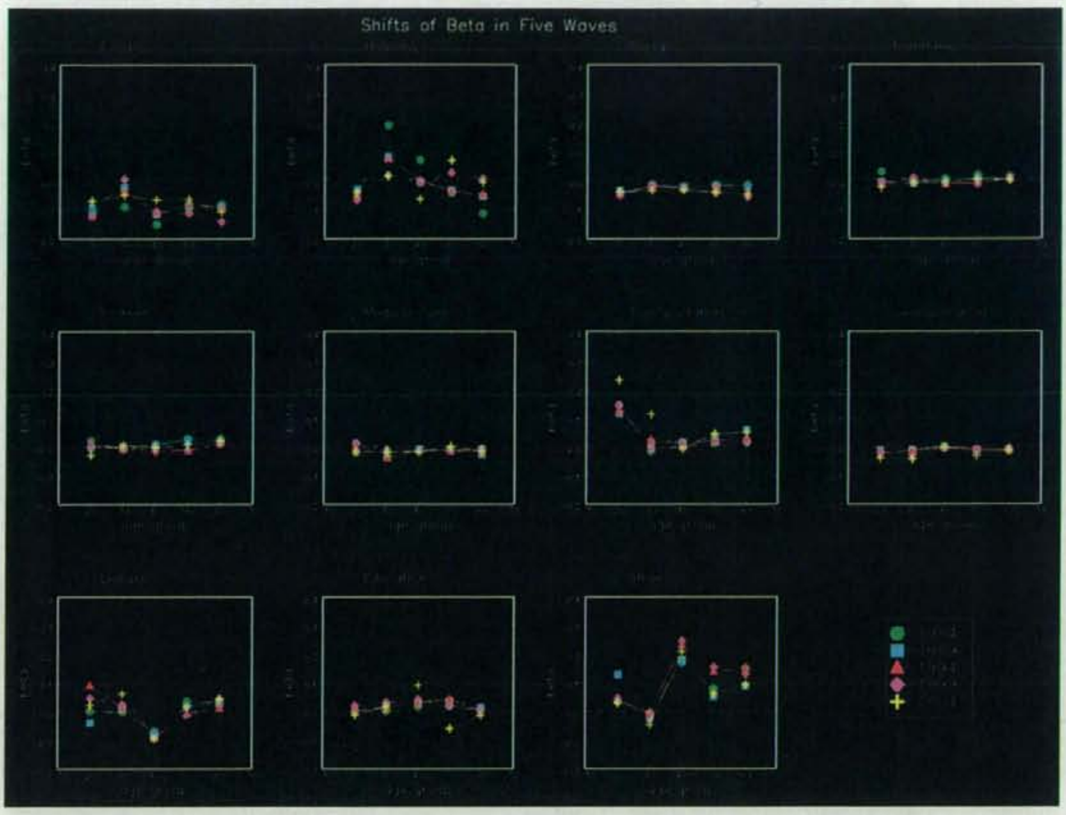
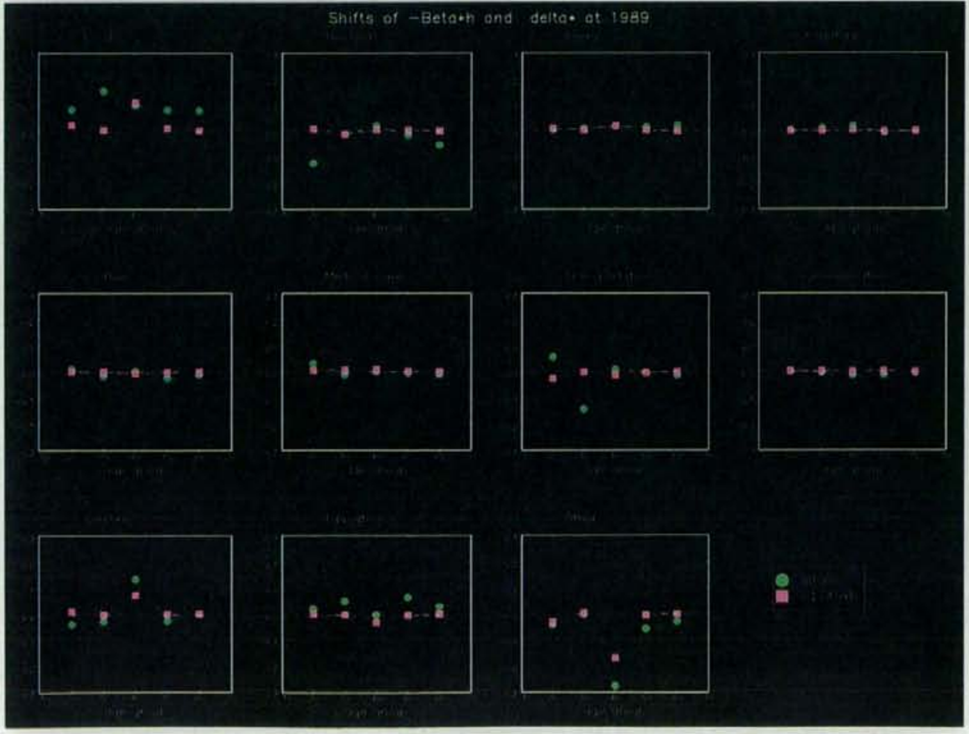


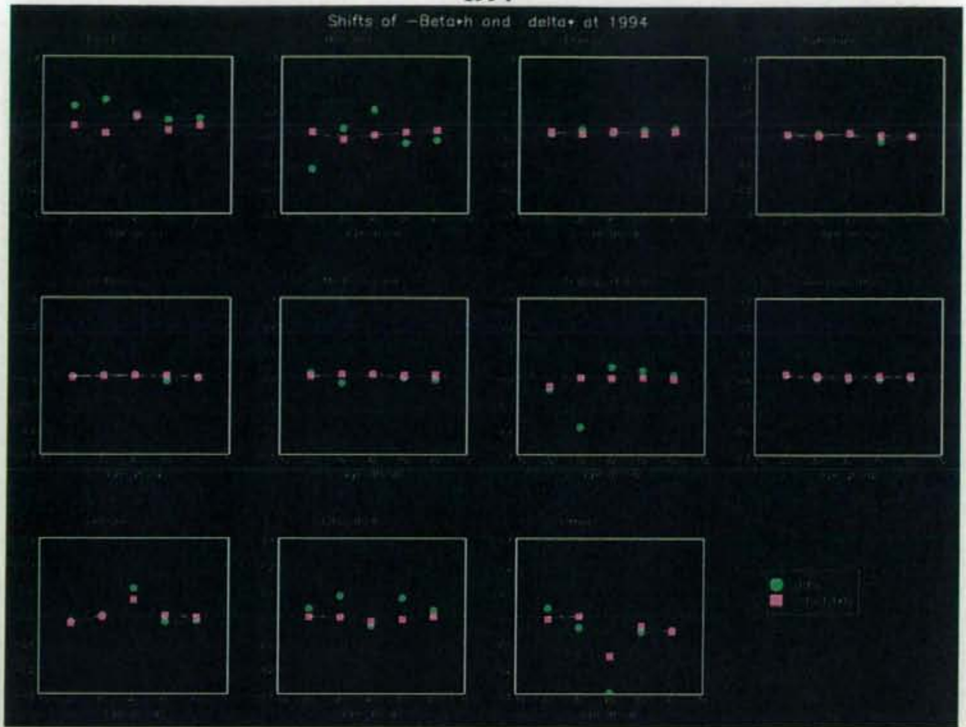
**Fig.3 Comparison of Proportionality Condition**

**1984**

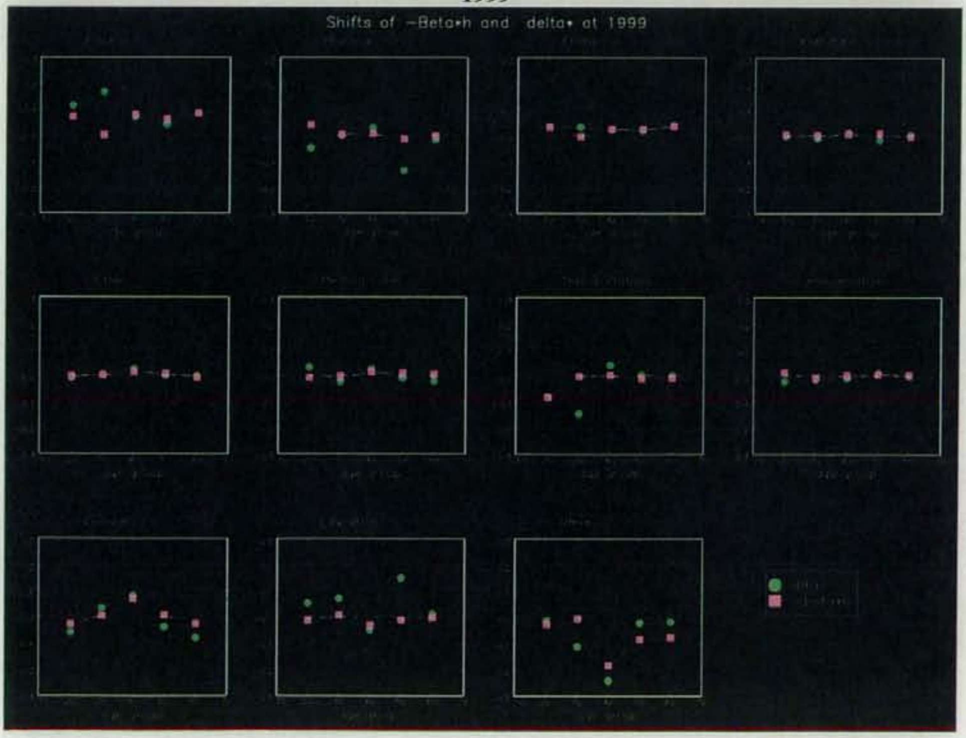

**1989**



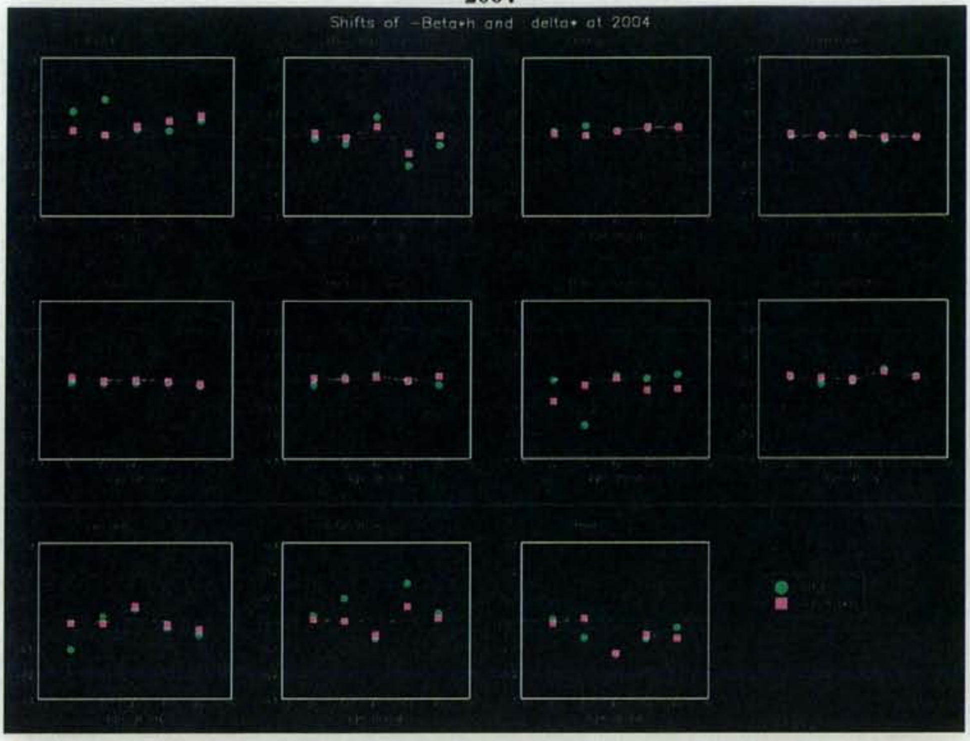
1994


Shifts of -Beta*h and delta* at 1994

1999


Shifts of -Beta*h and delta* at 1999

## 2004



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分担研究報告書

# 財の品質差別のモデル化の新しい試み

研究代表者　青木　玲子　一橋大学　経済研究所　教授

**研究要旨**　薬品や医療行為のように品質差別が重要である財やサービスにおいて、よく見られるのが「標準品」と「特注」または「カスタム製」などの品質差別である。これらの差別は単に「高」と「低」品質だかでなく、多数の消費者がある程の効用をみいだす「標準品」と極少数の消費者が非常に高い効用をみいたす「特注品」といった区別がよく見られる。インターネットにより情報の交換が容易になることは「特注品」の生産費の低下であり、このような品質差別は多くなってきた。この区別を反映することができる「スポーク型」品質差別のモデルを新たに構築する。独占と寡占における製品の均衡における製品の種類を分析する。独占企業もしくは2企業寡占の場合の一方の企業は「標準品」を提供するが、3企業の場合はどの企業も「特注品」を提供するので、「標準品」は存在しなくなる。これは保育や医療サービスの市場でそれぞれの子供や患者にあった医療を提供するためにはある程度のサービス提供者が市場に存在しなければ不可能なことを示唆している。

## A．研究目的

技術進歩によって、財やサービスのみならず、それらの提供方法が変化している。一方少子化と核家族化により、消費者のニーズは多様化している。結果的に品質差別は「高」と「低」よりも個人のニーズや好みに対応する「特注品」と大衆むけの「標準品」の区別に移行している。標準品は全ての人が特注品よりは劣ると評価しているが、特注品より多くの人がそのように評価しているという特徴がある。本研究は「特注品」と「標準品」の区別をより多くの消費者にある程度アピールするか、それとも少数の消費者に非常に高く評価されるといった区別を明確にモデルに導入して、市場構造と均衡において供給される財の質と価格を分析する。

市場構造と財の質と価格の関係を把握することにより、医療サービスに対する政策が市場をどのように考慮する必要があるのかが明らかになる。これは少子化や高齢化により、必要とされる医療その他のケア・サービスや財のニーズが多様化し、いかに個人のニーズに答えるかが問題になる。それぞれのニーズに対応する「特注品」の提供するために政策が目指すべきサービス市場を理解するあしがかりになる。

## B．研究方法

消費者が3本の枝があるスポークに一様に分布しているホテリング・モデルの拡張を考える。企業は製品の質と価格をそれぞれ選ぶ。スポークの中心を選ぶことは「標準品」の選択を現す。スポークから枝の一本を外側にいくにつれ、製品の特注度が増すころになる。同じスポークの消費者にとってはより自分の選好に近いものになる、他のスポークの消費者にとっては自分のニーズからほど遠いものである。標準品は多くの消費者のニーズをある程度満たしている。
企業がひとつである独占企業のほかに、企業が2つと3つの寡占の場合も考える。寡占の場合は企業は順番に参入して財の特化度と価格を選ぶ。分析をするのは3企業の場合ま

でであるが、その場合の議論が一般にN企業の場合も通用することも示す。

C．研究結果

独占企業はスポークの中心を選択する。つまり、独占企業は標準製品を供給するのである。特注製品を供給して高い価格で極少数の消費者に売るよりも、標準製品を多くの消費者に売った方が特ということである。2 企業の場合は、最初に参入した企業が標準製品を売り、後に参入した企業がどれかのスポークの枝の先に近いところに位置する。つまり、ある程度特注した製品を供給する。これは企業数がスポークの枝の数よりも少ない場合はつねに均衡で起こることで、必ず標準製品がある。

これに対して、枝の数が 3 本である場合は 3 企業の寡占であると、全ての企業が特注製品を供給する。一般に企業の数よりも枝の数が多い場合に均衡でおこるころである。企業の数が消費者の多様性（スポークの枝の数）よりも多い場合は、全ての企業が特注製品を供給し、市場には標準品は出回らない。

D．考察

大衆向けと思われる標準品は企業の数が多くなると市場から消えてしまう。全ての消費者が特注品を購入することになる。それに対して、独占企業は必ず標準品を供給する。標準製品の存在と市場が競争的であるということが単調な関係ではないことがわかる。

E．結論

消費者のニーズが多様な場合は、複数の企業の参入が望ましい。それぞれの消費者のニーズにあった製品が供給される。逆に標準品の有無を市場の競争、つまり経済効率性の指標とは考えるべきでない。

F．健康危険情報
該当しない。

G．研究発表

1. 論文発表
R. Aoki, J. Hillas, and T. Kao "Product Customization in the Spokes Model"
CIS ディスカッションペーパー

2. 学会発表
該当しない。

H．知的財産権の出願・登録状況
該当しない。

# Product Customisation in the Spokes Model

Reiko Aoki
Hitotsubashi University

John Hillas
University of Auckland

Tina Kao
Australian National University

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**Abstract**

We analyse firms' incentives to customise their products using the spokes model. Consumers are located along three rays with a common origin. The product space features a mass of consumers in the centre and gives a natural interpretation of product customisation. By locating close to the centre, the firm offers a more standardised product which appeals to the mass consumers. As the firm moves away from the centre, the degree of customisation increases. Our results indicate that a monopolist always offers the standard product. For duopoly firms, one firm always offers the standard product. With three firm oligopoly, for a wide range of parameter ranges, the standard product is not offered by any firm. Furthermore, the equilibrium prices may increase when the number of firms increases. The welfare implication from such price increase is however not straightforward since with more firms, consumers incur less travelling cost.

JEL Classification: L11, L13.
Keywords: product differentiation, product costomisation, spatial oligopoly.

# 1 Introduction

In this paper, we analyse firms' incentives to customise in a spokes model. The standard literature on product customisation balances firms' incentives to customise against the cost of customisation. However, as the cost of customisation declines due to developments such as E-commerce, such analysis becomes less relevant. Alternatively, the literature also looks at the Hotelling model. In the typical Hotelling model, each consumer has an ideal product and the notion of standardised product versus customised product is not captured. We propose a model of product customisation entirely driven by consumer preferences by using a modified Hotelling model. The product space specification looks like Chen and Riordan (2006), but the interpretation and focus is different.

Chen and Riordan (2006) use a spokes model to analyse differentiated oligopoly. In their model, consumers are uniformly distributed on a $N$ spokes network, with each spoke representing a product variety. There are $n \leq N$ firms, each locating at the end point of a spoke. Consumers desires at most two varieties. If the spoke where the consumer is located has a local firm at the end of the spoke, the consumer would desire this local brand. All other brands are of equal distance to the consumer and are bought each with probability $\frac{1}{N-1}$. Chen and Riordan fix firms' locations at the end of the spokes and analyse only price competition.

We analyse a three-spokes model and argue that the results extend to the general case of $n \leq N$, where $n$ is the number of firms and $N$ is the number of spokes in the product space. For the product space, the three rays have a common origin. This product space looks similar to the one in Chen and Riordan (2006). However, firms compete by choosing prices as well as locations in our model. Since there is a central point with mass consumers, this point represents the standard product. By moving further away from the centre, the degree of customisation increases. Examples of this type of product include for example, general sports shoes which appeal to most sports needs and specialised sports shoes such as running shoes and tennis shoes which cater for more specific markets. While firms' locations are fixed at the end point of the spokes in Chen and Riordan, it is an important endogenous variable in our model.

A paper which addresses a similar problem is Doraszelski and Draganska (2006). They also look at standard versus niche market. There are two types of consumers, $A$ and $B$, each prefer one type of good. Apart from the two customised goods $A$ and $B$, there is also a general good available, $S$. For given prices, a type $A$ of consumer would prefer good $A$ to good $S$ and good $B$ is the least prefered option. Doraszelski and Draganska include cost of customisation in the model.

In our model, customisation is driven by spatial competition, not the cost of specialization. We show that if there is only a monopoly, the monopolist always locates at the centre and offers the standard product. For duopoly competition or the more general case $n < N$ with sequential entry, one firm offeres the standard product and the other firm customises in equilibirum. When the market structure moves from duopoly to 3 firm oligopoly, or more generally, $n = N$, as long as firms do not act as unconstrained monopolists, the standard product is not offered anymore. Furthermore, the equilibirum prices may increase with 3 firm oligopoly compared with the duopoly setting. Although there is the possibility of price increase upon entry, the welfare results is not straightforward. With one more firm in the market, consumer welfare may increase due to better match of products despite the price increase.

The rest of the paper is organised as follows. Section 2 presents our model set up. Section 3 analyses the monopoly equilibrium. Section 4 presents the analysis for duopoly competition with sequential move. Section 5 studies 3 firm oligopoly game. We discuss some welfare analysis in Section 6, while the final seciton contains the concluding remarks.

## 2 The Model

Consumers are located uniformly along three rays with a common origin. Each ray represents a different type of customisation (different attribute of the product). Since the three rays intersect in the centre, by locating close to the origin, a firm sells a product which appeals to more customers. Along any given ray, the degree of customisation increases as the distance from the central point increases. By specialising in one attribute of the product, the product becomes less attractive to consumers who value other attributes of the product. Consumers and products are identified by both the ray and the distance from the origin. A firm $i$ is identified by,

$$i = (r_i, i),$$

where $r_i$ indicates the ray and $i$ is the distance of this firm from the center. Consumer $i$ is the consumer whose ideal product (most preferred product) is offered by firm $i$. For two points $x_1 = (r_{x1}, x_1)$ and $x_2 = (r_{x2}, x_2)$, the distance $\Delta(x_1, x_2)$ is defined by,

**Definition 1**

$$\Delta(x_1, x_2) = \begin{cases} |x_1 - x_2| & \text{if } r_{x1} = r_{x2} \\ x_1 + x_2 & \text{if } r_{x1} \neq r_{x2} \end{cases}$$

The product space is illustrated in Figure 1.

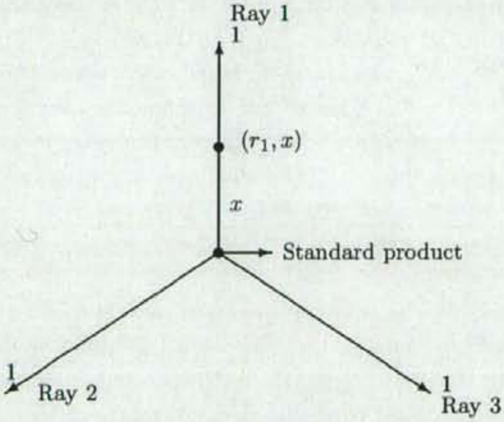


Figure 1: Product space.

It can be verified that $\Delta(x_1, x_2)$ is a metric in this product space. We can apply the standard analysis of product differentiation. That is, consumer $t = (r_t, t)$'s evaluation of a product $x = (r_x, x)$ with price $p_x$ is $v_t(x, p_x)$:

$$v_t(x, p_x) = V - \tau\Delta(t, x) - p_x,$$

where $V$ is some inherent value from consumption of one unit of the ideal product, and $\tau$ measures the marginal disutility of moving a unit distance away from the ideal product. A consumer will buy one unit of product if and only if the evaluation is non-negative. In the case of oligopoly, consumers buy the product that yields the highest non-negative evaluation. We assume no cost of production and customisation.

## 3 Monopoly

We first characterise the demand function for the monopolist's product $x$, $x \geq 0$. For any given $p_x$, demand will be a line segment which includes $x$. The marginal consumers $\bar{t} = (r_{\bar{t}}, \bar{t})$ and $\underline{t} = (r_{\underline{t}}, \underline{t})$ are those who satisfy $v_t(x, p_x) = 0$ or,

$$\Delta(t, x) = \frac{V - p_x}{\tau}.$$

We define $\bar{t}$ to be the consumer further away from the origin than $x$ on the same ray ($r_{\bar{t}} = r_x$, $\bar{t} > x$). If $p_x$ is high, then $\underline{t}$ will also be on the same ray ($r_{\underline{t}} = r_x$, $\underline{t} < x$). If $p_x$ is sufficiently low, then consumers who actually prefer other forms of customisation will buy $x$ ( $r_{\underline{t}} \neq r_x$). We define the upper bound for such a price as $p_0$:

$$V - \tau(x - 0) - p_0 = 0 \quad \Leftrightarrow \quad p_0 = V - \tau x.$$

For $p_x \geq p_0$, demand is,

$$D(p_x) = D = \bar{t}_x - \underline{t}_x = 2\frac{V - p_x}{\tau}.$$

When price is lower, $p_x < p_0$, the marginal consumers are $\bar{t}_x > x$ and $\underline{t}$. There are two marginal consumers, $\underline{t}$, one each on rays $i$ and $j$, where $i \neq j \neq x$. In this case, the marginal consumers $\underline{t}$ are defined by

$$V - \tau(x + \underline{t}) - p_x = 0.$$

For $p_x < p_0$, demand is,

$$D(p_x) = \bar{t}_x + 2\underline{t} = 3\frac{V - p_x}{\tau} - x.$$

The monopolist solves the problem

$$\max_{p_x, x} D(p_x, x)\, p_x.$$

We characterise the optimal monopoly pricing and corresponding profit for given $x$ below.

$$p^m = \begin{cases} \frac{3V - x\tau}{6} \\ \frac{V}{2} \end{cases}, \quad \pi^m = \begin{cases} \frac{(3V - x\tau)^2}{12\tau} & x \leq \frac{(3-\sqrt{6})V}{\tau} \\ \frac{V^2}{2\tau} & x > \frac{(3-\sqrt{6})V}{\tau} \end{cases}.$$

When product is very specialized (large $x$), then it is sold only to one type (ray) of consumers. With more standard product (small $x$), it is sold to all types of consumers. Both price and profit are decreasing in $x$ in this case. Any customization for a single type comes at the cost of becoming less attractive for the other two types (rays).

**Proposition 1** *A monopolist should sell the standard product. That is, choose* $x = 0$.

Demand by each type is $\frac{V}{2\tau}$ and total demand is $\frac{3V}{2\tau}$.

# 4 Duopoly Competition

Firms move sequentially. Firm $x$ first chooses price and location and upon observing $x$'s choice, firm $y$ chooses its location and price.[1] Since the follower can always choose to locate at the same position and undercuts the first mover marginally, in equilibrium, $\pi_y \geq \pi_x$. We solve the game backwards and start with the analysis for firm $y$, taking as given $x$ and $p_x$.

**Assumption 1** *Each ray is of length 1.*

Without this assumption, in equilibrium the firms would always act as local monopolists.

## 4.1 The follower's decision

Take $(x, p_x)$ as given, we analyse in the following order

1. $x = 0$
   (a) local optimum with $y > x = 0$
   (b) local optimum with $y = 0$
2. $x > 0$
   (a) $y > x$ and $r_y = r_x$ is never an equilibrium
   (b) $y > 0$ and $r_y \neq r_x$ is never equilibrium
   (c) local optimum with $x \geq y \geq 0$ and $r_y = r_x$

[1] Due to the mass consumers in the centre, there does not exist pure strategy equilibrium when firms move simultaneously.