Modernisation and Son Preference*

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Abstract

Gaps in welfare attainment between boys and girls in China have attracted international attention. In this paper demand analysis is used to try and uncover the factors which may be driving the emergence of these gender gaps. Drawing on household expenditure data from a poor (Sichuan) and rich (Jiangsu) Chinese province we are able to test for different types of gender bias in intra-household allocation. Spending on health is found to be biased against young girls in the poor but not in the rich province, whereas there is a bias in education spending against older girls in both provinces. These biases in household spending were found to correspond to gender biases in mortality and enrolment outcomes as revealed in census data for the same year. Split sample analysis reveals that poorer, less diversified households exhibit stronger biases against girls. Taken together, the results suggest that son preference in rural China is not driven solely by cultural factors pointing to a potential role for public policy.

Keywords: modernisation, son preference, intrahousehold allocation, demand analysis, China

JEL numbers: D10, D11, D12, D60, I12, I21, J16, J18, J71, J78

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1 Introduction

Son preference is a well known phenomena in many low income countries. What is less well understood is the extent to which economic factors influence preference for sons. China is perhaps the country where son preference and the consequent problems of excess female mortality have attracted the most intense media attention and scrutiny. Academic analysis of this topic, however, has been largely confined to census data (Arnold and Zhaoxiang, 1986; Zeng, 1988; Zeng, et. al, 1993). This tells us little about whether son preference simply reflects embedded cultural norms or whether there is potential for it to be eroded by modernisation. This also leaves us in the dark as to whether or not public policies will be effective in countering son preference.

This paper draws on household expenditure data to look more closely at these issues. We begin by examining whether we can detect gender-related biases in household spending in a rich (Jiangsu) and a poor (Sichuan) province. Since consumption by individuals is not observed in household expenditure data, our methods rely on detecting gender effects in the aggregate spending patterns of households. Engel and Rothbarth procedures developed by Deaton and Muellbauer (1986), Deaton, Ruiz-Castillo and Thomas (1989), Deaton and Subramanian (1990) and Subramanian (1995) are used to test for differential parental valuation of sons versus daughters. These procedures involve unpacking demand equations to examine whether the presence of children of similar ages but of opposite sexes affect key areas of household spending differently.

We then go on to match our household data with census data for the same locations. This allows us to check whether gender-related biases in household spending correspond with gender biases in living standard outcomes (e.g. sex ratios, age specific mortality and enrollment rates). We are aided in this respect by the fact that the national census in China was carried out in 1990, the same year for which our household data were collected. We are thus able to build up a fairly complete picture of living standard outcomes in the two provinces and can check whether any biases in expenditures that we can detect correspond to biases in outcomes. To our knowledge this represents the first attempt to undercover mechanisms that might underlie widely observed gender biases in welfare outcomes through direct observance of household demand behaviour using large representative samples. Going the other way, the matching of census and expenditure data allows us check whether widely implemented Engel and Rothbarth procedures are themselves capable of detecting discrimination.[1] Examination of census data also allows us to examine potential areas of discrimination which are not discernible in expenditure data. An example is

[1] This is an issue as a range of studies employing these methods have failed to reveal significant evidence of gender biases in household spending *despite* the fact that measures of outcomes, drawn from census and other sources, show clear differences in welfare outcomes between boys and girls (see Deaton, 1997 for a review).

the possibility that parents adjust the sex ratio of surviving progeny prior to birth through selective abortion. Expenditure data is incapable of picking up discrimination against unborn children, thus inclusion of census results has value for exploring this potentially important form of son preference.

Since the onset of reforms in 1978 different parts of China have experienced divergent rates of economic growth and market development. Our sample is designed to capture the two faces of modern China – Jiangsu which has experienced rapid rates of diversification and growth, and Sichuan which is considerably more backward and slower growing. In the final part of the paper we use sub-samples created by splitting provincial samples according to equivalised consumption expenditure or share of off-farm income to check whether gender biases in intrahousehold allocation vary with the standard of living or degree of diversification of the household. Formally this analysis may be seen as a check on whether income or the composition of income enter into the sharing rule implemented by parents.[2] This type of disaggregated analysis may provide further insights into whether son preference is driven by economic factors or whether it is simply a reflection of embedded cultural preferences (see Becker, 1981). Taken together our results allow us to say something about whether modernisation, as reflected in rising income and diversification, will improve the standing of female children *vis a vis* male children. This in turn has critical bearing on whether public policies which encourage growth and modernisation have any power to reduce son preference or whether more specific, targeted policies will have to be designed.

2 Data

The data used in this paper is drawn from the 1990 Sichuan and Jiangsu provincial sub-samples of the Rural Household Sample Survey conducted by the State Statistical Bureau (SSB) of the People's Republic of China.[3] Each sub-sample covers one third of the counties within a province, ten villages within a county and ten households within a village, selected by a multistage random sampling process. In 1990, the sample for Sichuan contained 5,380 households while the sample for Jiangsu contained 3,364 households. Urban household data for Sichuan in 1990 comprising 800 households is also used for the purpose of comparison (see Burgess, Zhu and Yun, 1996). Household data is matched and contrasted with rural and urban census data for Sichuan and Jiangsu drawn from the 1990 Population Census of China which provides information on mortality and school enrollment rates broken down by sex and age and sex ratios broken down by age (State Statistical Bureau, 1992).

Sichuan and Jiangsu represent the two faces of modern China, the former being

[2]Changing the overall budget constraint may change parental behaviour towards children. The composition of income, however, may also be important. Reducing dependence on agriculture, for example, may alter the valuation of boys versus girls.

[3]See Burgess and Wang (1995) for a full description of the rural data set (also see Chen and Ravallion, 1996).

poorer, slower growing, highly agricultural and located in the central interior of the country whereas the latter is richer, faster growing, has a high degree of rural industrialisation and is located on the Eastern 'miracle' coastal rim of China (see Table 1).[4] These contrasts enable us to derive a rich set of results on the interplay between modernisation and son preference in China.

Two features of the rural household data sets differentiate it from standard practice and reduce the incidence of non-sampling errors. First, households are required to maintain cash and in-kind log books on a daily basis over the course of an entire year. Second, there is an elaborate system for collecting, checking and processing the data.[5] The concept of household expenditure used in the paper is the value of annual consumption of goods and services. Total household expenditure thus includes expenditure on food, tobacco, liquor, tea, clothing, articles for daily use, culture and recreation, fuel and power, health, education, housing and building, and transport and communication. The survey also collects information on household members, including their number, age, sex, occupation and education (see Table 1 for summary statistics of the main variables used in the analysis).

3 Gender Biases in Household Spending

The time period we are interested in is when the spending decisions which affect children are under the direct control of parents. We therefore have in mind a unitary model of the household where intrahousehold allocation decisions are made jointly by the parents and children are passive recipients of such decisions. We abstract from the possibility that there may be disagreement between the parents regarding spending decisions (Thomas, 1994) or that different household members influence allocation decisions to differing degrees (Browning and Chiappori, 1996). We assume that parents have identical preferences and behave like a single unit.

3.1 Methodology

Intrahousehold allocation is not directly observed in the data as expenditure data is collected at the level of the household. Our methodology to detect gender biases in intrahousehold allocation depends on examining whether the presence of individuals of similar ages but of opposite sexes affect key areas of household spending differently.

[4] If we rank the rural sectors of Chinese provinces according to per capita expenditure (PCE) Jiangsu with 953 yuan is located near the top of the ranking whilst Sichuan with 569 yuan is located below the midpoint. Greater off-farm employment in Jiangsu partly accounts for these large differences. In Sichuan 86.5% of the labour force are employed in agriculture and 3.9% in rural industry whilst in Jiangsu the corresponding proportions are 61.2% and 18.6%. The share of rural industry in total rural output is 26.9% for Sichuan and 60.4% for Jiangsu (see Statistical Yearbooks for Sichuan and Jiangsu, 1990).

[5] Data entry is supervised by a part-time resident enumerator. Regular monthly inspection of log-books by county team staff adds another layer of checks to the system.

To look at these effects we use the familiar Working-Leser Engel form where different age classes (n_j) have been broken down by gender so that separate γ_{ij} coefficients for males and females can be calculated:

$$w_i = \alpha_i + \beta_i \ln x + \eta_i \ln n + \sum_{j=1}^{J-1} \gamma_{ij}(n_j/n) + \delta_i z + u_i \tag{1}$$

Here w_i is the budget share of the ith commodity, x is total household expenditure,[6] n is household size,[7] n_j is number of household members in sex-age class j. We also include a vector of variables (z) which control for location (county dummies) and for relevant socioeconomic characteristics of the household.[8] The test of gender bias we employ centers on whether the coefficients $\gamma_{ij} = \gamma_{ik}$, where j and k reflect boys and girls in the same age group. This can be tested in a straightforward manner using an F test.

3.1.1 Engel Framework

In the Engel approach to identifying equivalence scales, households with similar budget shares (typically of food) but varying demographic composition are considered to have similar standards of living. By comparing *across* different age classes (n_j) in (1) the costs of children relative to adults can be identified. Here we extend this analysis by examining gender related demand effects *within* a given age class. If there is a pro-boy bias we would expect $\gamma_{ij} > \gamma_{ik}$, where j and k reflect boys and girls in the same age group.

We focus on areas of spending where differential treatment of sons and daughters may have permanent and irreversible effects on their welfare as might be reflected in outcome data such as that from the 1990 census. Therefore we have selected food, calorie, health and education shares as left hand side variables.

Compared to the standard classification where adults are defined as the group aged $15-54$, we have chosen a more disaggregated age breakdown. A total of seven age classes are thus distinguished, $0-4$, $5-9$, $10-14$, $15-19$, $20-29$, $30-54$, 55+ and each of these are split by gender.[9] This allows us to effectively broaden our analysis from issues of survival to differences in human capital investment. A finer demographic categorisation, for example, enables us to check whether male and females aged $15-19$ age group receive different levels of investments in education. Comparisons across age groups are also made more exact as there may be considerable

[6] β_i is the expenditure elasticity; a positive value indicates a luxury and a negative value indicates a necessity.

[7] η_i indicates whether there are economies of scale in the consumption of commodity i.

[8] Specifically, share of net income derived from off-farm employment (OFF), education status of household head (EDU), whether in a minority region or not (MIN) can all affect demand and have thus been included as controls in the regressions.

[9] This gives us a total of 14 demographic classes. Thirteen of these are run in each of the regressions with the $F30-54$ group being excluded.

heterogeneity in demands for food, calories, health and education within the $15-54$ age group.[10]

3.1.2 Rothbarth Framework

The second approach we follow is based on the intuition of Rothbarth (1943) that expenditures on adult goods (e.g. alcohol, tobacco) can be thought of as indicators of parental welfare. Given a fixed household budget, the addition of children can be modelled as a negative income effect (child costs displace adult good consumption) leading to a reduction of adult good expenditures and adult welfare (see Deaton, 1997). If boys depress adult good consumption more than girls then this can be taken as an indicator of higher valuation of boys.

The validity of this framework rests on being able to find a set of goods which are consumed by adults only and for which there are no substitution effects of children. If adult goods can be identified and consumption of these goods can be interpreted as an indicator of adult welfare then one can test whether boys and girls have different income effects on adults goods consumption. In practice this is difficult because we can only find a few goods in our data sets which are consumed only by adults.[11] In addition, the presence of children may affect consumption of these goods through substitution effects even when parents have been fully compensated for the costs of children.[12]

Deaton, Ruiz-Castillo and Thomas (1989) proposed a procedure for testing separability between adult and non-adult consumption as a means of identifying adult goods. The procedure involves calculating the so-called outlay equivalent ratio, π_{ij}, from the coefficients estimated using adult good shares as left hand side variables in equation (1):

$$\pi_{ij} = \frac{\partial(p_i q_i)/\partial n_j}{\partial(p_i q_i)/\partial x}\frac{n}{x} = \frac{(\eta_i + \gamma_{ij}) - \sum_{j=1}^{J-1}\gamma_{ij}(n_j/n)}{\beta_i + w_i} \tag{2}$$

This ratio expresses the effect of an additional person in the jth age-sex category on consumption of the adult good in terms of the increase in total expenditure which produces the same change in expenditure on that commodity, written as a fraction of per capita expenditure (PCE). Therefore the outlay equivalent ratio of a female child for alcohol would be the fraction that PCE would have to be reduced to induce

[10] For instance, health demands may be particularly strong for women of child bearing age. We chose to use the more homogenous $30-54$ female group as our reference as it represents a group where reproduction has largely ceased and where health demands associated with old age have not fully set in. Demand for education is also likely to be uniformly low for this group.

[11] Our prime candidates are alcohol and tobacco. We also use tea as this commodity is typically not consumed by children in China. Other adult goods such as adult clothing and footwear are not available in our data.

[12] Parents, for example, may consume less alcohol, tobacco and tea outside the household when they have children due to child care considerations.

the same reduction in alcohol expenditure as would an additional female child (see Deaton, 1997). If adults goods are correctly identified we would expect equivalent ratios for children to be (significantly) negative which would be suggestive of children having effects which resemble reductions in income. With full separation and perfect correlation between adult goods it follows that these ratios should be the same for all adult goods. Wald tests can be used to check this and provide the basis for the selection of a valid set of adult goods.

If boys are favoured over girls one would expect the π_{ij} for boys to be more negative than those for girls in the same age group. This would indicate higher valuation of boys versus girls. To formally test the equality of π-ratios one can return to equation (1) and test for the equality of γ coefficients on male and female children in a given age class using an F test. If there is a pro-boy bias we would expect $\gamma_{ij} < \gamma_{ik}$, where j and k reflect boys and girls in the same age group.

3.2 Results

At each stage of the analysis, standard F tests were calculated comparing pooled and unpooled regressions for the two provinces. These tests rejected pooling confirming that the populations in the two provinces differ in their spending behaviour. We exploit these differences both by working in a comparative framework and by examining directly how income levels and degree of diversification affect the gender effects we observe.

3.2.1 Engel Framework

In Tables 2 to 4 we present the Engel curve regressions employing equation (1) for food, calories, health and education shares. F tests for the equality of γ coefficients are presented at the bottom of each of the tables.

Food and Calories Food represents the key element in Chinese rural budgets comprising 64.3% of the budget in Sichuan and 55.7% of the budget in Jiangsu (see Table 2). Demand patterns for food are similar across the two provinces – relative to the omitted female $30-54$ category, children $0-4, 5-9$ and $10-14$ have a similar negative impact on the share of the household budget devoted to food. Coefficients on children of different sexes within these age classes, however, do not appear to be significantly different. This is confirmed by F tests reported at the bottom of Table 2 where we can find no evidence of gender biases in spending on food in either province.

As an alternative test we can look at how children of different sexes affect demand for calories as opposed to demand for food.[13] If girls exert a more negative influence on household calorie demands than boys then this can be taken as an indication that

[13] In place of food share we use a calorie share measure defined as household calorie consumption divided by household total expenditure.

boys are valued more highly. Using calories directly may be advisable as food expenditures embody price variation which may not be relevant to the nutritional status of children – higher costing foods do not necessarily convey greater nutritional value than lower costing foods. Indeed, demographic effects on calorie demand revealed in Table 2, indeed, appear more reasonable than those for food share: coefficients increase with age across the three child groups $(0-4, 5-9, 10-14)$, signalling increases in calorie needs and convergence towards the needs of the omitted adult reference group. Despite this we are unable discern any significant difference in the magnitude of coefficients for male and female children as is confirmed by the F tests shown at the bottom of Table 2. There is no evidence of a bias in against girls in the allocation of calories within the household. Taken together the food and calorie results would suggest that parents do not engage in selective underfeeding of female children.

This result is common to a number of other studies (see Deaton, 1997 for a review). One explanation might be that because Chinese households obtain the bulk of their food and calorie requirements from home production they may be less inclined to exercise discretion in the allocation of this component of consumption. Universal and egalitarian access to land may also imply that parents feel less constrained in meeting food as opposed to non-food consumption needs. A final reason suggested by Ahmad and Morduch (1993) is that there may be two stage budgeting in food allocations. Parents may not change their food buying or production decisions if they have a boy or a girl but they might allot different portions or higher quality foods to sons rather than daughters. These effects will not necessarily show up in tests which focus on the allocation of total food or calories.

Health and Education Within health and education categories we distinguish between goods and services as these are distributed through different channels, the former primarily through the market and the latter primarily through public institutions (see World Bank, 1992; Bloom, 1994). Results for estimated health Engel curves are shown in Table 3. Health expenditures, and in particular health services, are characterised by having relatively low budget shares.[14] Positive coefficients on total expenditure (β) suggest that both health goods and services represent luxuries in both provinces. Patterns of demand for health goods and services are similar across provinces. Demands are highest for the young child groups $(0-4, 5-9)$ for child bearing women $(F20-29)$ and for the elderly (55+). If we focus our attention on the $0-4$ age group where mortality is highest we see that boys appear to receive more health goods than girls in Sichuan but not in Jiangsu. F tests shown at the bottom of Table 3 confirm that this difference is statistically significant. We therefore have strong and direct evidence of there being a significant bias against girls $0-4$ in the

[14] Health services have budget shares in the order of 0.5% in our two provinces whereas Subramanian (1995) reports medical service shares in the region of $3-5\%$ for Indian states. This partly reflects the subsidised nature of health services in rural China.

allocation of health goods in Sichuan but not in Jiangsu. The fact that this form of discrimination is absent in Jiangsu according to these tests raises the intriguing possibility that it may have been eroded by modernisation. Modernisation as reflected in rising incomes and off-farm diversification seems to exert an equalising influence as regards the allocation of health goods across young boys and girls. These results are striking, in particular as studies in other countries using the Engel method have on the whole failed to pick up any gender bias in spending on food or health, even in countries where health outcome data (e.g. sex ratios, mortality rates, anthropometrics) were strongly suggestive of gender bias.[15] Our finding therefore should be taken as *strong* evidence of the existence of a pro-boy bias in the allocation of health good expenditures in the poorer province.[16]

We could find no evidence of gender discrimination in the allocation of spending on health services in either province. The fact that health services were highly subsidised in 1990, however, does imply that our method may have limited power to detect discrimination.[17] Also, if attendance of a clinic is not costly, whereas drugs and other health goods need to be purchased in the market, son preference may be expressed more forcibly in decisions to purchase health goods as opposed to decisions to attend health clinics. Our decision to run separate regressions for health goods and services is thus validated. This has not been done in the bulk of other studies.[18]

The education Engel curve results are shown in Table 4. Shares of education services (e.g. tuition fees) are higher than those for education goods (e.g. books etc). On the whole education goods seem to represent necessities although the pattern is mixed for education services. Demand for education across age-groups is similar across the two provinces and is concentrated in the $5-9$, $10-14$, and $15-19$ age groups, being strongest for the $10-14$ group.[19] There is evidence of a pro-boy bias in the allocation of education goods in the $10-14$ age group in Sichuan and in the $15-19$ age group in Jiangsu.[20] In both provinces we find a significant bias

[15] See Deaton, 1989 for Thailand and Cote d'Ivoire, Ahmad and Morduch (1993) for Bangladesh, Subramanian and Deaton (1990) and Subramanian (1995) for India, Rudd (1993) for Taiwan, and Deaton (1997) for Pakistan.

[16] The correspondence of our results with census health outcome data will be checked in Section 4.

[17] This is reflected in the fact that health service budget shares are much lower than those for health goods (see Table 3).

[18] The fact we do not obtain significant evidence of discrimination when running health spending as an aggregate (in both our samples) suggests that failure to distinguish between these two elements of health expenditure may underlie some of the inconclusive results reported in the literature (see Deaton, 1997 for a review).

[19] One noticeable difference is that demand for education services appears to be much more pronounced in the $15-19$ age group for Jiangsu. The higher coefficients in the $10-14$ relative to $5-9$ group reflect both higher costs of secondary relative to primary education and the fact that primary school does not begin until children are aged 7.

[20] Failure to detect gender discrimination for education in the $5-9$ age group may be due to the fact that; (i) the gender gap in school attendance is lowest for this group (see Table 10), (ii) fees

against females in the allocation of spending on education services in the age group $15 - 19$. This difference is more pronounced for Sichuan suggesting that the bias against girls may be stronger in the poorer province. Overall the results suggest that biases against girls with regard to investments in human capital occur earlier and are more pronounced in the poorer province. Our results suggest that modernisation may be playing some role in eroding gender biases in education spending. A more disaggregated age breakdown has thus proved useful for pinpointing the incidence of gender bias in particular for older children and young adults.[21]

3.2.2 Rothbarth Framework

Table 6 reports the outlay equivalent ratios calculated using equation (2) from the regression results obtained from running equation (1) using alcohol, tobacco and tea budget shares (Table 5). If the adult goods we have selected are valid we would expect them to give similar estimates of the cost of children. To check this we report in Table 7 Wald tests of the equality of outlay equivalent ratios across our three adult goods for each age-sex group (see Deaton, 1987; Deaton, 1989). These tests indicate that the hypothesis of equality cannot be rejected for any group in Jiangsu and therefore our choice of adult goods would appear to be validated. For Sichuan, however, results are much more mixed with equality being rejected for both males and females in the $10 - 14$ age group. These rejections which are by no means uncommon in the literature highlight the practical limitations of the Rothbarth method. Not only is often extremely difficult to *ex ante* identify potential adult goods but these same goods *ex post* often turn out not to possess the characteristics that would make them suitable for testing for gender biases.

In Table 6 we observe that outlay equivalent ratios are negative for most child groups suggesting that children do exert a negative effect on the consumption of adult goods. The (absolute) size of the ratios also tend to increase with age as would be expected given that older children are likely to place greater demands on the household budget. The size of these effects tend to be greater for poorer Sichuan than richer Jiangsu. Ratios also tend to be more negative for male as opposed to female children aged $5-9$ or $10-14$ in Sichuan whereas in Jiangsu no clear pattern emerges. To test whether these ratios are significantly different from zero, we calculated their asymptotic standard errors and t statistics using the delta method suggested by Deaton (1987). In Sichuan we observe significant outlay ratios mainly for older male children whereas in Jiangsu all outlay equivalent ratios are insignificantly different

paid for primary education are negligible, (iii) opportunity costs of schooling are lower for younger children.

[21] Subramanian (1995), for example, finds evidence of gender bias against girls in education in the $15-54$ age group in all of the five Indian states he examines with the exception of the Punjab. Ahmad and Morduch (1993) find the same result for the $17 - 54$ age class in Bangladesh. Neither study, however, is able to ascertain the exact incidence of gender bias given that such broad classifications of adults are employed.

from zero.

The pattern of outlay equivalent ratios shown in Table 6 is suggestive of there being a pro-boy bias in overall household spending in Sichuan but not in Jiangsu. To test this we need to return to the original alcohol, tobacco and tea budget share regressions which are shown in Table 5.[22] The pattern of demographic effects is consistent with the π-ratio results with γ coefficients tending to be lower for males than females (in a given age class) in Sichuan but not in Jiangsu. F tests of the equality of γ coefficients shown in Table 8, however, indicate that in no case is the coefficient of a male child group statistically significantly different from that of a same aged female child group. The F test results therefore do not indicate any significant bias against girls. Our results are in line with evidence from Pakistan, India, Taiwan, Bangladesh, Cote d'Ivoire and Thailand where the Rothbarth method has failed to turn up any conclusive evidence of gender bias despite the fact that Bangladesh, India and Taiwan are places where census data is strongly indicative of son preference (see Deaton, 1997 for a review). This suggests that, due in part to limitations of data, the Rothbarth method is not an appropriate tool for picking up gender biases in household spending.

4 Correspondence with Welfare Outcomes

In this section we check whether the types of gender bias we detected using the Engel approach show up in health and education outcomes as revealed in the 1990 Chinese census. Checking for this correspondence is important to ascertain whether or not gender biases that we can detect in health and education spending translate into differential welfare outcomes. What we are observing using the Engel method are inputs into the determination of health and education status of male and female children. If we can demonstrate that these biases in inputs result in skewed outcomes then this can be taken as evidence that biases in spending do affect the welfare of sons versus daughters. Correspondence checking through the matching of expenditure and census data allows us to identify whether son preference in parental spending decisions is an important mechanism for explaining widely observed excess female mortality and gender gaps in education. Comparisons made across both Sichuan and Jiangsu and across rural and urban sectors will provide us with insights as to whether modernisation can or cannot erode son preference. The prevalence of son preference in the country as a whole combined with heterogeneous economic development make China the ideal laboratory for testing whether economic factors can affect preference for sons. This has important implications for whether public policy has any power to affect son preference.

[22] Coefficients on total expenditure (β) present a mixed picture of demand as regards tobacco and tea though alcohol appears to be a luxury as might be expected. Alcohol and tobacco have sizeable shares in the budget and are consumed by the bulk of rural households while tea has a relatively small share.

The other major reason for matching expenditure and census data is to check the robustness of indirect methods for detecting gender biases in household spending. This is a concern as various authors fail to detect gender bias in health and education spending despite evidence of large differences in health and education outcomes in census data (see Deaton, 1997 for a review of evidence). Our results are valuable as they confirm a close correspondence in results from these independent data sources and thus point to parental spending decisions as being an important mechanism through which son preference is expressed.

Outcome data such as sex specific mortality and enrollment rates are not available in household expenditure data sets. We therefore have to go further afield. The 1990 census data represents the obvious choice as both data sets cover the same time period and because the expenditure surveys are designed to be representative samples of the populations covered by the census. We confine our attention to three measures of welfare outcomes which can be obtained from census data arrayed by age; (i) sex specific mortality rates, (ii) sex ratios and (iii) sex specific enrollment rates (see Tables 9 and 10).

In Table 9 we array mortality rates and sex ratios by age. In examining these figures we have to keep in mind that in human populations boys and girls are not born in equal numbers nor do they die in equal numbers. Coale (1991) reports that in populations that provide unbiased health conditions and more or less equal nutrition to males and females the ratio of the number of male to female births is about 1.06 but male mortality rates are higher at every age from zero to the highest age attained. As he points out natural differences in ratios at birth can only be the source of differences of 1 or 2 percent in masculinity ratios of populations and that excess female mortality due to discriminatory treatment of females must be a major cause of skewed sex ratios in countries such as China and India. By comparing the actual sex ratio to that which would exist if there was a normal sex ratio at birth and equal treatment of the sexes, Coale (1991) comes up with a figure of 29.1 million females as being 'missing' from the Chinese population in 1990 due to the impact of higher female mortality that may have resulted from traditionally based differential treatment of the sexes.

If we compare mortality rates across rural Sichuan and rural Jiangsu in Table 9 we observe that differences in mortality rates (per 1000 population) between males and females correspond exactly to our Engel health results (compare Table 9 and Table 3). In rural Sichuan the female mortality rate is significantly higher than the male rate for individuals aged $0-4$. Whilst in rural Jiangsu there is little discernible difference.[23] This is consistent with lower health spending on girls leading to excess female mortality in rural Sichuan but not in rural Jiangsu. There is simply no way to reconcile the much higher mortality rates for girls in rural Sichuan, in particular in the first year of life, with what we would expect in a normal biological population where

[23]The fact that mortality rates as a whole are higher for Sichuan than Jiangsu is also consistent with the former being a poorer more backward province.

there is equal treatment of the sexes. Rural Jiangsu, in contrast, is closer to the Coale (1991) benchmark in that male mortality rates lie slightly above female mortality rates in the critical $0-4$ range where the bulk of child mortality is concentrated. For the older $5-9$ and $10-14$ age classes there is no evidence of male mortality rates exceeding female mortality rates for either rural Sichuan or rural Jiangsu. There is thus an exact correspondence between our results on health good spending and the pattern of mortality results. These results indicate that modernisation captured by rising economic growth and off-farm diversification have eroded son preference in the arena of health spending leading to a marked reduction in excess female mortality for children aged $0-4$. In rural Sichuan the traditions of son preference have led to discriminatory treatment adverse to females which is sufficient to outweigh their normal advantage of experiencing mortality rates lower than that of males. This is a highly significant finding as it suggests that the tradition of son preference is not immune to economic factors thus offering a route through which public policy can affect this behaviour.

We turn now to contrast our core rural results with those for urban Sichuan and Jiangsu (see Table 9). There is no discernible evidence of a pro-boy bias in the pattern of mortality rates $0-4$ which is consistent with our inability to find evidence of gender bias in health spending in urban Sichuan (see Table 11). Mortality results mirror those for rural Jiangsu, female rates being (on the whole) slightly lower than male rates and sex ratios gradually falling over time, results which are suggestive of populations which are relatively unconstrained in their health budget decisions. As urban populations in China are richer and health services more available they are interesting benchmarks against which we can compare the behaviour of poorer populations. Matching our mortality results with our Engel health results indicates that as modernisation and urbanisation proceeds, excess female mortality due to parents spending less on the health needs of female children diminishes.

Sex ratios (males per 100 females) at different ages are also reported in Table 9. Contrasting these with the mortality rates reveals an interesting paradox: sex ratios during year 0 are *higher* in rural Jiangsu (115.5) than in rural Sichuan (112.6) despite there being much stronger evidence of excess female mortality in the latter. To resolve this paradox we need to be clear on what is being captured in each of our tests of gender bias. Sex ratios capture the history of differential treatment of the sexes whether this is at the foetal or child stage. Expenditure and mortality based tests, on the other hand, look at biases within the surviving populations but cannot capture differential treatment of the sexes in the past. Higher sex ratios in rural Jiangsu must therefore be due to differential treatment *prior* to year 0. To ascertain whether this is in fact the case we need to examine what the sex ratios looked like *at birth*. Calculating this figure constitutes a problem as the one child policy creates an incentive to underreport female births.[24] This can be seen in Table 9 where we see that the reported sex ratio at birth does not appear to be consistent with the pattern

[24]See Zeng et. al., 1993; Ge and Xue, 1994.

of sex ratios and mortality rates across the $0-4$ range.[25] To correct for this we exploit the fact that there is less of an incentive to underreport female deaths than female births to arrive at a more reliable estimate of the sex ratio at birth using the reverse survival method (Zeng et al, 1993).[26] Both the official and recalculated sex ratios at birth are reported in Table 9. As can be seen from the table, the differences between the two sex ratio at birth estimates are quite significant in rural areas.[27] In addition, the sex ratios calculated using the reverse survival method appear consistent both with the pattern of reported sex ratios and gender specific mortality rates after birth. Having female mortality rates above male mortality rates across the $0-4$ range tends to increase the sex ratio (and *vice versa*).

The reverse survival estimates confirm that sex ratios are significantly higher at birth in rural Jiangsu. The most plausible explanation for this finding is that greater access to ultrasound and other methods for testing the sex of foetuses (due in part to higher incomes) combined with selective abortion have enabled rural residents in Jiangsu to express their preference for boys *prior* to birth. Following birth there is no evidence of discrimination as regards health spending or observed mortality rates. Sex ratios remain constant between birth and year 0 reflecting the equality of mortality rates. The pattern of mortality rates over the age range $1-4$, with slightly lower rates for females leading to a lowering of the sex ratio is consistent with what one would expect in an unconstrained developed country population (see Coale, 1991). The pattern in rural Sichuan is entirely different. Sex ratios at birth are only moderately skewed, which is suggestive of limited differential treatment *prior* to birth, however, they then increase significantly in years 0 and 1 as a result of excess female mortality which is in part driven by gender biases in health spending.

What is even more fascinating is that the (skewed) sex ratios at age 2 (and for the $0-4$ period as a whole) are close to being identical between the rural sectors of the two provinces. Rural populations in both provinces thus exhibit a similar

[25] For example, in rural Sichuan there is a fall in sex ratio from the actual reported ratio at birth to that in year 0 despite the fact that female mortality exceeds male mortality in year 0. Two factors may encourage underreporting. (i) If all a couple want is one boy, they will report male births but not female births. (ii) Sample surveys also suggest that when authorities investigate unauthorized births, parents are more likely to confess an unreported boy than an unreported girl because (a) they are more willing to pay fines for the former and (b) a couple with an unreported female baby is more afraid of being sterilized than a couple with an unreported male baby (see Ge and Xue, 1994; Mu, 1995).

[26] The method amounts to adding the number of deaths of male and female children aged 0 to the total number of male and female children surviving at the end of year 0 to arrive an estimate of the expected number of male and female births. Comparing these figures to reported births gives an idea of the magnitude of the underreporting bias and their ratio constitutes a corrected measure of sex ratio at birth.

[27] The differences suggest that underreporting of female births leads to 4 percentage point upward bias in the reported sex ratio at birth in rural Sichuan and a more than 5 percentage point upward bias in rural Jiangsu. The two sex ratios are the same for urban Sichuan suggesting that there is less incentive or scope to underreport female births in urban areas.

and significant preference for boys, however, the means by which they express son preference is different. Residents of rural Jiangsu depend more on adjustments prior to birth whilst residents of rural Sichuan (possibly due to cost constraints or limited availability of sex determination technology) rely more on biases in health spending. These findings raise interesting policy questions as to whether banning ultrasound and other procedures might displace the incidence of son preference from the foetal to the child stage, leading to excess female mortality in early life.

The fact that sex ratios for children aged $0-4$ in urban areas are considerably lower does suggest that modernisation is playing a role in eroding son preference. This is likely to reflect higher incomes and the absence of gender biases in health spending as well as restricted access to facilities for pre-birth sex determination. The fact that returns to male and female children are more similar in urban areas may also dampen the incentive to engage in son preference. This accords well with what we find with demand analysis where excess female mortality in early life seems now to be a characteristic of poorer, backward areas.

We turn next to census information on education outcomes (see Table 10). Again we find results which correspond almost exactly to our findings on the intrahousehold allocation of spending on education goods and services. Gender gaps in enrollment in rural areas relatively small for children aged $6-9$ but get larger for children $10-14$ and $15-19$. This is consistent with our finding a significant pro-boy bias in spending on education services for the $15-19$ age group in both provinces. Overall enrollment rates are higher and gender gaps larger in rural Sichuan which is consistent with the magnitude of the bias being larger for the $15-19$ age group. In stark contrast there is little or no evidence of a gender gap in enrollment in the $6-9$ and $10-14$ age groups in urban areas and the gap for the $15-19$ age group is modest compared to that in rural areas. This is consistent with us being unable to find any gender bias in education spending in urban Sichuan (see Table 11). Matching household and census data leaves us with the strong impression that modernisation and urbanisation are powerful forces for reducing son preference in education. The challenge now is to understand why richer parents treat thier sons and daughters more equitably. Finding that economic factors do affect son preference is nonetheless an important first step as it makes it transparent we are not dealing with an immutable social norm and that public policy can play a role.

5 Determinants of Son Preference

Demand analysis using data from rural Sichuan and rural Jiangsu generated three key sets of gender bias results. (i) There is no evidence of discrimination in the allocation of food and calories. (ii) There is evidence of discrimination against young girls $(0-4)$ in the allocation of health goods in the poorer, less diversified province (Sichuan) but not in the richer, more diversified province (Jiangsu). (iii) There is evidence in both provinces of a pro-boy bias spending of goods and services associated with secondary and tertiary education. The previous section demonstrated that these biases corresponded to significant differences between the sexes in mortality and enrollment outcomes.

In this section we look more closely at which factors might be driving son preference. To do this we begin by looking at whether gender biases in health and education spending vary across rural and urban households. This work thus builds on our analysis of census data which suggest that urban populations treat daughters and sons more equitably than do rural populations. We then look within the rural samples to see whether households which are poorer or more dependent on agriculture exhibit greater son preference than households which are richer and more diversified. This comparative analysis should provide some insights into what are the key determinants of son preference in China.

We begin by exploiting the fact that we have comparable household expenditure data for urban Sichuan.[28] As these households are richer, more educated and have access to a greater array of social services they may be characterised as being less constrained in terms of the choices they make regarding the intrahousehold allocation of health and education expenditures. Economic factors would thus enter with less force in the expenditure decisions of these households, however, if biases are driven by purely cultural factors then we would expect the discrimination results identified in rural Sichuan to carry over to the urban setting.

In Table 11 we report F tests of the equality of γ coefficients for both health and education goods and services for the urban Sichuan sample.[29] To facilitate comparison these are presented alongside the results for rural samples drawn from Tables 2-4 (see top panel). As regards both health goods and services we could find no evidence of a pro-boy bias at classical significance levels. These results complement the rural Jiangsu results in suggesting that higher incomes lead to an erosion of son preference which is still prevalent in poor rural regions. They are also in line with census data which show that mortality and enrollment gender gaps are of a much lower magnitude in urban China indicating a more equitable treatment of the sexes. Taken together the results indicate that economic factors do affect parental allocation decisions so that we observe that son preference varies across China, being most pronounced in poor, backward, rural areas.

To investigate this theme further we rank households from all three samples according to equivalised consumption expenditure where equivalence scales are derived using the calorie Engel method (see Burgess, 1997). The full sample is then split into two equal sized samples depending on whether households are above or below the median consumption value. Separate health and education Engel regressions are

[28] For a full description of the urban data see Burgess, Zhu and Yun (1996). Regression results for urban Sichuan have been omitted to avoid clutter. An urban household data set is not available for Jiangsu.

[29] In common with the rural samples, we could find no evidence of a pro-boy bias in spending on food and calories.

then run on each of the sub-samples and F tests are constructed to examine whether γ coefficients for male and female children differ.[30] Results are shown in the bottom panels of Table 11. To aid comparison, full sample results are presented in the top panels of these tables.

Split sample results suggest that the pro-boy bias in health good spending in rural Sichuan is more pronounced for poorer households. The difference between the γ coefficients in the $0-4$ age group remains significant for the poor sub-group but is insignificant for the rich sub-group. This suggests that gender biases in health spending amongst poor households is driving the overall finding of a pro-boy bias in health spending for the $0-4$ age group. Rural Jiangsu and urban Sichuan results remain insignificant in the split samples. Again this is in line with what we observe in census data where mortality patterns are closer to what we would expect to see in unconstrained populations where there is no tradition of treating the sexes unequally (see Table 9). Taking the (i) rich rural versus poor rural, (ii) rural versus urban and (iii) split sample results together, we have a strong indication that income growth leads to an erosion of son preference in health spending.

Education results for samples split by equivalised consumption expenditure show a similar pattern. For education goods, both discrimination results detected in the overall rural samples ($10-14$ age group in Sichuan and $15-19$ in Jiangsu) show up with greater force in the poor sub-sample whilst there is no evidence of discrimination in the rich sub-sample. For urban Sichuan there is no evidence of discrimination in either of the split samples. How rich parents are would seem to affect the degree to which they favour boys in spending on goods associated with secondary and tertiary education. For education services, the evidence of a pro-boy bias in spending on tertiary education for the $15-19$ group, detected for both provinces in the overall sample, carries over to the poor sub-group. This type of discrimination disappears for the rich sub-group in Jiangsu but not for Sichuan where a clear pro-boy bias remains. There is evidence of such a bias in the urban Sichuan sub-samples. This is consistent with son preference being more entrenched in rural Sichuan than rural Jiangsu. These different results are consistent with the idea that richer parents exhibit less son preference as regards investments in secondary and tertiary education.

Since the onset of rural reforms in 1978 there has been rapid growth in rural off-farm employment. The pattern of diversification is uneven both within and across Chinese provinces; Jiangsu having experienced a high degree of diversification and Sichuan a relatively low degree of diversification (see Table 1). As diversification simultaneously affects the family budget set and the relative returns of male and female children it is likely to influence parental decisions on the intrahousehold allocation of household resources. To investigate this hypothesis we sort households in the provincial samples by the share of off-farm income[31] in total income, use the

[30] We only examine categories of household expenditure for which we found evidence of discrimination in the full sample results.

[31] Off-farm income includes all income sources except those associated with from farming, forestry,

median diversification value to split household into equal sized low and high diversification sub-samples, and then proceed to test for gender bias within these samples. The results are shown in Table 12. Regarding health spending, the split sample results mirror those for consumption expenditure (Table 11) but are more clear-cut. The only significant evidence of pro-boy bias in spending on health goods is found amongst households with low levels of diversification. This would suggest that households which have a strong dependence on agriculture value male children more than female children. This result may partly be driven by differential returns to male and female children being higher on-farm than off-farm.

For education goods, diversification also affects the strength of son preference. Only the less diversified subset of households exhibit pro-boy biases, strongly for the $10-14$ age group in Sichuan and weakly for the $15-19$ age group in Jiangsu. All F tests for the more diversified subset of households are insignificant. Diversification would therefore appear to erode this form of discrimination. For education services the impact of diversification is more complex. Pro-boy discrimination detected in the full sample for $15-19$ group in Sichuan appears to be more pronounced for households with higher levels of diversification reflecting both a pro-boy bias and the fact it is mainly these households that engage in tertiary education. Less diversified households in Sichuan, however, also exhibit a pro-boy bias in investments in secondary education services which was not apparent in the full sample $(10-14)$. Son preference as regards expenditure on education services thus appears to occur at an earlier stage for households which are more dependent on agriculture. For rural Jiangsu we find only suggestive evidence of gender bias for less diversified households whereas more diversified households exhibits no signs of son preference in spending on education services.[32]

6 Conclusions

The tradition of son preference is widespread in South and East Asia and is manifested in excess female mortality during early life, imbalanced sex ratios and large gender gaps in education. This paper has matched Chinese household and census data for 1990 to better understand the determinants of son preference. This has enabled us to convincingly show that biases in household spending on health and education correspond to observed biases in age specific mortality and enrollment. Gender biases in spending within particular age groups seem to correspond fairly exactly to gender biases in outcomes in the same age groups. This would suggest that gender biases in the intrahousehold allocation of resources at least partly underlie observed differences in outcomes.

animal husbandry and fishing.

[32] The F test for the $15-19$ age group is on the margin of significance (at the 5% level) in the less diversified sub-sample but is clearly insignificant for the more diversified one.

Comparisons within and across rural and urban samples confirm that gender biases in health and education spending occur predominately in poor, rural households which are highly dependent on agriculture. We have generated a convincing body of evidence that shows that economic factors do affect preference for sons. Public policy, to the extent that it can affect such factors as economic growth, off-farm diversification and urbanisation can therefore have a role in counteracting gender biases in household spending in key areas such as health and education. As treatment of female and male children within the household become more equitable as the result of improving economic conditions we would expect gender gaps in mortality and enrollment rates to narrow. Son preference therefore, should not be treated as an immutable social norm or tradition. Modernisation does appear to have the power to reduce the gap between female and male outcomes by changing the manner in which parents allocate health and education resources within the household. Understanding which specific policies lead to more equal treatment of the sexes within households is the challenge that must now be taken up.

The comparison of the health results for rural Sichuan and Jiangsu also raises the pressing issue of what to do about ultrasound and other procedures for expressing son preference prior to birth. Though illegal, there is strong evidence from this and other studies that use of these methods are widespread, particularly in richer rural areas. The Chinese authorities are introducing stricter regulations in an attempt to prevent this form of pre-birth discrimination. While such policy measures are essential, comparison of the Sichuan and Jiangsu results does raise the worrying possibility that banning pre-birth discrimination might lead to higher mortality rates for surviving girls. That is son preference might be expressed at the child as opposed to foetal stage.

Our study is also important methodologically as it suggests that indirect Engel methods do have the power for picking up gender biases in intrahousehold allocation. This is meaningful as attempts to pick up gender biases in household spending using these methods have been largely unsuccessful despite some of the tests being carried in data from countries where census data is strongly indicative of son preference. As regards Rothbarth methods, our results, in common with the majority in the literature, have failed to pick up any clear signs of gender bias which points to the strength of the assumptions underlying these tests.

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Table 1: Summary Statistics of Basic Variables

Variable	Rural Sichuan	Rural Jiangsu
Log total expenditure	7.6762 (0.446)	8.0397 (0.562)
Log household size	1.4205 (0.327)	1.3651 (0.350)
Budget share of food	64.2685 (11.130)	55.7166 (15.033)
Budget share of calories	4.7446 (1.271)	3.4953 (1.643)
Budget share of health goods	2.0895 (2.997)	1.6069 (3.234)
Budget share of health services	0.4242 (1.155)	0.7926 (2.898)
Budget share of education goods	0.9659 (1.416)	0.5197 (1.211)
Budget share of education services	2.0894 (2.997)	1.6069 (3.274)
Budget share of cigarettes	2.1403 (1.983)	3.6797 (3.455)
Budget share of alcohol	2.2259 (1.770)	2.0970 (1.987)
Budget share of tea	0.1815 (0.427)	0.1156 (0.3166)
Share of males aged 0-4	0.0353 (0.089)	0.0321 (0.086)
Share of females aged 0-4	0.0305 (0.085)	0.0274 (0.082)
Share of males aged 5-9	0.0367 (0.095)	0.0391 (0.100)
Share of females aged 5-9	0.0334 (0.091)	0.0302 (0.087)
Share of males aged 10-14	0.0530 (0.105)	0.0443 (0.103)
Share of females aged 10-14	0.0466 (0.101)	0.0383 (0.095)
Share of males aged 15-19	0.0848 (0.135)	0.0609 (0.120)
Share of females aged 15-19	0.0752 (0.124)	0.0481 (0.103)
Share of males aged 20-29	0.0780 (0.129)	0.0906 (0.140)
Share of females aged 20-29	0.0727 (0.121)	0.0838 (0.129)
Share of males aged 30-54	0.1756 (0.134)	0.1971 (0.145)
Share of females aged 30-54	0.1703 (0.120)	0.1848 (0.128)
Share of males aged 55 and over	0.0557 (0.122)	0.0579 (0.134)
Share of females aged 55 and over	0.0519 (0.111)	0.0646 (0.136)
Education level of household head	2.1563 (0.798)	2.4106 (0.943)
Share of off-farm income	0.1664 (0.215)	0.3076 (0.297)
Dummy for minority household	0.0576 (0.233)	0.0059 (0.077)

Note: Budget shares are expressed in percentages.

Table 2: Food and Calorie Engel Curves, 1990

	Food		Calories	
	Sichuan	Jiangsu	Sichuan	Jiangsu
Constant	194.216 (667.4)	210.072 (56.9)	21.270 (82.898)	17.947 (58.199)
ln(*x*)	-18.858 (-52.482)	-20.33 (49.978)	-2.474 (-77.260)	-2.007 (-58.835)
ln(*n*)	14.307 (30.365)	13.262 (19.430)	2.061 (49.232)	1.673 (29.045)
M0-4p	-11.919 (-6.337)	-18.104 (6.684)	-1.338 (-7.987)	-1.056 (-4.344)
F0-4p	-10.825 (-5.706)	-15.456 (5.655)	-1.059 (-6.264)	-1.376 (-5.693)
M5-9p	-15.965 (-8.407)	-18.135 (-6.687)	-0.862 (-5.096)	-0.724 (-2.991)
F5-9p	-12.986 (-6.797)	-19.923 (-6.944)	-0.797 (-4.681)	-1.001 (-3.891)
M10-14p	-13.269 (-7.279)	-20.300 (-7.392)	-0.518 (-3.189)	-0.671 (-2.927)
F10-14p	-15.334 (-8.430)	-17.558 (-6.512)	-0.707 (-4.361)	-0.363 (-2.745)
M15-19p	-6.856 (-4.142)	-15.010 (-6.384)	-0.264 (-1.791)	-0.544 (-2.562)
F15-19p	-4.727 (-2.843)	-11.919 (-4.609)	-0.314 (-2.118)	-0.282 (-1.381)
M20-29p	-7.252 (-4.760)	-10.229 (-4.584)	-0.212 (-1.562)	-0.427 (-2.097)
F20-29p	-3.314 (-2.446)	-6.418 (-3.120)	-0.177 (-1.467)	-0.271 (-1.578)
M30-54p	-7.146 (-4.381)	-10.858 (-4.417)	-0.321 (-2.211)	-0.133 (-0.639)
M55+p	-1.873 (-1.174)	-3.801 (-1.690)	-0.192 (-1.350)	0.187 (0.635)
F55+p	-1.173 (-0.849)	-6.887 (-3.579)	-0.127 (-1.032)	-0.373 (-2.654)
EDU	-0.255 (-2.318)	0.078 (0.393)	-0.063 (-4.622)	-1.949 (-1.949)
OFF	-2.984 (-5.218)	-5.138 (-6.398)	-0.742 (-14.558)	-5.006 (-5.006)
MIN	3.163 (3.316)	-1.295 (-0.522)	0.630 (7.419)	-0.196 (-0.196)
Adj R^2	0.461	0.567	0.672	0.747
Mean w_i	64.268	55.709	4.744	3.494
F tests:				
0-4	0.36	0.77	3.77	1.76
5-9	3.12	0.37	0.04	1.32
10-14	1.90	1.10	2.05	0.15

Note: t-statistics in parentheses.

Table 3: Health Engel Curves, 1990

	Health goods		Health services	
	Sichuan	Jiangsu	Sichuan	Jiangsu
Constant	-1.108 (1.025)	0.409 (0.339)	-1.885 (-4.691)	-2.072 (-1.959)
ln(*x*)	0.483 (3.774)	0.300 (2.211)	0.323 (6.434)	0.306 (2.570)
ln(*n*)	-0.481 (-2.865)	-0.421 (1.884)	-0.181(-2.752)	0.174 (0.888)
M0-4p	2.002 (2.989)	2.710 (3.059)	0.552 (2.104)	2.120 (2.730)
F0-4p	0.419 (0.621)	3.730 (4.172)	0.559 (2.111)	1.646 (2.100)
M5-9p	0.709 (1.049)	1.702 (1.901)	0.287 (1.083)	0.239 (0.304)
F5-9p	0.325 (0.477)	-1.125 (1.198)	-0.240 (-0.902)	1.433 (1.741)
M10-14p	-0.729 (-1.123)	0.558 (0.621)	-0.020 (-0.079)	1.774 (2.254)
F10-14p	-0.959 (-1.481)	0.863 (0.971)	-0.240 (-0.944)	0.816 (1.048)
M15-19p	-1.077 (-1.827)	-0.096 (-0.118)	-0.062 (-0.267)	0.383 (0.532)
F15-19p	-0.413 (-0.697)	0.761 (0.900)	0.029 (0.232)	0.253 (0.341)
M20-29p	-1.282 (-2.363)	-0.379 (-0.519)	-0.022(-0.102)	0.147 (0.230)
F20-29p	0.363 (0.635)	1.045 (1.551)	0.369 (1.953)	0.216 (0.365)
M30-54p	-0.006 (-0.010)	0.391 (0.481)	0.412 (1.810)	0.298 (0.418)
M55+p	0.740 (1.302)	-0.390 (0.514)	0.496 (2.228)	0.567 (0.852)
F55+p	1.233 (2.506)	0.499 (0.793)	0.345 (1.787)	0.529 (0.959)
EDU	0.056 (1.030)	-0.145 (-2.213)	-0.021(-0.986)	-0.089 (-1.553)
OFF	0.223 (1.094)	-0.170 (-0.649)	-0.053(-0.663)	0.117 (0.506)
MIN	-1.252 (-3.686)	-1.347 (-1.660)	-0.342(-2.566)	-1.089 (-1.531)
Adj R^2	0.058	0.026	0.026	0.045
Mean w_i	2.089	1.609	0.424	0.793
F tests:				
0-4	6.07	1.00	0.00	0.33
5-9	0.41	0.43	0.04	2.48
10-14	0.19	0.17	1.10	1.78

Note: t-statistics in parentheses.

Table 4: Education Engel Curves, 1990

	Education goods		Education service	
	Sichuan	Jiangsu	Sichuan	Jiangsu
Constant	0.574 (1.3413)	1.734 (4.233)	-0.232 (-0.239)	2.693 (3.031)
ln(*x*)	-0.108 (-2.020)	-0.238 (-5.162)	0,083 (0.686)	-0.318 (-3.182)
ln(*n*)	0.296 (4.222)	0.282 (3.715)	0.323 (2.034)	0.633 (3.844)
M0-4p	-0.605 (-2.162)	-0.021 (-0.071)	-2.145 (-3.385)	-1.293 (-1.983)
F0-4p	-0.562 (-1.992)	-0.344 (-1.134)	-1.696 (-2.654)	-0.722 (-1.097)
M5-9p	2.310 (8.179)	0.900 (2.961)	2.706 (4.231)	2.813 (4.266)
F5-9p	2.294 (8.073)	1.292 (4.056)	3.450 (5.362)	2.962 (4.287)
M10-14p	3.844 (14.181)	2.628 (8.623)	5.565 (9.065)	5.906 (8.936)
F10-14p	3.411 (12.612)	2.859 (9.474)	5.125 (8.367)	5.299 (8.098)
M15-19p	0.770 (3.127)	1.229 (4.413)	1.933 (3.468)	3.292 (5.451)
F15-19p	0.578 (2.339)	0.630 (2.193)	0.361 (0.644)	2.192 (3.521)
M20-29p	-0.758 (-3.346)	-0.208 (-0.837)	-2.297 (-4.476)	-1.397 (-2.599)
F20-29p	-0.515 (-2.553)	-0.339 (-1.483)	-0.531 (-1.163)	-0.872 (-1.757)
M30-54p	-0.362 (-1.494)	-0.125 (-0.452)	-0.950 (-1.730)	-1.236 (-2.067)
M55+p	-0.446 (-1.881)	-0.193 (-0.748)	-1.334 (-2.501)	-0.507 (0.907)
F55+p	-0.366 (-1.778)	-0.059 (-0.275)	-1.184 (-2.544)	-0.789 (-1.702)
EDU	0.419 (6.552)	0.044 (1.992)	0.218 (4.243)	0.168 (3.495)
OFF	0.267 (3.138)	-0.196 (-2.201)	0.304 (1.580)	-0.561 (-2.899)
MIN	-0.201 (-1.415)	-0.045 (-0.162)	-0.230 (0.717)	0.451 (0.754)
Adj R^2	0.264	0.179	0.180	0.231
Mean w_i	0.966	0.521	1.821	1.403
F tests:				
0-4	0.03	1.02	0.55	0.53
5-9	0.00	1.54	1.71	0.04
10-14	3.78	0.62	0.76	1.04
15-19	1.16	6.07	15.33	4.74

Note: t-statistics in parentheses.

Table 5: Alcohol, Tobacco and Tea Engel Curves, 1990

	Alcohol		Tobacco		Tea	
	Sichuan	Jiangsu	Sichuan	Jiangsu	Sichuan	Jiangsu
Constant	-0.795 (-1.404)	5.087 (7.388)	-6.097 (-9.409)	0.599 (0.509)	-0.335 (-3.136)	0.390 (3.761)
ln(x)	0.365 (5.192)	-0.269 (-3.492)	0.957 (11.893)	0.197 (1.500)	0.064 (4.822)	-0.012 (-1.027)
ln(n)	-0.266 (-2.873)	-0.159 (-1.257)	-0.912 (-8.602)	-0.574 (-2.659)	-0.051 (-2.923)	-0.007 (-0.370)
M0-4p	-0.303 (-0.827)	0.239 (0.484)	1.678 (3.994)	3.000 (3.552)	-0.187 (-2.708)	-0.029 (-0.394)
F0-4p	-0.504 (-1.359)	0.129 (0.256)	2.083 (4.903)	2.256 (2.625)	-0.190 (-2.711)	-0.102 (-1.345)
M5-9p	-0.587 (-1.576)	0.524 (1.042)	1.022 (2.399)	1.800 (2.095)	-0.212 (-3.023)	-0.038 (-0.501)
F5-9p	-0.319 (-0.851)	-0.429 (-811)	1.277 (2.978)	1.624 (1.796)	-0.189 (-2.669)	-0.158 (-1.977)
M10-14p	-0.880 (-2.454)	-0.138 (-0.271)	0.272 (0.662)	0.973 (1.120)	-0.253 (-3.742)	-0.002 (-0.019)
F10-14p	-0.406 (-1.135)	0.412 (0.819)	0.571 (1.396)	1.738 (2.021)	-0.217 (-3.218)	-0.026 (-0.343)
M15-19p	-0.390 (-1.200)	-0.257 (-0.554)	0.357 (0.959)	1.170 (1.475)	-0.177 (-2.890)	-0.014 (-0.205)
F15-19p	-0.694 (-2.123)	-0.398 (-0.832)	0.009 (0.023)	0.564 (0.689)	-0.156 (-2.533)	-0.049 (-0.676)
M20-29p	0.909 (3.036)	0.880 (2.126)	1.945 (5.672)	2.728 (3.859)	-0.169 (-2.990)	0.033 (0.529)
F20-29p	-0.139 (-0.521)	0.401 (1.053)	0.744 (2.437)	0.568 (0.874)	-0.146 (-2.904)	-0.065 (-1.137)
M30-54p	0.834 (2.604)	1.230 (2.684)	1.882 (5.132)	5.246 (6.701)	-0.137 (2.263)	0.0481 (0.694)
M55+p	1.436 (4.585)	1.645 3.848)	0.930 (2.593)	2.701 (3.699)	-0.122 (-2.060)	0.052 (0.805)
F55+p	0.424 (1.562)	0.039 (0.109)	0.603 (1.939)	0.747 (1.228)	-0.068 (-1.327	-0.027 (-0.506)
EDU	-0.015 (-0.476)	-0.105 (-2.955)	0.092 (2.548)	0.009 (0.143)	0.009 (1.509)	0.006 (1.040)
OFF	0.177 (1.564)	0.330 (2.412)	0.844 (6.504)	0.959 (4.099)	0.067 (3.142)	0.067 (3.247)
MIN	2.166 (11.548)	0.462 (0.408)	0.086 (0.399)	0.355 (0.449)	0.177 (5.010)	-0.020 (-0.294)
Adj R^2	0.177	0.143	0.141	0.171	0.496	0.234
w_i	2.226	2.100	2.140	3.679	0.182	0.116

Note: t-statistics in parentheses.

Table 6: Outlay Equivalent Ratios

	0-4		5-9		10-14	
	Male	Female	Male	Female	Male	Female
SICHUAN						
Alcohol	-0.2546	-0.3321*	-0.3646*	-0.2611	-0.4773*	-0.2941
	(-1.314)	(-1.697)	(-1.821)	(-1.304)	(-2.474)	(-1.527)
Tobacco	-0.0475	0.0835	-0.2572	-0.1750	-0.5038*	-0.4067*
	(-0.256)	(0.446)	(-1.337)	(-0.910)	(-2.716)	(-2.194)
Tea	-0.4600	-0.4629	-0.5464	-0.4493	-0.7089*	-0.5636
	(-1.177)	(-1.173)	(-1.353)	(-1.113)	(-1.821)	(-1.451)
JIANGSU						
Alcohol	-0.1678	-0.2469	-0.0857	-0.5507	-0.3633	-0.0668
	(-0.456)	(-0.666)	(-0.224)	(-1.401)	(-0.940)	(-0.177)
Tobacco	0.1016	-0.0938	-0.2283	-0.2540	-0.3998	-0.2069
	(0.340)	(-0.312)	(-0.734)	(-0.797)	(-1.285)	(-0.675)
Tea	-0.3207	-1.0185	-0.3879	-1.6179	-0.0902	-0.2765
	(-0.322)	(-1.007)	(-0.375)	(-1.502)	(-0.089)	(-0.272)

Notes: * Significant at 10% level or less. Asymptotic t-statistics in parentheses.

Table 7: Testing for the Equality of Coefficients of Different Adult Goods (χ^2)

	0-4		5-9		10-14	
	Male	Female	Male	Female	Male	Female
SICHUAN	2.838	4.825	5.313	2.905	12.728	7.127
JIANGSU	0.557	1.358	0.610	3.979	2.075	0.485

Table 8: F-Tests for the Equality of Gender Coefficients

	Alcohol		Tobacco		Tea	
	Sichuan	Jiangsu	Sichuan	Jiangsu	Sichuan	Jiangsu
0-4	0.321	0.072	0.996	0.661	0.001	0.766
5-9	0.653	3.018	0.449	0.014	0.144	2.907
10-14	2.606	1.406	0.788	0.961	0.408	0.075

Table 9: Mortality and Sex Ratio Information for 1990 Census

Age		RURAL SICHUAN Mortality rate (per 1000) Male	RURAL SICHUAN Mortality rate (per 1000) Female	RURAL SICHUAN Sex ratio	URBAN SICHUAN Mortality rate (per 1000) Male	URBAN SICHUAN Mortality rate (per 1000) Female	URBAN SICHUAN Sex ratio	RURAL JIANGSU Mortality rate (per 1000) Male	RURAL JIANGSU Mortality rate (per 1000) Female	RURAL JIANGSU Sex ratio	URBAN JIANGSU Mortality rate (per 1000) Male	URBAN JIANGSU Mortality rate (per 1000) Female	URBAN JIANGSU Sex ratio
At birth	Reverse method			111.9			110.2			115.5			112.2
	Actual reported			115.8			110.2			120.8			116.0
0		25.1	30.0	112.6	29.2	27.8	107.7	15.3	15.5	115.5	12.9	12.6	112.1
1		4.3	5.5	113.7	3.6	3.6	107.2	3.1	2.8	113.7	1.8	2.0	110.8
2		2.7	3.2	111.3	2.6	2.5	105.8	2.5	2.1	111.3	1.6	1.3	108.8
3		1.5	1.7	111.5	1.4	1.5	106.5	1.4	1.3	110.0	1.0	0.8	106.8
4		1.0	1.0	110.4	0.9	0.9	106.2	1.1	0.9	109.3	0.8	0.9	106.8
0-4		10.3	11.8	111.8	7.0	6.7	106.6	5.1	4.8	112.1	3.8	3.6	109.1
5-9		1.2	1.0	109.4	0.9	0.5	106.4	0.7	0.5	108.3	0.6	0.4	106.0
10-14		1.0	0.7	106.4	0.8	0.5	105.4	0.4	0.4	106.6	0.4	0.3	106.8
15-19		1.3	1.1	104.3	1.1	0.7	107.3	0.8	0.8	103.8	0.5	0.4	112.8
Total		7.4	7.2	106.6	8.5	7.5	108.7	6.8	5.9	102.2	5.2	4.8	109.5

Notes: (1) The mortality rate is the number of deaths at each sex-age group between 1st July 1989 and 31st June 1990 per 1000 surviving children at the same sex-age group on 31st June 1990. (2) The sex ratio at birth is the number of male births between 1st July 1989 and 31st June 1990 per 100 female births during the same period. (3) The sex ratio at other age groups is the number of surviving males on 31st June 1990 per 100 surviving females on the same day. Sources: Sichuan 1990 Census, pp.1316-1317, pp.2812-2815, pp.2836-2840, pp.2861-2863, pp.3240-3241; Jiangsu 1990 Census, pp.470-497, pp.1453-1615, pp.1788-1829.

Table 10: School Enrolment Information for 1990 Census

	RURAL SICHUAN		URBAN SICHUAN		RURAL JIANGSU		URBAN JIANGSU	
Age	Enrolment (per 100 of same sex)		Enrolment (per 100 of same sex)		Enrolment (per 100 of same sex)		Enrolment (per 100 of same sex)	
	Male	Female	Male	Female	Male	Female	Male	Female
6-9	80.1	76.6	79.8	79.8	89.6	87.1	84.7	84.6
10-14	83.1	73.2	89.3	86.9	95.3	88.9	96.9	96.1
15-19	25.7	16.1	38.2	33.9	35.0	22.0	55.4	48.4

Sources: Sichuan 1990 Census, p.1316, p.1394, pp.1535-1537; Jiangsu 1990 Census, pp.470-497, and pp.508-581.

Table 11: F-tests for the Equality of Gender Coefficients: Equivalised Consumption Expenditure Breakdown

	Health Goods			Health Services			Education goods			Education services		
	Urban Sichuan	Rural Sichuan	Rural Jiangsu	Urban Sichuan	Rural Sichuan	Rural Jiangsu	Urban Sichuan	Rural Sichuan	Rural Jiangsu	Urban Sichuan	Rural Sichuan	Rural Jiangsu
Overall sample												
0-4	0.30	6.07	1.00	0.39	0.00	0.33	0.71	0.03	1.02	0.04	0.55	0.53
5-9	0.01	0.41	0.43	0.33	0.04	2.48	0.38	0.00	1.54	0.18	1.71	0.04
10-14	0.00	0.19	0.17	0.00	1.10	1.78	0.03	3.78	0.62	0.12	0.76	1.04
15-19	-	-	-	-	-	-	0.42	1.16	6.07	1.77	15.33	4.74
Bottom ½ sample												
0-4	0.04	4.37	0.32	2.18	2.04	0.27	0.82	0.10	0.59	0.47	1.37	0.05
5-9	2.74	0.03	0.01	1.64	0.20	2.10	0.53	1.12	2.60	0.01	0.13	0.24
10-14	0.16	0.19	0.03	0.61	0.34	0.00	0.35	16.31	0.36	0.02	3.52	0.52
15-19	-	-	-	-	-	-	0.55	0.02	7.91	9.12*	4.02	4.91
Top ½ sample												
0-4	0.08	2.64	3.05	0.20	1.01	0.06	0.00	0.02	1.25	0.51	0.03	0.13
5-9	2.34	0.81	0.12	0.32	0.00	1.12	0.14	0.84	0.00	0.00	1.13	1.00
10-14	0.00	0.44	0.71	0.69	0.65	2.22	0.70	1.40	0.18	0.00	0.23	0.72
15-19	-	-	-	-	-	-	0.10	1.44	0.69	5.20	6.82	0.96

Notes: * indicates pro-girl bias.

Table 12: F-tests for the Equality of Gender Coefficients: Degree of Diversification Breakdown

	Health Goods		Health Services		Educational Goods		Educational Services	
	Rural Sichuan	Rural Jiangsu	Rural Sichuan	Rural Jiangsu	Rural Sichuan	Rural Jiangsu	Rural Sichuan	Rural Jiangsu
Overall sample								
0-4	6.07	1.00	0.00	0.33	0.03	1.02	0.55	0.53
5-9	0.41	0.43	0.04	2.48	0.00	1.54	1.71	0.04
10-14	0.19	0.17	1.10	1.78	3.78	0.62	0.76	1.04
15-19	-	-	-	-	1.16	6.07	15.33	4.74
Bottom ½ sample								
0-4	6.57	1.54	1.05	0.60	0.16	0.55	0.07	0.90
5-9	0.62	0.12	0.04	1.75	0.00	0.58	0.76	0.00
10-14	0.32	0.83	1.99	3.76	10.81	0.21	6.34	0.08
15-19	-	-	-	-	0.99	3.53	1.73	1.91
Top ½ sample								
0-4	0.76	0.03	0.99	1.72	0.11	0.64	0.40	0.06
5-9	0.21	0.40	0.28	0.72	0.00	0.71	1.16	0.08
10-14	0.02	2.83	0.01	0.00	0.22	0.64	0.97	1.09
15-19	-	-	-	-	0.15	1.46	13.02	1.62