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Counting Women's Labor: A Reanalysis of Children's Net Production in Mead Cain's Bangladeshi Village

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Abstract

Due to the inherent difficulties in valuing women's and children's labor in pre-industrial economies, their time inputs are frequently excluded from analyses of net production. This additionally leads to underestimation of consumption costs, which do not reflect the value of time inputs. As a result, not only is the net production of females understated, but that of men is overstated. Here we use Mead Cain's seminal (1977) study of children's economic contributions in a Bangladeshi village to illustrate these points. We combine Cain's data on female hours of work with unusual data on the productivity of males and females by age in a variety of agricultural and domestic tasks, from a Maya village practicing extensive subsistence agriculture. Incorporating the value of female labor raises the estimated age at which boys produce as much daily as they consume by three years, from 9 to 12 (crossover age), and raises the age at which their cumulative production equals their cumulative consumption to between 30 and 50 (breakeven age). Girls crossover 1.5 years earlier, at 11.5, and breakeven substantially earlier, in their mid-20s. On average, children's net cost to their parents up to their age at marriage is three years of adult consumption for both boys and girls. When female labor is taken into account, the Bangladeshi children in Cain's (1977) analysis are found to be expensive to their parents, although their economic contributions offset much of their cost. We believe these methods could be usefully applied in other contexts.

Introduction

Assigning value to the economic contributions of women and children in pre-industrial economies is difficult because much of their labor takes place outside of labor markets and does not produce a readily quantified output. Conversely, the labor of men, even when it is outside the market, often generates observable output that can be measured, for example by its caloric content. Thus anthropologists may measure age- and sex-specific production by "calorie counting." This technique, however, understates the contributions of women through meal preparation, fetching water, and other important domestic tasks.

Often we seek to estimate net production, in which case we must somehow value consumption as well as production. If women's work preparing a meal is a valuable activity, then this value must be included as part of the value of the meal when it is consumed. Taking account of women's economic production also means raising the estimated value of men's consumption while leaving their production largely unchanged, thereby reducing men's measured net economic contributions.

Mead Cain's (1977) seminal study of the economic value of children in the Bangladeshi village of Char Gopalpur illustrates the traditional calorie counting approach. He used his time use data to calculate the caloric contributions of males by age, which he then balanced against their imputed caloric consumption to derive his main results. Females entered the calculation only as consumers. He concluded that boys' production first exceeded their consumption on a daily basis at age 12, and on a cumulative life time basis at age 15 (breakeven age), and made up for a non-productive sister's cumulative consumption by age 22.

Cain's pioneering study both established a methodology for studying economic production in a non-market economy, and made an important contribution to the literature on

Caldwell's (1976) wealth flows theory of the fertility transition. Cain's conclusion that children in this Bangladesh village were economically valuable to their parents provided empirical support for Caldwell's wealth flows theory, which posits that in traditional societies, wealth flows upwards from children to parents, making high fertility economically rational.

Other work, however (Kaplan 1994; Kramer 1998, 2005; Lee 1994, 2000; Lee and Kramer 2002; Mueller 1976; Stecklov 1999), has found that in pre-industrial settings children are *expensive* to their parents. For the most part, these studies have used methods that are conceptually similar to Cain's, but reach alternate conclusions by using differing estimates of production or consumption by age. Although children may make substantial economic contributions, these only partially offset their cumulative consumption costs. Cain (1982) himself found that children are costly when applying his methods to data from other Asian countries. Specifically, Cain (1982, p. 164) noted that including female production in his Bangladeshi case would significantly increase breakeven ages such that children would be unlikely to compensate for their cumulative consumption by their age of leaving home.

In this paper we take a different tack, and question the conceptual basis for Cain's accounting. Our purpose is not to criticize Cain's seminal contribution, but rather to build on it in new ways. Specifically, we ask what happens if the economic contributions of females are taken into account using Cain's own time-use data, both as production and as a component of consumption. Were the children of Char Gopalpur really as economically beneficial to their parents as Cain suggested?

Although Cain only calculated the productive value of male work, he presented age-specific time-use data for both males and females. In this paper, we draw on estimates by Karen Kramer (2005) of the relative productivity of male and female labor at different ages in a Maya village practicing extensive subsistence agriculture in Yucatan, Mexico. We use these productivity estimates to assign value to the work time of females and males at different ages in Char Gopalpar. These new estimates of total production, including women's household production, allow us to form new estimates of consumption and therefore of net production by age. These results give us a fresh look at the contributions of women and children in the Banglaeshi setting, and provide a different estimate of wealth flows based on this classic study. The methods we describe should be more generally applicable.

Data

As discussed in the introduction, in order to assess the balance of production and consumption in any setting, researchers must first measure their respective values. This measurement task is complicated by the fact that often neither production nor consumption can be directly observed, and even simply tallying the hours spent by each individual in productive work neglects differences in the rate of return by age and sex. In order to account for these differences, we use productivity "weights" which indicate how productive an individual of a given age and sex is relative to an adult. Multiplying the hours worked by each age-sex group by the appropriate weight expresses output by males and females of different ages in equivalent units. Individuals in traditional societies often eat from a common pot, so we rely on standard tables to estimate how consumption is distributed across the different age-sex groups in the population. The following section describes our measures of production and consumption as well as other factors (population age structure, mortality) that we use in our analysis.

Cain (1977) followed the standard economic approach of using wages to measure productivity. Observed market wages were multiplied times the hours worked by males in agricultural tasks to estimate their production by age. Because women and girls rarely, if ever, engaged in market work, Cain could not assess their productivity. As a result, women's economic contributions, largely in household production, were excluded from the analysis and Cain's count of total production was limited to the food production activities of males. This strategy underestimated the amount produced by villagers, especially by females and younger children, and also the amount they consumed, since the time costs of meal preparation and other home production tasks were ignored. Cain's overall approach, thus, favored his conclusion that boys cumulatively covered their consumption costs by age 15.

In the analysis presented below, we rely on Cain's (1977, p. 216) age-sex specific daily time-use measurements. These data refer to his entire sample, which include all three economic classes discussed in his article, and we use the hours of total work (not just those labeled "productive") in our calculations. Although Cain's (1977) conclusions were based on the productive hours of the landless class, we choose to consider all classes and all hours worked so that our results fully reflect how energy was expended in Char Gopalpur. Instead of using wages to infer productivity, we use data gathered by Kramer (1998) on the actual productivity of Maya males and females in various tasks. We believe that this cross-cultural application of Kramer's productivity weights to the Bangladeshi setting is justified since in both populations, villagers practice subsistence agriculture, individuals perform similar tasks, children begin productive work by age four, daily hours worked increases sharply during the early- to mid-teens, and there is a strong sexual division of labor.[i] As a sensitivity check for these production profiles, we also calculate variations of Kramer's profiles as well as use Mueller's (1976) estimates, based on survey data from India and Egypt. Table 1a gives the production profiles we use.

As in almost all studies, we infer consumption from standard age-sex specific caloric-need tables. Our baseline assumption refers specifically to Bangladeshi caloric needs in the

1970s (Chen 1975) and is the same source Cain (1977) used. For sensitivity testing, we employ various profiles from Kramer (2005), Mueller (1976), and estimates of contemporary American energy requirements (HHS and USDA 2005). Table 1b shows these consumption profiles.

We assume that total household production is allocated to household members for consumption in proportion to caloric needs, and that total production equals total consumption. Consequently, the average age profiles of production and consumption should yield equal totals when multiplied by the population age distribution of the village and summed. Because Cain did not report the full age-sex structure of the population of Char Gopalpur, we use the national age distribution reported in the 1974 Bangladeshi census (US Census Bureau 2005). Our fragmentary information about the age distribution in Char Gopalpur is sufficiently consistent with the national population age distribution that we feel justified in doing so. In particular, Cain (1977, p. 201) reported that almost 50% of the villagers were less than age 15, which agrees well with the 48% reported in the national census.[ii]

Because Cain only provided data on individuals younger than 60, we are forced to limit our analysis to this age range as well. Almost 95% of the 1974 national population of Bangladesh was younger than 60, suggesting that excluding those 60 and older from our analyses should have at most a small effect on our results. If production and consumption of those 60 and over were equal on average, omitting them would have no effect at all. Sensitivity tests show that including adults over age 60 would not qualitatively alter our conclusions, although in some tests adults at very old ages begin to produce less than they consume, which results in a second crossover and breakeven (based on Mueller's 1976 age profiles).

We seek to estimate the expected economic value of children to their parents at their time of birth, so we need to take into account their likelihood of survival to each age. We assume mortality follows the Coale Demeny model west female life table with e_0 = 50 (Coale and Demeny 1966), which is approximately the national level reported for Bangladesh in the 1970s by the United Nations (2003).[iii] Net production in each age interval is multiplied times life table person-years lived and then summed to calculate the cumulative net value up to each age and to find the breakeven ages. Incorporating survival in the estimates reflects the net contributions of siblings who die before reaching each age. Cain did not incorporate mortality into his analysis, and although its inclusion is justified on theoretical grounds, it does not significantly affect results.

Overall, although our analysis requires slightly more data than Cain's, including population age structure and mortality makes the calculations more realistic without excessively complicating Cain's elegantly simple accounting procedures.

Methods

We convert time spent on food as well as home production into calories so that all production and consumption can be compared in the same units (calories). Although we make our comparisons in units of calories, we refer to our method as a "time-use" approach because it is based fundamentally on the hours worked per day, rather than on the calories produced per day. We then compare production and consumption in calculating our main output measures: crossover age, breakeven age, cost at age of marriage, and proportion of cost at age of marriage paid for by child by that age.

Our calculation of production and consumption involves the following steps, as illustrated in Tables 2a-d for our baseline case using Baseline_P and Baseline_C as the production and consumption profiles, respectively.

1. We multiply hours worked each day (column (A) of Table 2a) by the production profile (column (B)) to get weighted daily work hours by age and sex (column (C)). We then multiply these weighted daily work hours by the population age distribution (column (D)) to arrive at the population-weighted total daily production at each age and sex. We sum output over age and sex to get total, aggregate population-weighted daily production for the village as a whole (5.64 units in this example).
2. We then multiply the age-sex profile of daily individual caloric intake (column (A) of Table 2b) by the population age distribution (column (B)) to find the total amount of daily caloric consumption (column (C)). Total, aggregate population-weighted daily consumption in this example is thus 1712 calories.
3. We use the total, aggregate population-weighted daily production from (1) and the total, aggregate population-weighted daily consumption from (2) to calculate a factor for converting production into units of calories. This factor is the average calories produced by an adult in one hour of work: 1712 / 5.64 = 304 calories.
4. We then multiply *individual* daily production (hours worked times the production profile) by the conversion factor in order to express it in calories and compare it to individual daily consumption (in calories). We use these values to calculate the age at crossover [iv] (Table 2c) and age at breakeven [v] (Table 2d) as well as the cost of raising a surviving child to marrying age.

Of course, even poor people consume more than food, but so long as consumption and production at each age are proportional to consumption and production of food, the measures in which we are interested – crossover and breakeven ages – will not be affected.

The "cost" to marriage age – 16 for females and 26 for males (Cain 1978, p. 423) – is the individual's cumulative production minus cumulative consumption up to that age, expressed in terms of years of average annual adult consumption, divided by the probability of surviving to that age. (Thus this is assessed at age of marriage rather than as an expectation at time of birth.) In the case of our baseline consumption profile (see Table 2b), average annual adult consumption equals [(2476 + 1598) / 2] * 365.35 = 743832 calories. In our baseline example, male net cumulative production calculated at the individual level at the time of marriage (age 26) is –2,061,130 calories, or 2.8 years of adult consumption (2061130 / 743832 = 2.8). We adjust this number to account for the probability of surviving to marrying age by multiplying it by 1 / $l_{\text{age at marriage}}$, which leaves us with a "cost" of 3.7 years.

We also show this cost as the proportion of total consumption "paid" for via cumulative production by individuals by the time of their marriages. Marriage in Char Gopalpur marked adjustments to household living arrangements – young women moved out of their natal household, young men either started their own households or their new wives moved into their natal households (Cain 1977; 1978). Thus the producers and consumers within a given household shifted at the time of a child's marriage. Although these changes affect household accounting in complicated ways (i.e., even though a daughter leaves, a daughter-in-law might appear), given that our framework for this paper is at the individual, and not the household, level, we choose to calculate measures related to cost of children at the age of marriage as if both daughters and sons left their parents' homes at the time of marriage.

The analyses presented below do not include a discount factor to measure the difference in value between present and future consumption because we expect that opportunities for earning interest in rural Bangladesh in the 1970s were limited to nonexistent. However, we did conduct sensitivity tests for discount rates from two to five percent and found that, although applying these does increase the breakeven ages as would be expected, it does so only marginally (by no more than three years for males and by no more than one year for women).

Analysis

We begin by reviewing Cain's (1977) analysis and find that he misinterpreted his data, which actually imply a younger crossover age using his own data and methods than he reported. We then replicate the analysis in Cain (1977), using his production and consumption profiles, looking only at male production but using our method as described above. We then incorporate female production, and estimate crossover and breakeven ages for a variety of production and consumption profiles. The breakeven results we report for profiles other than Cain_P include both male and female production as well as mortality. (See Tables 1a and 1b for variations in production and consumption profiles, respectively.)

For the part of the analysis that includes both male and female production, for each sex, we present tables with the crossover and breakeven ages as well as graphs of net cumulative production by age. On these figures, crossover occurs at the age where the cumulative production curve reaches its minimum value, and breakeven is at the age where the curve crosses the x-axis.[vi] We show the effect on the net cumulative production curves of varying the consumption profile while holding production at its baseline level, and for varying the production profile while holding consumption at its baseline level.

Our analysis attributes value to female work, which makes up 47% of total production in the example using our baseline production and consumption profiles as outlined in Tables 2a and 2b. This 47% produced by females includes activities such as the processing and preparation of food, sewing, child care, and domestic maintenance. In Cain's analysis, males consumed roughly half of what they produced, with the balance consumed by females. In our analysis, males still consume roughly half of the food they produce, but in addition they consume approximately half of female production. In other words, relative to Cain's analysis, males produce the same amount but consume roughly twice as much. This causes their breakeven and crossover ages to occur later than Cain (should have) found. Overall, we find that the interaction of changes in production and consumption resulting from valuing female production indicates that Cain overstated the productivity of children, and reverses his conclusion that boys have positive asset value to their parents.

Comparison to Cain's male-only results

Cain (1977) reported that boys achieved crossover by age 12. However, he appears to have used the top-end of the age interval, rather then the midpoint, to calculate this value. If instead we interpolate across his net cumulative production estimates from the same table (Table 7, p. 222), for which the data refer unambiguously to the endpoint of each age interval, we find that the low point of the interpolated curve in Figure 1 corresponds to a crossover age at 9.1 rather than 12. Breakeven is still at age 15, where the curve crosses the x-axis. Thus it appears that Cain's data and methods actually imply that boys produced as much as they consumed starting three years earlier than he thought.

When we use our methods as described earlier along with the productivity weights and time-use data that Cain (1977) reports in Table 7, but still without including female work, we find that male crossover occurred at age 9.0 years and breakeven took place at 14.6 years. These figures are extremely close to the 9.1 years and 15 years yielded by Cain's method, indicating that our method for calculating crossover and breakeven does not deviate significantly from Cain's. The small differences arise because our assumption that aggregate production must equal aggregate consumption raises the age profile of production somewhat relative to consumption. To illustrate this difference, consider that an adult male in Cain's (1977) analysis produces 4,951 calories in a day's work of 9.6 hours (Table 5, p. 218) of productive work, which means that he produces 516 calories an hour. In our analysis of the same data, an adult male produces slightly more calories (540) an hour, leading to slightly younger crossover and breakeven ages.

Results incorporating both male and female production, with various production profiles

We now turn to our estimates that include both male and female production. Figures 2 and 3 plot cumulative net production by age for males and females, respectively, for baseline consumption and various age-specific production profiles as described in Tables 1a and 1b. Recall that cumulative net production is the sum from birth up to a given age of production minus consumption, weighted for survival. The different production profiles used in these plots all give very similar estimates of the crossover point (the age at which the curve reaches it local minimum), at about 12.5 for males and 11.0 for females. The 12.5 crossover value for males is a good deal higher than the 7.5 obtained from our revision of Cain's own analysis, indicating that including female production significantly changes the results.

Looking at where the curves cross the x-axis in Figure 2, we can see that the baseline male breakeven age is 53.3 (corresponding to Baseline_P), bracketed by age 29.8 (for Mueller_P) to above 59 (using Kramer_P1). Regardless of the scenario, breakeven occurs very much later than Cain's estimate of 15. For females (Figure 3), our baseline breakeven estimate is 23.3, which is bracketed by 23.0 (Kramer_P1) and 27.5 (Mueller_P). Our baseline estimate is far younger for females than males, at 23 versus 53, because females consume so much less than males. (Viewing some of male consumption as an input to their production activities would change the interpretation of these results.) Table 3a summarizes the findings for crossover and breakeven from these different production profiles for both males and females.

We also evaluate cumulative net production up to the average age of marrying, conveniently expressed relative to the total consumption costs up to that age (see Table 3b). This leads us to conclude that males repay about 90% of their consumption costs before marrying at age 26. Girls, who marry much younger, repay only about 70% before they marry at age 16. We can also compare these amounts to the average annual consumption of an adult, which is calculated as the average of male and female adult consumption times 365.25 days in a year. Across all production and consumption profiles, this measure indicates that raising a surviving son to age at marriage costs approximately three years of adult consumption.

Results incorporating both male and female production, with various consumption profiles

Next we calculate exactly the same estimates, except this time we hold production constant at the baseline assumption (Baseline_P) while varying consumption. We get exactly the same baseline estimates of all quantities (using Baseline_C), so we will not discuss these again, but we get a new set of brackets based on variations in the consumption profiles. Because our consumption profiles range more widely than our production profiles, varying consumption profiles produces more disparate crossover and breakeven ages. Crossover and breakeven ages for different consumption profiles are summarized in Table 4a. The male crossover still occurs around 12.5 and cumulative breakeven takes place between ages 36 and over 59 (see Figure 4). We find that males still “owe” their parents the equivalent of about three years of adult consumption when they marry at age 26, having paid for about 90% of their production (Table 4b). Girls, who have relatively higher net production than boys, crossover around 12 and breakeven in their early- to mid-twenties (see Figure 5). They also owe their parents about three years of consumption (roughly 2.5 million calories) when they marry (and move away) at age 16, having only paid for approximately 75% of their consumption (Table 4b).

Conclusion

Valuing the labor of females in the agricultural setting of Char Gopalpur provides a picture of their net economic costs and contributions over the life cycle and alters our pre-existing picture of these measures for males. The consequences of valuing female labor follow not only from acknowledging the worth of their work, but also from raising the estimates of male and female consumption to reflect the value of female labor embodied in it. When this is done, we find that although children in Char Gopalpur were economically productive from a young age, they were still expensive to their parents.

Cain's estimated crossover age for boys should have been 9 rather than 12, whereas his estimated breakeven age of 15 was correct. The benchmark ages for a male-based analysis are 9 and 15. Our specific findings when female labor is valued are as follows:

1) The male crossover age is 12.5, three and a half years older than the male-only benchmark.
2) Males have not produced enough to cover the consumption costs of themselves and their deceased siblings until between 30 and 60+, depending on the particular choice of consumption and production profiles. This is well after they have left home, so they have negative asset value for their parents. Indeed, to raise one surviving son to marriage age costs three years worth of adult consumption. At marriage, males have paid for 90% of their net consumption.
3) The female crossover age is 1.5 years earlier than for males, at around 11 years.

4) The female breakeven age is much younger than for males, between 23 and 28, depending on choice of production and consumption profiles. As with males, it costs about three years of adult consumption to raise a girl to marriage age. At marriage, females have paid for 75% of their net consumption, less than males because of younger marriage.

Were children the economic asset to their parents that Cain suggested? We find that they were not. However, both boys and girls worked, and this work reduced their cost to their parents, suggesting that although Cain's conclusions were overstated, children's labor was valuable to the families of Char Gopalpur.

A number of studies of agricultural and pre-agricultural populations seek to estimate the economic contributions of individuals across their life cycles. We hope to have shown the importance of accounting for female labor in any such enterprise, both in production and in consumption. We believe that the results of omitting female production would be similar in most settings, and that the methods we have developed and applied here could be usefully applied in other contexts.

Endnotes

[i] There are also important differences: the Maya practiced extensive agriculture rather than intensive, the Maya village was isolated from markets, and the Maya women were not Muslim, and therefore did not practice purdah. We believe that the similarities outweigh the differences, however, and thus feel justified applying information on their productivity to the Bangladeshi setting.

[ii] Similarly, a Coale Demeny female, model west life table ($e_0 = 50$) with a total fertility rate (TFR) of 7.3 (the same TFR that Cain noted (1978, p. 423) in the village) indicates that 45% of the males and 44% of the females should be under 15.

[iii] The scant evidence that Cain (1977; 1978) provided on the demographic characteristics of Char Gopalpur (TFR of 7.3, almost 50% of the population less than 15) is consistent with the stable population implied by this model life table.

[iv] For calculating crossover age, we assume that production and consumption estimates for age groups describe behavior at the midpoint of each age interval (between one and six years wide).

[v] For calculating breakeven age, we assume that production and consumption estimates for age groups are achieved at the end of the age interval.

[vi] No significance should be attached to the levels of the cumulated totals, since our total daily production is somewhat arbitrary and these could be calculated either per birth (as we have done) or per child surviving to leave home, for example. It is the shape and crossover point that are of interest, and these are not affected by such issues of scaling.

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Table 1a. Production Profiles

Profile Name	Description
Cain_P	From Cain (1977), Table 7 (p. 232). By age 13, boys are as productive as adults. Values are available only for males.
Baseline_P	Until age 12 boys and girls are weighted roughly the same. Adult females (ages 16+) are weighted at 84% of adult males for heavy/physical tasks (chopping wood, harvesting maize, and hauling water). Percentage is from Kramer (2005).
Kramer_P1	The same as Baseline_P, except women and men age 22 and older are weighted equally.
Kramer_P2	Same as Kramer_P1, except adult females (ages 16+) are weighted at 75% of adult males for heavy/physical tasks (chopping wood, harvesting maize, and hauling water). Percentage is from Mueller (1976).
Kramer_P3	Based on Kramer (2005), separate weights are calculated for housework (making tortillas, hauling water, and cutting firewood) and fieldwork (weeding, harvesting and shelling maize). Weights for females are similar to Baseline_P, and for males are the same as Kramer_P1.
Mueller_P	Based on Mueller (1976), Table 4-8, Column 2 (p. 118). Children are not productive until age 10 (because weights are based on labor force participation rates which are not measured or are extremely low before that age), adult women are 75% as productive as adult men, and productivity declines from age 55 onwards.

Table 1b. Consumption Profiles

Profile Name	Description
Baseline_C	From Chen (1975), used in Cain (1977). Girls and boys consume roughly the same amount until age 9, there is a decrease in consumption among 7-9 year-olds relative to younger and older age groups, and adult women consume massively less than adult men (1598 calories per day compared to 2476).
US_C1	Applies the distribution from the 2005 Estimated Energy Requirements for the US (HHS and USDA 2005) to Baseline_C. We assume all individuals are active and take the midpoint of caloric needs for ages where a range is given. Children's consumption is lower relative to Baseline_C, but there is no decrease in consumption among 7-9 year-olds.
US_C2	Applies the distribution from US_C1 to the total for males from Baseline_C, but assigns total caloric intake for adult women to be 80% of that of adult men.
Kramer_C	From Kramer (1998). Caloric needs are based on observed height, weight, and activity levels of Maya children.
Mueller_C	Uses Mueller's (1976) medium-consumption profile from Table 4-2 (p. 107) and sets adult male consumption at Baseline_C (2476 calories per day).

Table 2a. Example of Steps Taken to Calculate Production (Baseline Data)

Age Group	(A) Daily Work Hours	(B) Production Profile	(A)*(B) = (C) Weighted Daily Work Hours	(D) Age Distribution	(C)*(D) = (E) Total Daily Production
Males					
<1	0.0	0.00	0.00	0.01	0.00
1-3	0.0	0.00	0.00	0.06	0.00
4-6	2.1	0.41	0.85	0.06	0.05
7-9	4.6	0.51	2.34	0.06	0.14
10-12	7.2	0.65	4.69	0.04	0.21
13-15	9.5	0.94	8.89	0.04	0.35
16-21	9.5	0.99	9.42	0.05	0.49
22-59	9.1	1.00	9.10	0.19	1.76
				Sub-Total	2.99
Females					
<1	0.0	0.00	0.00	0.01	0.00
1-3	0.0	0.00	0.00	0.06	0.00
4-6	1.9	0.47	0.89	0.06	0.05
7-9	5.1	0.58	2.98	0.06	0.17
10-12	6.7	0.71	4.79	0.04	0.18
13-15	9.0	0.86	7.74	0.03	0.26
16-21	9.4	0.91	9.00	0.05	0.41
22-59	9.3	0.95	9.30	0.18	1.58
				Sub-Total	2.65
			Total Daily Production (Both Sexes)		5.64

Note: Production profile is Baseline_P. Daily work hours (column (A)) is for individuals and total daily production (column (E)) is per population age group.

Table 2b. Example of Steps Taken to Calculate Consumption (Baseline Data)

Age Group	(A) Daily Consumption	(B) Age Distribution	(A)*(B) = (C) Total Daily Consumption
Males			
<1	1043	0.01	15
1-3	1368	0.06	77
4-6	1368	0.06	79
7-9	1201	0.06	71
10-12	1728	0.04	77
13-15	2158	0.04	84
16-21	2476	0.05	128
22-59	2476	0.19	479
		Sub-Total	1010
Females			
<1	1043	0.01	15
1-3	1344	0.06	76
4-6	1344	0.06	77
7-9	1140	0.06	66
10-12	1399	0.04	52
13-15	1567	0.03	52
16-21	1598	0.05	76
22-59	1598	0.18	287
		Sub-Total	702
Total Daily Consumption (Both Sexes)			1712 calories

Note: Consumption profile is Baseline_C. Daily consumption (column (A)) is per individual, while total daily consumption (column (C)) is per population age group.

Average Calories Produced By an Adult in One Hour: **1712 / 5.64 = 304**

Table 2c. Example of Steps Taken to Calculate Crossover Age

Age Group Midpoint	(A) Daily Work Hours	(B) Production Profile	(A)*(B)*304 Daily Production (Calories)	Daily Consumption
Males				
0.5	0.0	0.00	0	1043
2.5	0.0	0.00	0	1368
5.5	2.1	0.41	259	1368
8.5	4.6	0.51	711	1201
11.5	7.2	0.65	1424	1728
14.5	9.5	0.94	**2699**	**2158**
19	9.5	0.99	2859	2476
22	9.1	1.00	2763	2476
Females				
0.5	0.0	0.00	0	1043
2.5	0.0	0.00	0	1344
5.5	1.9	0.47	269	1344
8.5	5.1	0.58	905	1140
11.5	6.7	0.71	**1453**	**1399**
14.5	9.0	0.86	2350	1567
19	9.4	0.91	2594	1598
22	9.3	0.95	2673	1598

Note: Daily production and consumption values apply to the *middle* of the age range in Tables 2a and 2b. Bolded values indicate the age by which crossover has occurred: 12.6 for males and 10.9 for females. We multiply production by 304, which comes from Tables 2a and 2b, because it is the average number of calories produced by an adult in one hour.

Table 2d. Example of Steps Taken to Calculate Breakeven Age

Age Group End-point	(A) $_nL_x$	(B) Daily Production	(C) Daily Consumption	Σ(A)*(B)*365.25 = (D) Cumulative Production	Σ(A)*(C)*365.25 = (E) Cumulative Consumption	(D)-(E) = (F) Cumulative Net Production
Males						
1	0.92	0	1043	0	351542	-351542
4	2.57	0	1368	0	1636306	-1636306
7	2.47	259	1368	233622	2868012	-2634390
10	2.42	711	1201	860600	3927623	-3067022
13	2.39	1424	1728	2102099	5434651	-3332552
16	2.36	2699	2158	4430581	7296626	-2866045
22	4.63	2859	2476	9263116	11481200	-2218083
25	2.26	2763	2476	11542779	13523936	-1981156
30	3.67	2763	2476	15249424	16845346	-1595922
35	3.55	2763	2476	18826810	20050932	-1224122
40	3.41	2763	2476	22263585	23130521	-866936
45	3.26	2763	2476	25549174	26074636	-525462
50	3.09	2763	2476	28670359	28871435	-201076
55	2.90	2763	2476	**31597081**	**31493980**	103101
60	2.66	2763	2476	34281460	33899370	382090
Females						
1	0.92	0	1043	0	351542	-351542
4	2.57	0	1344	0	1613766	-1613766
7	2.47	269	1344	242360	2823863	-2581503
10	2.42	905	1140	1040906	3829655	-2788749
13	2.39	1453	1399	2308219	5049755	-2741536
16	2.36	2350	1567	4335873	6401801	-2065928
22	4.63	2594	1598	8720293	9102208	-381915
25	2.26	2673	1598	**10925805**	**10420435**	505370
30	3.67	2673	1598	14511881	12563821	1948060
35	3.55	2673	1598	17972904	14632463	3340441
40	3.41	2673	1598	21297889	16619796	4678093

45	3.26	2673	1598	24476606	18519705	5956901
50	3.09	2673	1598	27496267	20324547	7171721
55	2.90	2673	1598	30327790	22016939	8310851
60	2.66	2673	1598	32924853	23569195	9355658

Note: Cumulative production and consumption values are achieved at the *end* of the age range in Tables 2a and 2b. Bolded values indicate the age by which breakeven has occurred: 53.3 for males and 23.3 for females.

Table 3a. Crossover and Breakeven Ages (Years), Varying Production Profiles (Consumption Constant at Baseline_C)

	Crossover Results		Breakeven Results	
Production Profile	Males	Females	Males	Females
Baseline_P	12.6	10.9	53.3	23.3
Kramer_P1	12.7	11.2	NA	23.0
Kramer_P2	12.4	10.6	43.0	23.9
Kramer_P3	12.6	11.3	51.6	23.7
Mueller_P	12.0	11.2	29.8	27.5
Average	12.5	11.1	44.4	24.3

Note: "NA" means that net cumulative production was still negative at age 59.

Table 3b. Cost of Raising Child to Marrying Age,
Varying Production Profiles (Consumption Constant at Baseline_C)

	Proportion Paid		Cost	
Production Profile	Males	Females	Males	Females
Baseline_P	0.89	0.73	3.7	3.8
Kramer_P1	0.87	0.72	4.3	3.9
Kramer_P2	0.91	0.75	2.9	3.5
Kramer_P3	0.89	0.71	3.6	4.0
Mueller_P	0.97	0.56	0.9	6.1
Average	0.91	0.69	3.1	4.3

Note: Marrying age is 26 for males and 16 for females.
Proportion paid is the amount of their cumulative consumption children have produced by marrying age.
Cost is measured in years of average adult consumption.

Table 4a. Crossover and Breakeven Ages (Years),
Varying Consumption Profiles (Production Constant at Baseline_P)

	Crossover Results		Breakeven Results	
Production Profile	Males	Females	Males	Females
Baseline_C	12.6	10.9	53.3	23.3
US_C1	13.4	11.5	NA	21.5
US_C2	12.7	12.4	36.3	26.4
Kramer_C	12.3	11.9	41.8	25.3
Mueller_C	13.1	12.3	40.5	24.8
Average	12.8	11.8	43.0	24.3

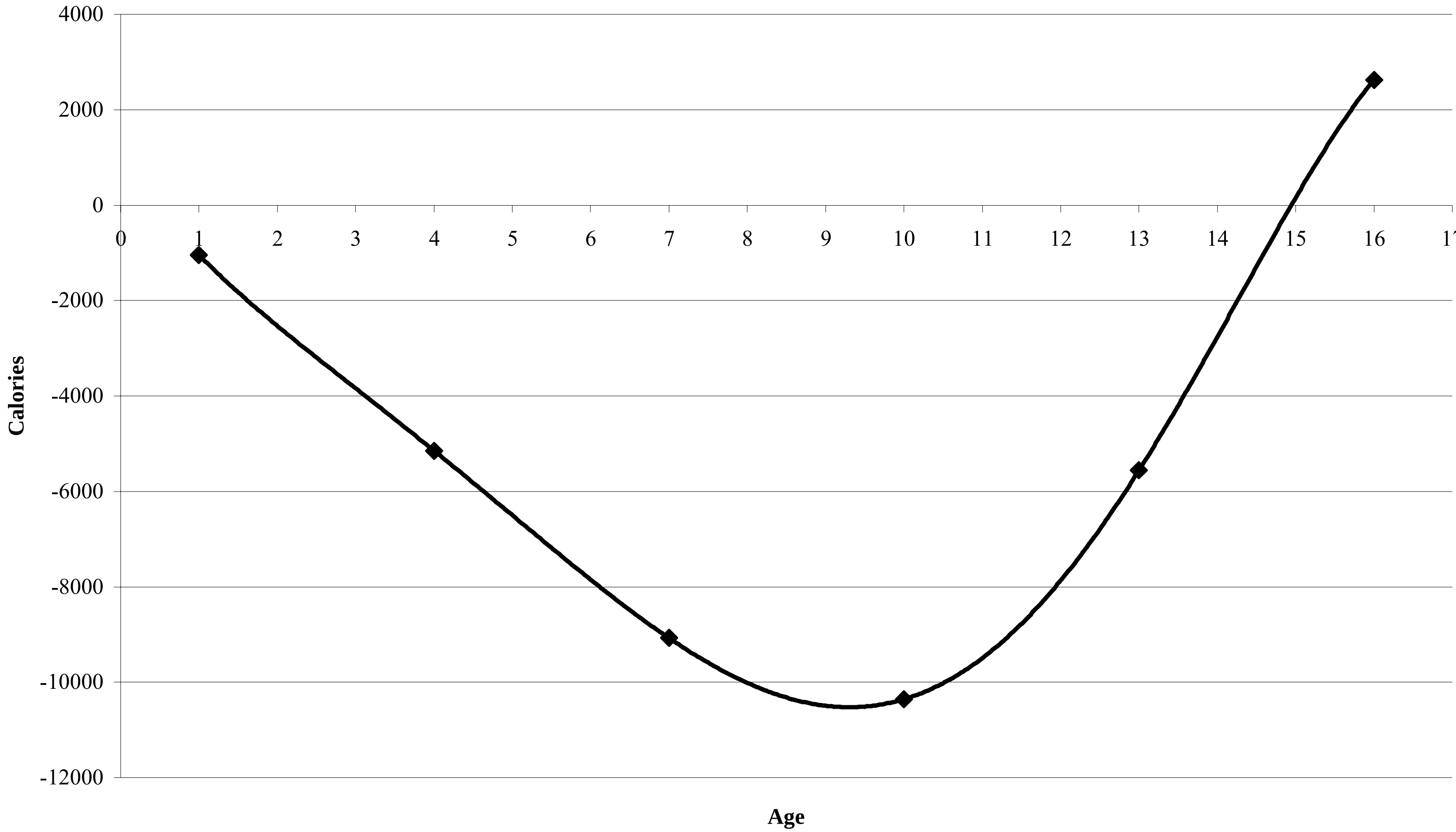
Note: "NA" means that net cumulative production was still negative at age 59.

**Table 4b. Cost of Raising Child to Marrying Age,
Varying Consumption Profiles (Production Constant at Baseline_P)**

	Proportion Paid		Cost	
Production Profile	Males	Females	Males	Females
Baseline_C	0.89	0.73	3.7	3.8
US_C1	0.85	0.82	5.3	2.3
US_C2	0.93	0.72	2.4	4.0
Kramer_C	0.94	0.77	1.7	2.8
Mueller_C	0.93	0.77	2.2	2.9
Average	0.91	0.76	3.1	3.1

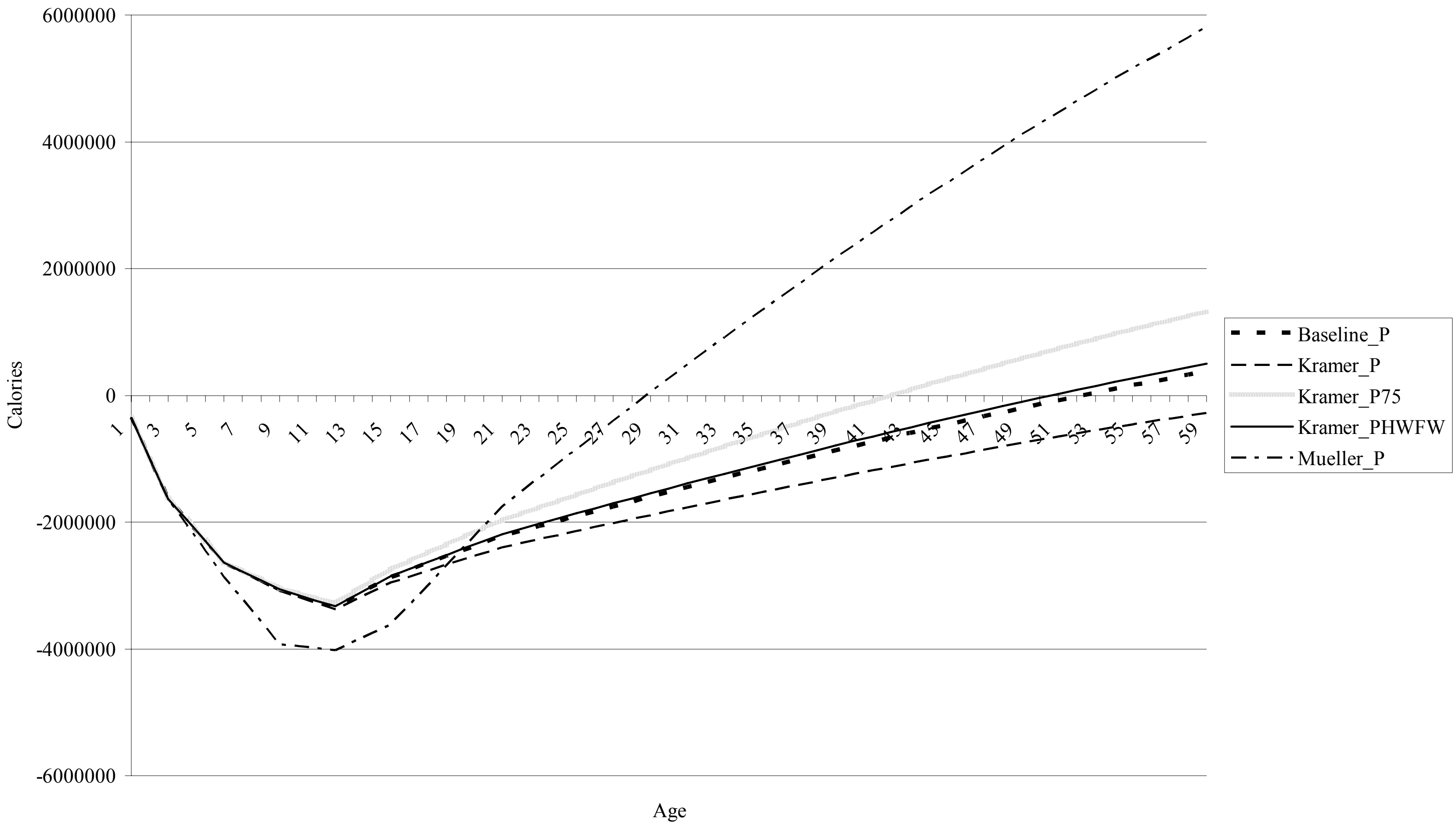
Note: Marrying age is 26 for males and 16 for females.
Proportion paid is the amount of their cumulative consumption children have produced by marrying age.
Cost is measured in years of average adult consumption.

Figure 1. Cain's (1977) Male Cumulative Net Production



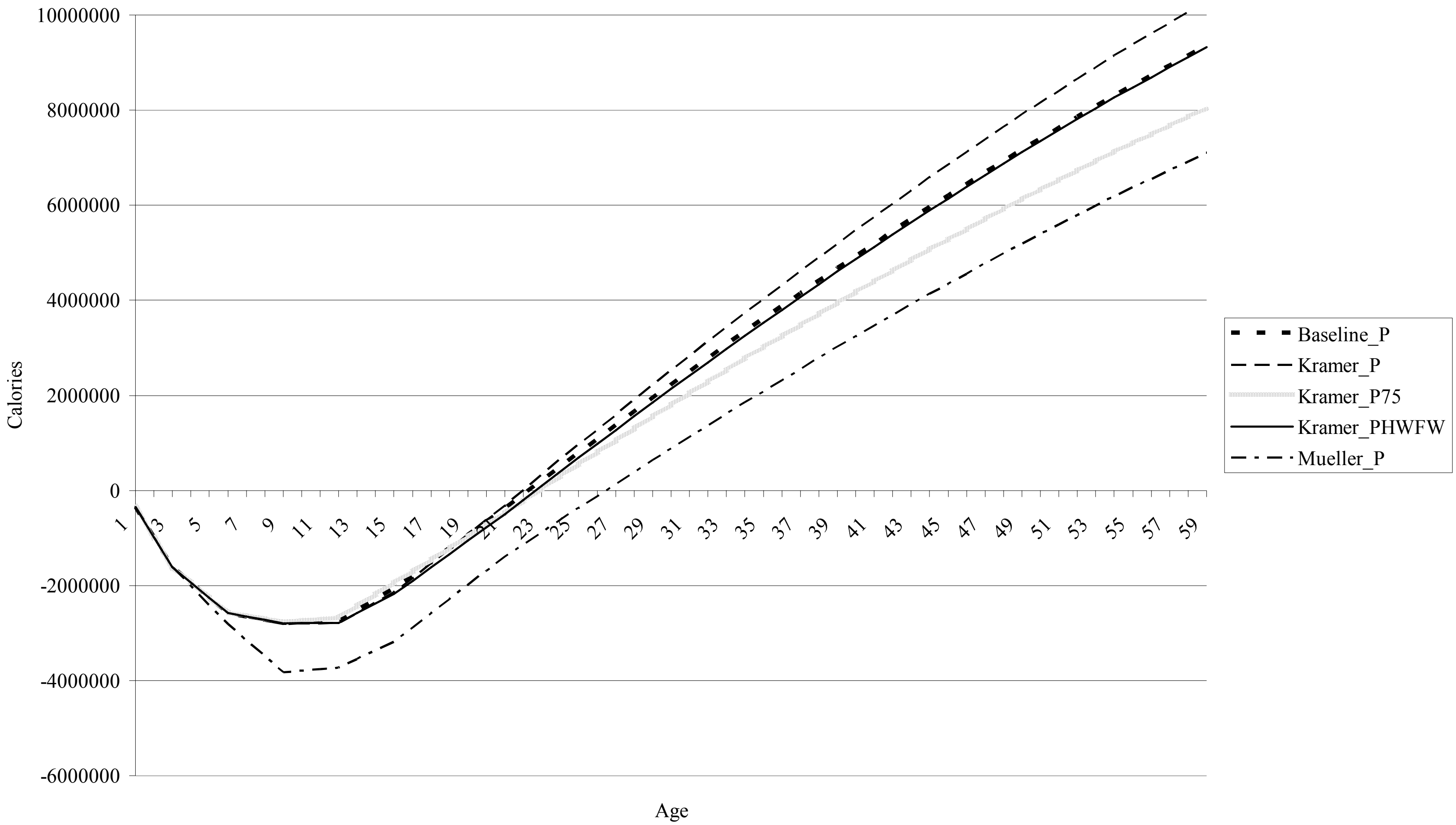
Source: Interpolated from data in Cain (1977: 222, Table 7, Column (8)) and smoothed using a fifth order polynomial; markers indicate values at exact age *x* from Table 7

Figure 2. Male Cumulative Net Production, Varying Production Profiles (Consumption Constant at Baseline_C)



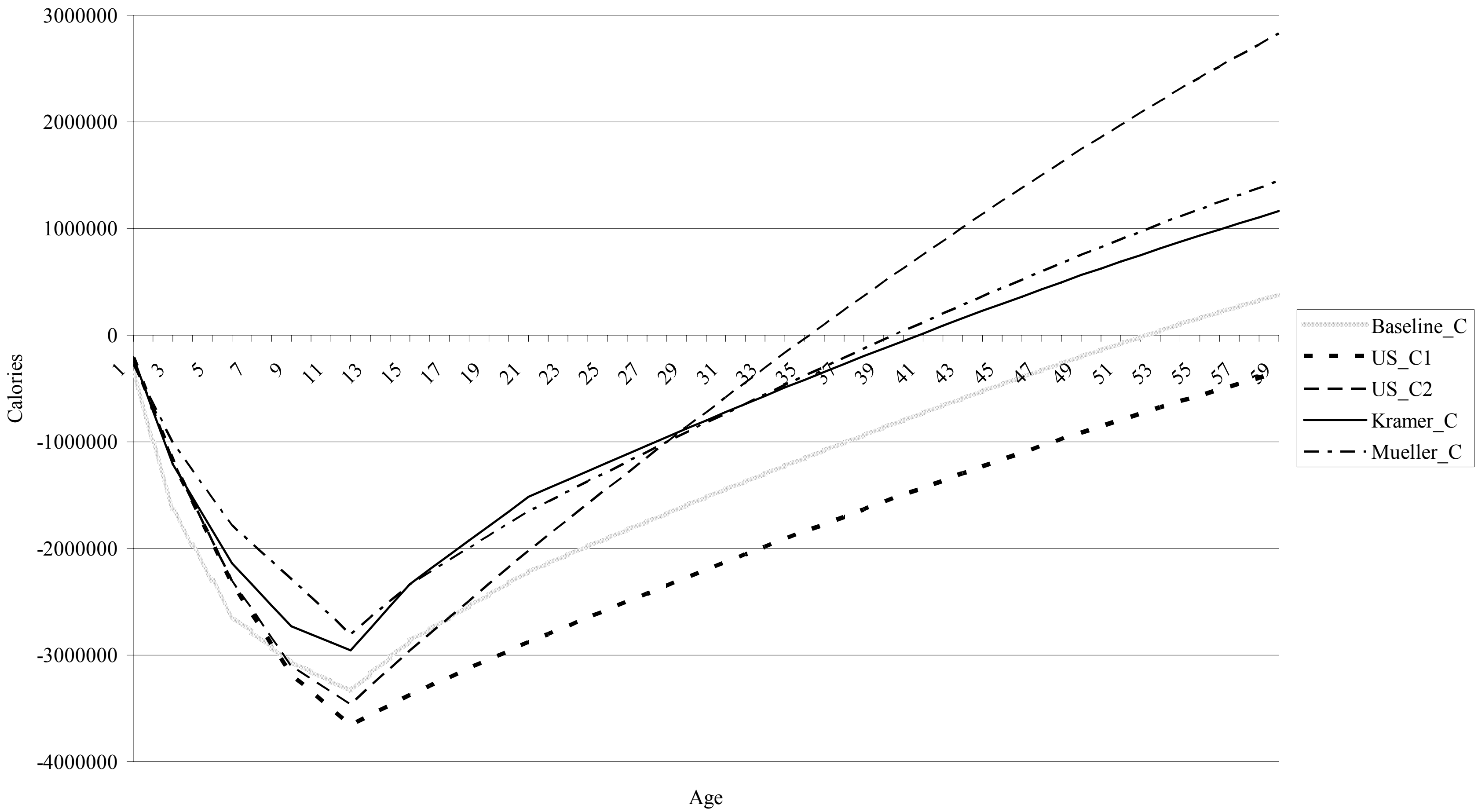
Source: Authors' calculations based on data from Chen (1975), Kramer (2005), and Mueller (1976)

Figure 3. Female Cumulative Net Production, Varying Production Profiles (Consumption Constant at Baseline_C)



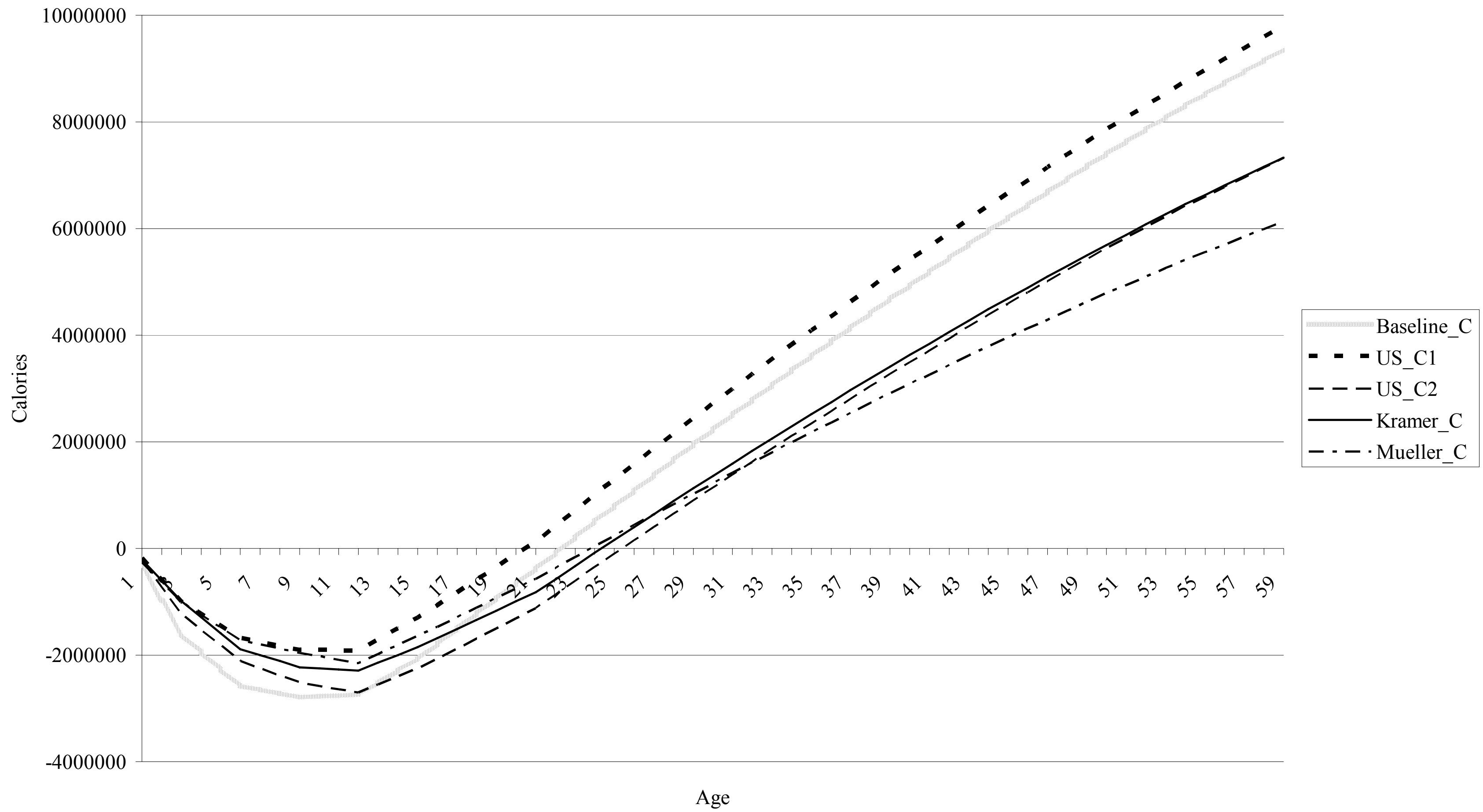
Source: Authors' calculations based on data from Chen (1975), Kramer (2005), and Mueller (1976)

Figure 4. Male Cumulative Net Production, Varying Consumption Profiles (Production Constant at Baseline_P)



Source: Authors' calculations based on data from Chen (1975), HHS and USDA (2005), Kramer (1998), and Mueller (1976)

Figure 5. Female Cumulative Net Production, Varying Consumption Profiles (Production Constant at Baseline_P)



Source: Authors' calculations based on data from Chen (1975), HHS and USDA (2005), Kramer (1998), and Mueller (1976)