Nutrition and the Standard of Living of Native Americans and Europeans in the Mid-Eighteenth Century

Ann M. Carlos
Department of Economics
University of Colorado at Boulder
Boulder, CO 80309
ann.carlos@colorado.edu

Frank D. Lewis
Department of Economics
Queen's University
Kingston, Ontario
Canada K7L 3N6
lewisf@econ.queensu.ca

and

Alexander C. MacDonald
Department of Economics
University of British Columbia
997 - 1873 East Mall
Vancouver, B.C.
Canada V6E 4P2
alexcmacdonald@yahoo.co.uk

Prepared for the Canadian Network for Economic History Conference, April 15 - 17, Queen's University. **Preliminary**. Not to be quoted without permission.

Introduction

The work of Richard Steckel, John Komlos and others has given new perspective to the relation between standard income measures and nutritional status, a relation first pointed out in the pioneering work of Robert Fogel.[1] The generally positive relation between height, a measure of nutritional status, and per capita income, conventionally defined, is by no means universal; and there is now a significant strand in the anthropometric literature dealing with the "exceptions:" heights pre-famine Ireland, declining heights in the mid-nineteenth century U. S., heights in the medieval period, and, most recently, the findings of Steckel and Prince that the American Plains Indians were "the tallest in the world."[2] The work on heights highlights somewhat of a dichotomy between what Komlos has referred to as the "nutritional standard of living" and the standard of living as reflected by conventionally-defined income. As Komlos and others have pointed out, the consumption of goods that improve nutrition need not increase with rising income; indeed the reverse may be true if the relative prices of these goods go up enough.

Arguments about the distinction between nutritional and conventional living standards are by now well-known among economic historians, but here we propose at least the beginnings of a formalization of the relation between these measures. The model highlights the central role of relative prices, while at the same time allowing us to derive measures of living standards across groups with very different consumption patterns. These are the Native Americans who lived in the region of Hudson Bay during the mid-nineteenth century and contemporary English workers and colonial-Americans. Steckel and Prince (2001, 2003) found that, in the mid-nineteenth century, Plains Indians were considerably taller than Europeans. The groups in the Hudson's Bay hinterland were likely not as tall those on the plains; the Cree and Assiniboine, groups that

occupied part of the region, were somewhat shorter than the more southerly Plains Indians, but even so they were still taller than Europeans (Steckel and Prince 2003, pp. 289, 290).[3] It seems unlikely that the heights of Native Americans rose from the mid-eighteenth to the mid-nineteenth century, suggesting that Native Americans were taller than Europeans in the mid-eighteenth century as well.[4]

Measures of living standards can involve comparisons over time, across groups, or both. Here, the primary objective is to compare the real incomes of Native Americans living in the region of Hudson Bay in a particular year with the incomes of contemporary English workers in that same year. The specific area chosen is the hinterland of York Factory, the most important of the Hudson's Bay Company trading posts, and the year is 1740. The main Native groups occupying the York Factory hinterland, an area of roughly one million square kilometers, were the Western Woodland Cree and the Assiniboine. In 1740, Natives living in that hinterland traded almost exclusively with the Hudson's Bay Company. The French had recently established posts in the region but they were still an emerging presence. As a consequence, by focussing on this area at this particular time, we can derive reasonably firm measures of Indian consumption of European products. Subsequently, the French became more active in the area and we do not have data on the specifics of what the French were trading.

From the Hudson's Bay Company trade at York Factory and the anthropological evidence, we can derive reasonably complete estimates of Native consumption patterns in the region, which we compare with those of contemporary Europeans. Deriving relative income measures from these consumption baskets is beset with the usual index number problem, more pronounced in this case because the nature of the societies was so different. Certainly both

market prices in England and imputed prices in the Hudson Bay region give a distorted picture of relative living standards. To address this problem, a model is developed that attempts to mitigate the index number problem, and highlights the importance of nutrition, as reflected by the diets of Native Americans and Europeans, to the relative incomes of the two groups. Our preliminary results indicate that because of the far superior diet of Native Americans, a diet much more heavily weighted to meat, as well as the high quality of their clothing, Native Americans living in the hinterland of Hudson Bay likely had a standard of living that may have been comparable to that of contemporary low-wage English workers. Indeed for those groups living in what would eventually become Western Canada, and in keeping with the findings of Steckel and Prince, the eighteenth century might very well have been a Golden Age.

Native American Consumption Patterns

The Hudson's Bay Company was chartered in 1670 and began trading in 1672 with the opening of Fort Albany on James Bay. More posts were opened to the west and east over the next few decades. During the early years the French disrupted the trade even to the extent of occupying Hudson's Bay Company posts, and it was not until the signing of the Treaty of Utrecht in 1713 that the Company's legal right to trade in the hinterland of Hudson Bay was secure. York Factory resumed trade shortly after that time, and by 1740, the post, located on the Bay coast roughly six hundred kilometers west of James Bay, had been in continuous operation for 25 years. York Factory was the largest of the Hudson's Bay Company trading posts, serving nearly one million square kilometers. Although the land in the immediate vicinity of the Bay was quite barren, much of the hinterland was ideal habitat for beaver and other fur-bearing animals. Most

of the region, which extended from James Bay to just east of the Churchill River, was controlled by Algonquian-speaking Cree bands; while the lands along the southwestern boundaries were controlled by Cree allies; the Siouan-speaking Assiniboine and the Algonquian-speaking Ojibwa. Thus in 1740, the Cree, Assiniboine, and some Ojibwa were the main groups who travelled down the Nelson River to York Factory to exchange their furs for European goods.

The post records for York Factory document the range of commodities purchased by Native traders in each year. In previous work, we have broken down the goods purchased into four main categories: producer goods, household goods, alcohol and tobacco, and other luxury goods. In 1740, Native traders received more than 50 different European commodities in exchange for their furs, goods that ranged from guns to awls to blankets to brandy to Brazil tobacco, and included a large variety of luxury items among them cloth of various kinds, beads, jewellery and vermillion. Guns and other "producer" goods accounted for 43.4 percent of the value of goods received, "household" goods, mainly blankets and kettles, made up 9.2 percent, alcohol and tobacco accounted for 24.3 percent, and other luxuries for 23.1 percent (see Table 1).

The commercial fur trade transformed some aspects of Native life, but even in 1740 by which time the trade was well established, European goods accounted for a small part the Native economy. Perhaps 20 to 30 percent of Native activity was devoted to the fur trade. Nevertheless, the commercial fur trade in the Hudson Bay hinterland had a profound effect on Native Americans and this is reflected in our real income measures. The trade gave Natives access to an iron technology that changed the way they hunted and to a lesser extent prepared their food. In addition, the trade introduced to Native Americans a wide variety of consumer goods, many of which had been completely unknown. Although it may seem difficult to assess the extent to

which Brazil tobacco, brandy (either French or produced in England), English cloth, and beads improved the well-being of Natives; the fact is, Native Americans chose to divert time from traditional activities in order to purchase these items. Such decisions indicated that, at least from their perspective, the new European consumer goods represented an improvement over the alternatives available in their traditional society. By combining the traditional goods with those newly-available though trade, we derive income measures. It is to those traditional goods, food, clothing and housing that we turn to next.

Food

As is evident from Table 1, Indians purchased no food from the Hudson's Bay Company.[5] There has, however, been a great deal of study of aboriginal diets much of which is summarized in the *Handbook of American Indians* (Helm 1981). The estimates in addition to relying on direct observation, are based on nutritional, especially caloric, requirements, and the availability in the region of different foods. The consensus, and this applies to the various tribal groups, is that Natives in the region of Hudson Bay had an extensively meat-based diet, with much of the meat derived from large game. Although often disparaged, fish also formed an important component during certain times of the year.[6] Both meat and fish were preserved in large quantities though smoking and drying, and where it was available, wild rice supplemented meat, especially during the winter.[7] Fats were a quicker energy source than proteins, and there is some evidence that Native Americans "may be able to absorb them more efficiently than can other peoples (Steegman 1983, p. 253)." Dried meat would also be stored in skins full of oil; cranberries and blueberries were dried and stored; and tree sap was a source of sugar. Pemmican, a cake of dried meat mixed with melted fat with berries for flavouring, was to

become a staple provision of fur traders and was provided to them by the Indians.

Anthropologists have not only formed a good picture of the types of food consumed, they also have determined within fairly narrow bands the quantities. Given the climate and their level of physical activity, Edward Rogers and James Smith estimate that adult males consumed as much as 4,500 to 5,000 calories per day in winter, somewhat less during the warmer months, and that over the course of the year their daily consumption of meat flesh would have averaged at least 4 pounds (Rogers and Smith 1981, p.135).[8] Most of this requirement was met by red meat from big game, supplemented during periods of scarcity with hare and other small animals. In the York Factory region, the main, indeed, essential food source was moose and to a lesser degree, in this sub-arctic region, woodland caribou.[9] Moose and caribou were hunted mainly in the spring, March and April, and the autumn, September and October. Geese and other wildfowl were available during their seasonal migrations and there was extensive fishing during the summer (Steegman 1983, p. 223; Smith 1991). Allowing for meat from small game, fish and other food items, we put average daily consumption of moose, caribou and other large game by adult males at 1.5 kilograms.[10]

How to value this consumption depends on one's perspective. If the question is: how much would have been needed in Britain to purchase the Native consumption basket, British prices are appropriate. In the mid-eighteenth century the price of the less expensive cuts of beef, mutton, and pork and was .38 shillings per pound.[11] Applying this price to Native consumption implies an extraordinary and unrealistically high expenditure on food. In England, the annual cost of consuming 1.5 kilograms of meat per day was £23. Assuming women consumed 25 percent less than men and children 50 percent less, the annual cost to a family of five would have been

nearly £75. In 1750 the annual earnings of non-farm English common labour was £21 (Lindert and Williamson 1983, p. 4). Indeed valuing food in this way would place the cost of a Native diet at a level well above that of the highest paid workers in England at the time, solicitors and barristers.[12] We would hardly argue that Native had living standards as high as solicitors and barristers; nevertheless, the comparison does point to the potential importance of food in assessing the relative incomes of Europeans and Native Americans.

Clothing

The value of Native American clothing is based on the input of material, although labour would have been an important component. Cree women were highly skilled seamstresses, suggesting that the tailoring of their clothes was of a quality equivalent to that worn by the middle classes in England. Cree clothing was made from animal skins procured by the men and then tanned and tailored by the women, who used thread made usually of moose-hair, and needles from porcupine or bird quills. The commonly used hides were moose and caribou with beaver and rabbit fur used for lining, edges, leggings and moccasins.[13] The shirts and dresses were semi-tailored with fitted sleeves or with sleeves attached at the shoulder with leather thongs. During the severe winters, the Cree wore trousers rather than the breechcloth that was more common further south.

That clothing was made of skins rather than cloth in no way impeded the Cree's ability to fashion elaborate garments. Embroidery was common. Indeed, the high levels of decoration of their clothing is another indication of their living standards, a standard that may have been higher than for other native groups.[14] Jenness (1963, pp. 72-3), quoting the explorer Mackenzie, describes Cree clothing as follows:

Their dress is at once simple and commodious. It consists of tight leggings, reaching near the hip: a strip of cloth or leather, called assian, about a foot wide, and five feet long, whose ends are drawn inwards and hang behind and before, over a belt tied to the former garment, and cinctured with a broad strip of parchment fastened with thongs behind; and a cap for the head, consisting of a piece of fur, or small skin, with the brush of the animal as a suspended ornament; a kind of robe is thrown occasionally over the whole of the dress, and serves both night and day. These articles, with the addition of shoes and mittens, constitute the variety of their apparel. The materials vary according to the season, and consist of dressed moose-skin, beaver prepared with the fur, or European woolens. The leather is neatly painted, and fancifully worked and leggings are also adorned with fringe and tassels, nor are the shoes and mittens without somewhat of appropriate decoration, and worked with considerable skill and taste...The female dress is formed of the same materials as those of the other sex, but of a different make and arrangement. Their shoes are commonly plain, and their leggings gartered beneath the knee. The coat, or body covering , falls down to the middle of the leg, and is fastened over the shoulders with cords, a flap or cape turning down about eight inches, both before and behind, and agreeably ornamented with quill-work and fringe; the bottom is also fringed, and fancifully painted as high as the knee. As it is very loose, it is enclosed round the waist with a stiff belt, decorated with tassels, and fastened behind. The arms are covered to the wrist, with detached sleeves, which are sewed as far as the bend of the arm; from thence they are drawn up to neck , and the corners of them fall down behind, as low as the waist... The upper garment is a robe like that worn by the men.

The quantity of skins needed to clothe a Cree adult is derived from several sources. Lucien Turner's (2001) nineteenth-century account provides information about Taiga dwelling Native Americans, the Nenenot. Although not specifically Cree, they are nonetheless one of the hunting tribes of the sub-arctic who inhabited the Hudson Bay territory and as such would have had similar dress. According to Turner, who lived with the Nenenot for two years, most adults had two sets of clothing, one for the winter and one for the summer (Turner 2001, p. 282). Each adult required 15 to 25 pairs of moccasins annually due to their intense use in trapping and hunting. One deerskin provided enough leather for five to seven moccasins, implying that an adult male would have used, for footwear alone, at least three deerskins per year or the equivalent. Moccasins too could be elaborately embroidered .

In addition to the skins for moccasins, Jenness (1963, p.75) estimates that the material in

a single outfit would have required seven caribou hides, if the clothing was for an "Eskimo" (Inuit) and three moose skins for Native American living in eastern Canada. The Cree were not "Eskimos" in that they inhabited forest rather than tundra, but they lived in the taiga forest north of the Canadian Shield, which was much colder than the forested lakes area of the Iroquois or Huron. Thus Cree required less coverage than the "Eskimos" but more than Native American living in the East. Five moose skins seems a reasonable estimate of their annual clothing requirement. Jenness confirms that in the North two sets of clothing were used, but the summer clothing was often winter clothing that had been dehaired through use.

Based on these descriptions, it seems reasonable to assume that the Cree living in the Hudson Bay region used annually five moose skins, or their equivalent, for garments and three deerskins, or their equivalent, for moccasins. The price of a moose or deer skin at the Hudson's Bay Company trading post was 2 Made Beaver (*mb*), implying a total value for all skins used of 16*mb*. A prime beaver pelt sold at the post for 1*mb* and in England, depending on the year, a beaver pelt sold at auction for between about 5 and 12 shillings. In 1740 parchment beaver was selling for 8 shillings and a coat beaver close to 7 shillings; but at the time the Official Standard, which set relative prices, was established beaver pelts were selling for about 5 shillings. Applying a conversion rate of 1 m to 5 shillings, gives an implied cost of the materials in England of £4. If the value of the labour is included, the value of the clothing would be much higher. The appropriate comparison for England is unclear, but it appears that Native Americans were clothed at a level at least comparable those of middle income. For example, the annual clothing allowance of the King's Watermen was 4¼ yards of cloth and 4 yards of serge. At 1740 prices, the total cost was £2.6, which likely understates their full expenditure on clothing

(Beveridge 1939, insert).

Spending on clothing by lower income workers would have been less. If it assumed that 6 percent of the budget of a low income worker was allocated to clothing, then a non-farm household would have spent £1.2 per year (Lindert and Williamson 1983, p. 4; Feinstein 1998, p.135). Noting that the value of skins (in England) for an male adult Native American was £4, the value of skins used by a Native family of five was perhaps £13.[15] As middle and upper income households in England were allocating about 25 percent of household expenditure to clothing, it suggests that Native clothing was similar to that of workers in England, who were in the 75th percentile of the wage distribution (Lindert and Williamson 1983, pp. 3-4). As in the case of food, applying British prices to animal skins likely overstates the relative quality of Native clothing; nevertheless, to the extent that the prices of skins and cloth in England bore some relation to their relative value, Native Americans must be regarded as having been very well clothed by English standards.

Housing

Because of the semi-nomadic nature of Native life, estimating the value of Native American housing consumption is more problematic than in the case of food or clothing. If Native living conditions are regarded as encompassing the outside environment as well as the size and quality of their dwellings, then Native living standards might have been considerably higher than a housing valuation would indicate. Certainly Native housing served a very different, or at least much more limited, purpose than did European or colonial American dwellings.

The Cree were semi-nomadic and had two different forms of habitation. In the winter, they lived in small units of three to four families, with about fifteen people per lodge (Jenness

1963, p. 88; Helm and Leacock 1971, p. 365). The winter dwelling of the Cree was a dome or conically-shaped *wigwam*, which was normally constructed within two hours of setting up camp. It was covered with animal skins, that were transported between sites, but also included readily available materials such as birch bark. The typical *wigwam* or *tipi* was ten to eighteen feet in diameter and ten to fifteen feet high.[16] Typically eight to twelve large skins were needed to cover a dwelling, although these were usually of inferior grade. The skins had to be replaced regularly due to the harsh conditions associated with the cold, windy Hudson's Bay taiga. Assuming a diameter of twelve feet, the Cree's winter dwelling had an area of 113 sq. ft., which for a group of fifteen implied 7.5 sq. ft. per person.[17] Given the unique nature of the Cree winter dwelling it is hard to find comparable European or colonial housing; but allowing that an average of ten caribou or moose skins were used each winter, and assuming a value of 1*mb* or 8 shillings per skin, the implied material cost was 80 shillings, or 5 shillings per person for a group of fifteen.

Natives congregated in larger groups during the summer, when they lived in long houses. These log structures ranged in size depending the number of families in the group. Long houses of 100 feet by 20 feet were typically occupied by twelve families with 60 members, implying a living area of 33 sq. ft. per person.[18] These long houses were also often part of a cluster of lodges. One such site comprised 32 small structures which housed some 300 people. (Francis and Morantz 1983, p.14) Although time spent in the lodge has been described temporally as a "regional band meeting," the fact that Natives might occupy a lodge for months at a time suggests that their primary function was to provide housing during the summer.

In colonial New England, there was a change in the nature of the housing stock right around 1740. Prior to this date, houses were very basic one or two room structures with a central

fireplace (if two rooms). Although Gloria Main is most interested in this transition, she notes that "in 1729 the Massachusetts General Court required that houses in new towns be a minimum of eighteen feet square and seven feet stud [ceiling height](Main 2001, p. 304)." Even if this was the minimum size, it suggests that New Englanders were living in small, low-ceilinged spaces which were oriented to maximize light and heat from the sun. It was only in the decades after 1740, that housing structures began to take on Georgian proportions, typified by a central hallway and two stories. Main points out, however, that although there was a trend towards a Georgian style, many of the houses only exhibited aspects of that style. Some houses even lacked a central hallway, and as Main notes "without a hallway, there can be no real privacy (Main 2001, p. 219)." The amenities she lists for these newer housing structures are "higher ceilings, larger and more numerous windows, plaster walls and painted surfaces (Main 2001, p. 219)." These changes, however, were not introduced to any significant degree until the mid-nineteenth century. In 1740 the basic housing stock in New England was still quite primitive. The average family in Main's genealogies had a little more than six children, so the average living space was 40 sq. ft. per person (Main 2001, p. 104). The home of Samuel Lane, a tanner, may have been typical:

> He finally chose his spot on the north side of a mill pond, two acres, for which he paid £26 Old Tenor (depreciated currency of the province) on February 19, 1741. He bargained for a "House Frame 26 feet long 29 wide to be raised for 30£, 18£ of it to be pd in mens shoes, 18/ a pair, womens 13/6, & 12£ in money (Main 2001, p. 213).

If we value the 20 by 100 ft. long house at that of Samuel Tanner's home, the implied value of summer housing per Native was £0.5, which compares to £5 per person in the Tanner home (excluding the land), hypothesizing a household of six persons.[19]

Although the period is later, another indication of the quality of Native housing is given

by the dwellings of slaves in the U.S. South in the mid-nineteenth century. Slaves typically occupied square cabins of about 18 to 20 feet for a family of five (Fogel and Engerman 1974, p. 116). Slave houses had planked floors, windows with wooden shutters, and were constructed of sawn lumber as well as logs. The implied living area of 64 to 80 sq. ft. person was more than double that in a typical Native long house, and also for a dwelling that, like the Tanner house, was of much higher quality. A basis of comparison is also provided by the houses of early nineteenth-century settlers to Upper Canada, a province with a climate more similar, if somewhat milder, that the Hudson Bay hinterland. The basic timber one-story house was perhaps closest in value to the long house. Based on the property assessment of the time, it had a value of about $120 which converts to £25 sterling in the mid-eighteenth century.[20] Assigning a long house, which was larger but of lower quality, this value implies housing per Native £0.4.

Housing in England was heavily dependent on income, where lower income household in the late-eighteenth century were allocating about 10 percent of their income to rent. In 1755, the lowest wage non-farm workers received just over £20, which suggests their rent was about £2 (Lindert and Williamson 1983, p.4; Feinstein 1998, p.135). Capitalizing this rent over 20 years at 6 percent gives a dwelling value of about £20, or £4 per person for a family of five.[21] If Native housing in the summer was equivalent to the winter wigwam, it appears that the housing of the lowest wage non-farm households in England had a value perhaps ten times that of Native Americans. Central to the higher quality of English or colonial dwellings was their relative permanence. Although Natives did return to particular locations year after year, and some material from the wigwams could be carried over, theirs were at most semi-permanent structures.[22] This meant that whereas the cost of English houses could be amortized over many

years, such was not true of Native dwellings. This created an incentive among the English to invest more in their dwellings and the result was much higher quality housing.

These estimates of housing consumption are a least qualitatively in line with Jenness's view that Native shelters could not compare even with medieval European houses. Because of the lack of a floor Cree long houses were equipped with 4 ft. high benches for sleeping; and planks, suspended from ropes, were used to store food, but perhaps most serious in terms of the quality of the indoor environment was the lack of a chimney.[23] The Cree's quality of housing was likely similar to that of other semi-nomadic Native groups. For example, The Montagnais, who occupied the territory just east of the James Bay Cree, seldom stayed in one location for more than a few weeks and occupied relatively primitive structures.[24] It should be recognized, though, that the poor state of Native housing may have been offset by the much greater living space outside their dwellings in comparison to those of English workers, particularly non-farm workers. The greater land per person not only affected the quality of life directly but also could have contributed, like their diet, to improved health.[25]

Luxuries

Some luxury items associated with customs and ceremonies were Native-produced, but for the purpose of comparing living standards with English workers it will be assumed that most Native luxuries were acquired through trade with the Europeans. The Hudson's Bay Company's York Factory trading post was insulated from competition until the late 1730s; and although by 1740 a number of French posts had been established in the region it can be assumed that nearly all trade in the hinterland of York Factory was with the Company. Thus the volume of goods received by the Native traders, who visited the post, should provided a reasonable, if slightly

understated, measure of the total volume of European goods that were available to the Native population in the region. Our approach is to sum up the quantity or value of luxury items received in trade and divide by an estimate of the Native population in the region.

There are a variety of aboriginal population estimates for the period before European contact and in the subsequent years (Dobyns 1983; Steckel and Rose 2002; Ubelaker 1992). A major part of this literature, however, deals with the effect of European-carried disease on Native populations, when these population might have exposed, and the extent of mortality. Without addressing the evidence on the devastation that disease caused Native populations further to the south, it seems that in the more northerly climates, the impact of smallpox, tuberculosis, and the other new diseases was much less severe. As well, it appears that to the extent there was an effect, it was not felt until later in the eighteenth century.[26] A rough indication of the aboriginal population can be formulated from an estimate of population density over the type of terrain typical of that region. The area was part of the sub-arctic northern Canadian shield, where the environment in pre-contact times supported an average of one person per 50 to 70 square miles. The York Factory hinterland was about one million square kilometers. Taking the lower figure as more reflective of conditions in this comparatively southern and well-forested region, the implied pre-contact Native population was about 7,500.[27] This number turns out to be very close to estimates derived from eighteenth-century reports of Europeans who spent time in the Hudson Bay area. The reports from these Europeans were based on lodge counts. Using these, essentially, house counts, Ray suggests population ranges for the three main native groups that inhabited the region: the Plains Assiniboine at 2,400 to 3,000, the Ojibwa roughly 1,400, and the Woodland Cree 2,200 to 6,800 (Ray 1974, pp.105, 111). Taking the mean of these ranges

implies a population in the mid-eighteenth century of 8,600 and a density of one person per 43 square miles. This seems a plausible density for the type of terrain.

In 1740, expenditure on luxury items comprised 47.4 percent of total expenditure, with alcohol and tobacco and other luxuries accounting for roughly equal shares.[28] A complete list of the items purchased is given in Table 1. The total value of the luxury goods received by Native traders at York Factory was 14,094*mb*. Allowing that by this time, the French were accounting for at least 10 percent of the trade, and that the French, for transportation cost reasons, tended to trade in the high value luxury goods, Natives were likely acquiring the equivalent of at least 17,000*mb* in luxury goods, or about 2*mb* per Native living in the region. Based on comparisons of retail prices in England with the Made Beaver prices used by the Hudson's Bay Company, it appears that the cost to the Hudson's Bay Company in England of 1*mb* in trade goods was about 1 shilling (Carlos and Lewis 1999, p.714). Assuming that the Company, as a large purchaser, would have been paying closer to the wholesale price, the appropriate conversion was likely between 1.5 and 2 shillings, depending on the good. It appears that those Natives, who actually came to the posts, consumed more luxury goods than those inland, particularly in the form of alcohol, but ignoring distributional factors, the average consumption of a Native family of five in the region of York Factory was, according to these calculations, between 15 and 20 shillings, and about 2 shillings less if alcohol is excluded.[29]

These expenditures can be compared to the budgets of English workers. Feinstein (1998, p. 635) does not include a category for luxury items but estimates that tea, coffee, sugar and treacle accounted for 6.9 percent of workers' expenditures. In addition, 10 percent of the budget went to "drink." Ignoring alcohol, and assuming that the remaining items accounted for nearly all

luxury expenditure, it follows that the family of the lowest wage workers, that is, someone earning £20, would have been 28 shillings. This expenditure was 50 to100 percent greater than that of the average Native household. Consumption of alcohol by Natives was even less, averaging just 1.5 to 2 shillings per household as compared to 40 shillings for even the lowest paid English workers. Those Natives came to the posts, however, would have consumed much more than the Native average.

One can also compare the consumption of specific luxury goods. In 1740, Natives received 4,741 lbs. of tobacco from the Hudson's Bay Company and likely about 6,000 lbs. if the French trade is included. This trade would have allowed an annual consumption of 1.4 lbs. per adult, and close to 3 lbs. per adult male.[30] According to Carole Shammas this rate of consumption would have made tobacco a "mass consumed" item. By Shammas' definition, a grocery is mass consumed "if enough was imported to allow 25% of the adult population to use it at least once daily (Shammas 1990, p. 78)." In the region of York Factory, enough tobacco was imported to provide 25 percent of the adults consumption about 5.5 lbs. per year. Shammas (1990, p. 78) estimates that "2 lb. of tobacco a year would probably allow enough for every person to have a pipeful a day," implying that Native Americans in the region were well beyond the point where this luxury item was mass-consumed. It should be noted as well, that the Brazil tobacco, which Natives purchased exclusively, was of much higher quality than the Virginia tobacco typically used by English workers. Unlike the case of some luxury goods, notably alcohol, purchases of tobacco remained quite stable over time.

Assessment

Comparisons of incomes across such different societies as Native American and English

are fraught with index numbers problems. Nevertheless, even allowing the severity of the problem, some clear qualitative impressions emerge from the analysis. First, Native Americans in the region were extraordinarily well fed. Theirs was an almost exclusively meat diet, where at least 75 percent of that meat was derived from large game. Few workers in England could have afforded that level of food consumption. Rather the English worker allocated about 70 percent of their food expenditure to grains and potatoes.[31] In terms of nourishment, these workers would have been obtaining 85 percent of their calories in these forms, with 5 percent coming from meat and 10 percent from dairy products.[32] This difference may very well account for the dramatically tall adult heights found among Native Americans by Steckel and Prince (2001).

These findings on food consumption are perhaps not surprising, but the consumption by Natives of other goods may be. Given the materials used, it appears Natives were consuming very high levels of clothing. Although the index number problem means we need to be wary of comparisons, the material used in the clothing used by a Native family was at English prices worth £13, roughly ten times the expenditure on clothing of a low-wage English household. The high quality of Native clothing was dictated to a large degree by the climate and the nature of Native housing; but even so, any measure of real income must consider this item as having increased the level of Natives in comparison with most Europeans.

If Natives were relatively well-fed and well-clothed, certainly the reverse was true of housing. The problem was not so much the level of implicit expenditure on housing, which may very well have been comparable to that of a low-wage English worker; rather it was the semi-nomadic nature of Native life. The cost of a sedentary English worker's house could be amortized over its lifetime. Undoubtedly maintenance was necessary and there was the cost of

fuel to consider, but a given structure typically survived many years. By contrast, the housing of Natives was fully or almost fully consumed each year.[33] This difference meant that, abstracting from other factors, the price of housing to a semi-nomadic Native American was at least ten times the price to a European. Since the overall allocation to housing of Natives in the region of Hudson Bay and low-wage English workers was about the same, it seems that Natives has shelter worth one-tenth that occupied the worst-housed English worker.[34] Fuel represented about 30 percent of the overall cost of housing for English workers (Feinstein 1998, p.635) and Native Americans could hardly have been using less fuel. Including this component reduces the ratio of English to Native housing consumption to about 3.

Also intriguing are the findings on luxury goods. Until the coming of the Europeans, any luxuries would of course have been Native-produced and it is not clear whether such luxuries made up a significant part of the economy. Once a trade was introduced to Hudson Bay, however, Natives began consuming a range of goods that were regarded by European consumers as luxuries and would certainly have been treated as such by the Native population. If alcohol is excluded from the calculation, then Native Americans in the region of York Factory were consuming perhaps one-half to three-quarters the luxuries of low-wage English workers. There were some luxuries, though, for which consumption was greater. Per capita consumption of tobacco was more than 40 percent the England and Wales average suggesting a rate above that of low-income English workers. As well, Natives purchased high-quality Brazil tobacco. Despite the correspondingly high price, tobacco fell well within Shammas' definition of a mass consumed good. English workers did however spend much more than Native Americans on alcohol, consuming it in the form of beer and cider rather than as (English) brandy or rum as did

Native Americans. This finding is significant given the emphasis on alcohol that has been placed in some discussions of alcohol use among Indians.

Comparing Living Standards - A Model

These estimates of Native consumption produce perhaps more questions than answers regarding the issue of relative living standards. Here we propose a model that begins to address those questions and provides a consistent way of comparing such dramatically different consumption bundles as those purchased or produced by Native Americans and the consumption bundles of English workers. A key element involves the treatment of food which was by far the largest item in terms of expenditure share. Based on English prices, Native Americans were consuming more food in terms of value than all but those at the upper tail of the English income distribution. This consumption differential was a result of the low cost of meat in America in comparison to other foods. Because food made up by far the largest share of the budgets of English workers as well as Natives, how food is treated becomes central to the issue of overall real incomes.

Key to our approach is the assumption that food plays two roles in regard to utility. First it provides the energy and other food inputs needed for survival. The notion here is that, regardless of the mix of food types, individuals must meet a nutritional constraint. This constraint includes more than energy, but for the purpose of the analysis here, it is assumed that there is a calorie constraint alone.[35] Second, although all agents consume the same number of calories they do so in forms that can produce different levels of utility. An agent is assumed to be better off if they reach their nutritional constraint with a diet that is preferred. Here it is

assumed that the diet is made up of two types of food: meat (high quality) and grain (low quality). The calorie (nutritional) constraint is normalized to one, and meat or grain is defined in terms of those normalized calorie units. Thus the utility function includes the constraint:

(1) $$1 = g + m,$$

where g is consumption of grain, m is consumption of meat, both in normalized calories. The utility function is assumed to be Cobb-Douglas in food and other goods, where the food component allows for a diminishing marginal rate of substitution between grain and meat:

(2) $$u = (g + am^{\alpha}) \prod_{i=1}^{n} c_i^{\beta_i} \quad ,$$

where c_i is consumption of (non-food) good, i, and a, α, and β_i are utility parameters. Substituting the calorie constraint, the utility function becomes:

(3) $$u = (1 - m + am^{\alpha}) \prod_{i=1}^{n} c_i^{\beta_i} \quad .$$

Treating grain as the numeraire, the income constraint is:

(4) $$Y = 1 + (p_m - 1)m + \sum_{i=1}^{n} p_i c_i \quad ,$$

where p_m is the price of meat and p_i is the price of non-food good, i. The optimization problem is:

(5) $$\max_{m,\, c_i} U = (1 - m + am^{\alpha}) \prod_{i=1}^{n} c_i^{\beta_i} + \lambda [Y - 1 - (p_m - 1)m - \sum_{i=1}^{n} p_i c_i] \quad .$$

The first order conditions give rise to the following:

(6) $$\frac{a\alpha m^{\alpha-1} - 1}{1 - m + am^{\alpha}} = \frac{\beta_k (p_m - 1)}{p_k c_k} \quad , \qquad k = 1, \ldots\ldots, n.$$

Assuming the price of meat is no less than the price of grain, ie, $p_m \geq 1$, it follows that the consumption of meat is between 0 and $(a\alpha)^{\frac{1}{1-\alpha}}$. Over this range the LHS of equation (6) is

decreasing in m. It follows that an increase in p_m leads to a decline in meat consumption; and an increase in expenditure on any of the non-food goods will imply an increase in consumption of meat as well.[36] Finally, an increase in income leads to an increase in expenditure on all goods other than grain, which in this model is an inferior good.

As we noted above, Native Americans consumed a basket of goods very different from that of English workers. Their diet was almost exclusively meat, in contrast to the English diet which was dominated by grain; and Natives appear to have had much better clothing. On the other hand, Native housing was much inferior, perhaps having a value as little as one-tenth that of a low-income English dwelling, although once fuel is included the ratio was likely closer to one-third. As well, offsetting the poor housing was the greater land available to Native households. Natives purchased in value far fewer luxuries than even low-wage English workers. Although tobacco use among Natives was likely greater than among low-income English consumers, overall their purchases of European luxury goods was, excluding alcohol, perhaps 25 to 50 percent less. If alcohol is included among luxuries,. Natives were likely consuming just one-quarter that of the low-income English. Natives, though, produced luxuries goods, which makes any consumption, based on the European alone, biased downward.

The suggested utility function provides a way of comparing the real income levels of these two very different consumption baskets. The results turn out not to be very sensitive to the parameter values chosen. Calculations are based on an elasticity, α, of .5 and a value of a, 1.41, which is consistent with an equal caloric intake from "meat and "grain" in the optimum diet. For a price of meat equal to the price of grain (p_m =1), a = 1.41 is consistent with optimal grain consumption of .5.[37] Treating coffee, tea, sugar, and alcohol as luxuries rather than food, the

percentage consumption shares derived by Feinstein for English workers in 1788 are: food - 62.1, of which 72 percent is grain-based; housing - 14; clothing - 6; and luxuries - 16.9.[38] The values of β_i (1- housing, 2- clothing, 3- luxuries) are derived from the first-order condition, equation (6), and the income implied by Feinstein's expenditure shares.[39] The values are $\beta_1 =$ .093, $\beta_2 =$ .037, and $\beta_3 =$ .104.

The relative real income levels of Native Americans and English workers can now be derived by comparing their relative consumption of food (grain and meat), housing, clothing, and luxuries. It is assumed for the purpose of this comparison that Native Americans consume the optimal English diet.[40] English workers consumed a diet that, in terms of calories, was 85 percent grain-based. Housing consumption of English workers, according to our estimates, was three times the consumption of Natives;[41] whereas the value of Native clothing was, at English prices, ten times the cost to the lowest paid English workers. If, however, the prices of clothing material, specifically the prices of skins and cloth, are more reflective of prices at Hudson Bay, then the value of Native clothing was between three and four times that of English workers.[42] Finally, the consumption of luxuries by English workers, where alcohol is included, was about four times that of Native Americans, but allowing for Native production of luxury goods would reduce this ratio.

Table 2 presents the estimates of the relative real incomes of English workers and Native Americans. Based on English utility weights, the English workers are found to be better off, but possibly surprising is the small differential. Holding prices constant the decline in income that would have reduced English utility to that of Natives is on the order of 2 to 7 percent. If Native utility weights are used, the utility ratios are reversed. Holding the prices faced by Natives

constant, the decline in their income, that would have reduced their utility to the level implied by the English consumption basket, is 7 to 20 percent depending on the relative consumption measures assumed. The implication of these results is that moving to the Native American diet would not have compensated even low-wage English for their higher rates of non-food consumption. At the same time, Native Americans would not have chosen the higher levels of consumption of housing and luxury goods enjoyed by Europeans, if they were forced to reduce their consumption of food and clothing to European levels. The results, although possibly not surprising, do point to the potential importance of tastes in determining which society people from will choose.

These comparisons have implications both for real income and nutrition. The first is that, viewed from the European perspective, low-wage English workers were better off than Native Americans. The differential, though, may not have been great, possibly under 5 percent. On the other hand, moving to the English consumption basket would from the perspective of Native Americans have more seriously have reduced their real incomes; we estimate a loss of as much as 20 percent. Equally important, especially in light of the literature on nutrition, is the implication of differences in the relative prices of food types for the nutrition of English workers and Native Americans. In England the relative price in calories of "meat" to "grain" was about 3; whereas to Native Americans the price of "meat" was certainly no higher than "grain." As a result Natives chose a much more desirable diet.

Clearly a wide variety of factors determine nutrition, but other than the calories themselves, the factor that seems most important both to nutrition and the evidence on heights is intake of protein. The nutritional content of even narrowly defined food types may have changed

over time, but recent nutritional studies can provide an indication of how much lower was the level of protein in the low-income English diet. Allowing adult male consumption of 2,500 calories per day and applying English expenditure shares and English food prices, their estimated daily intake of protein was a little over 100 grams (see Table 3). By comparison a diet that included 1.5 kg of moose meat per day would contained 327 grams of protein even assuming the rest of the diet had no protein (USDA 2005). The higher level of protein does not imply that the Native American diet was superior in a nutritional sense; in fact, the recommended daily allowance of protein in some current food guides is close to what the low-wage English were consuming. Nevertheless, given the active lifestyles of English workers and, to a much greater extent, Native Americans, a predominantly meat diet may have led to better health, and it almost certainly contributed to greater heights. And central to the differing diets was the difference between the relative price of meat and other foods. That difference allowed Natives to achieve a level of meat consumption, and perhaps a level of nutrition, comparable to that of the highest income British households. Indeed, the results illustrate more broadly the central role of relative meat and grain prices in determining nutrition, or at least protein intake, especially for lower income consumers.

There is ample evidence that the composition of food consumption depended on income. Households with higher income allocated a larger share of their food expenditure to meat and less to grain-based food (Hoffman et al. 2002, pp. 326-27). In 1688 England and Wales, households in the bottom 40 percent of the income distribution allocated 12 percent of their food expenditure to meat, while households in the top 20 percent of the income distribution allocated 55 percent to meat. Nevertheless, it may be that in the eighteenth century prices, specifically the

relative prices of meat and grain products, rather than income was more important to changing nutrition and height. Figure 1 describes the demand for meat consumption, where the base is taken to be a meat price of 3, consumption of .15 and income of 2.09 (using the normalizations assumed in the model). The (uncompensated) elasticity of demand for meat at the initial consumption level is 1.3, and a decline in price from 3 to 2 raises meat consumption to .25, an increase of 66 percent. From the levels derived in Table 3, this shift implies an increase in protein consumption of about 10 percent. Holding prices constant, income would have to go up by more than 50 percent to achieve this nutritional shift (see Figure 1). Although it intended to be no more than suggestive, Figure 2 describes the possibly central role of meat and grain prices. The figure juxtaposes the heights of working-class 16-year-old boys in England (Floud et al. 1990, pp. 168-69) and the ratio of the price of bread (manchets) to the price of pork (Beveridge 1939, insert). Although both measures are imperfect, they illustrate in dramatic fashion the extent to which changes in nutrition, as reflected in heights, may have been price-induced. By implication, downplayed is the role of income.

Conclusion

The utility function introduced in this paper provides a way of assessing how the composition of what household were consuming was reflected in relative income. The results, not surprisingly, depend on the weights assumed. If English consumption weights are applied, the low-wage English are derived to have higher real incomes; whereas if Native American weights are applied, the reverse is true. But there is another aspect of utility that is hidden by a framework that includes only five types of consumer goods; that is variety. If producer goods are

excluded, Natives at York Factory were receiving about 50 different European trade goods of which perhaps 21 were received in sufficient quantities (at least 100*mb*) that they might have been widely used. Their diet, although high in protein, was also quite limited. By contrast, English consumers, even low-income English consumers, had access to a variety of food stuffs and other goods that would easily have numbered in the thousands. For example, the prices listed by Beveridge (1939, insert) for Lord Stewart's Department includes more than 50 categories of food alone, and there would have been sub-categories of these. Natives could have increased the variety of their food consumption by trading with the Hudson's Bay Company and chose not to. Nevertheless, lack of variety in consumption, if not serious to Native welfare, was quite possibly a major concern to Europeans considering if not a Native than a colonial American lifestyle.

Endnotes

1. See, for example, Steckel (1994, 1995), Steckel and Floud (1997), Komlos (1994, 1995), and Fogel (1986).

2. On Ireland see Mokyr and O Grada (1994) and Steckel and Nicholas (1997); on Medieval heights see Steckel (2004); and on heights of American Plains Indians see Steckel and Prince (2001, 2003).

3. The northern Cree were taller than their Naskapi-Montagnais neighbours to the East. The taller Plains Cree who dominated Manitoba and Saskatchewan were part of the Cree "empire" that expanded after trading began and were directly descended from the northern Cree groups (Crowe 1991, p. 45).

4. Komlos (1995, VI) suggests that heights in the United Kingdom fell from 1750 to 1850, but the declines he estimates would not have been enough to offset the height advantage of Native Americans in the Hudson Bay region. Moreover, Floud et al. (1990, pp.134-95) estimate that U.K. heights were rising from the late-eighteenth to the mid-nineteenth century, suggesting the possibility that the height gap in the mid-eighteenth century was even greater than Steckel and Prince estimate.

5. The food energy provided by brandy and other alcohol was very small.

6. See in particular the work of Smith (1991) and Holzkamm et al. (1991).

7. Meat lost two thirds of its weight through drying, making it easier to transport in addition to preserving it. In a good harvest, over thirty bushels of wild rice a day could be collected by one canoe. This could then be husked, dried and stored. Both oil and fruits were preserved and both were of nutritional value. Berries were a source of vitamins A, B- complex, and C, which prevented scurvy and other health problems. Steegman (1983, pp. 252-53).

8. These estimates are for the shield of the McKenzie borderlands, which is a region west of the Hudson's Bay hinterland and includes a more northerly portion. Caloric requirement in the fur-trading area of Hudson Bay may have been somewhat less.

9. The energy content of moose is about 100 kilocalories (subsequently referred to as calories) per 100 grams, and caribou is about 130 calories per 100 grams. This energy content applies to the raw meat (http://www.nal.usda.gov/fnic/foodcomp). In this northern climate the higher fat content of the moose and caribou may have provided more energy than this. At 130 kcals. per 100gms., and an average daily requirement of 4,000 kcals., an exclusively large game diet would have consisted of 3 kilograms of meat per day.

10. Average dressed weight would run about 400 lbs. for a moose and 125 lbs. for a caribou (Rogers 1963, p.35). Treating a family of five as equivalent to 3.25 male adults, where an adult male consumed daily 1.5 kgs. meat from large game, a Native family would have consumed annually 10 moose, 30 caribou, or some combination of these game animals. The density of moose in the Hudson Bay hinterland was much greater than for caribou, and so moose made up a much larger share of the Native diet. Hare and other small game, while potentially more abundant, were much less important (Rogers 1963, pp. 32-40; Winterhalder 1983, pp. 42-44).

11. The prices of the three types of meat were all close to 3 shillings per stone of 8 pounds (Beveridge 1939, insert).

12. The annual earnings of solicitors and barristers was £231 (Lindert and Williamson 1983, p. 4) and they would have allocated less than 30 percent to food (Hoffman et al. 2002, p. 326).

13. Canada, Department of Indian Affairs and Northern Development (1979).

14. Possibly an indication of higher living standards is evidence that the Cree were the only Algonquian-speaking people to practice tattooing.

15. The weights applied are .75 for women and .5 for each of three children.

16. The typical lodge was circular, 10-18 ft in diameter and 10-15 ft high according to Turner (2001, p. 299) and 10-12 ft in diameter and 8-10 ft high according to Jenness (1963, p. 89).

17. This is the upper estimate for Jenness (1963, pp. 84-99), and although her estimate specifically describes the Cree she does not provide a reference. Given Turner's (2001) first-hand experience, Jenness's numbers are more likely to be a slight underestimate suggesting our figures are biased downward.

18. Francis and Morantz (1983) note the varied sizes of pre-contact Cree dwellings based on archaeological evidence. Their lodges were comparable to the Huron long houses, described by Jenness (1963, p. 88) as being 50 to 60 yards by 12 yards and housing 24 families.

19. The walls of the Tanner home were 7 ft. high and there would have been planked floors. Ignoring the roof and interior rooms, the surface area of lumber would have been about 1,500 sq. ft. A long house of 20 by 100 ft. with 10ft. high walls and no floor, had a timber surface area of about 2,400 sq. ft. Given that logs rather than sawn lumber was used, the roof was primitive, and amenities such as windows and a fireplace were missing, it seems generous to value the long house the same as the Tanner dwelling. Because of wide fluctuations in the Massachussetts currency, converting the values to pounds sterling is problematic for this period.

20. In 1826 only one-third of residences were assessed. The one-story timber houses were of higher quality than the log houses that were occupied by most of the population. In addition to a planked floor and other amenities, the feature that may have contributed most to the higher quality of colonial homes was a chimney (Lewis and Urquhart 1999, pp. 164-65).

21. Shammas (1990, p.160) reports that an eighteenth century "mud and stud cottage could be built for £20 to £30."

22. Even their larger structures were likely rebuilt every year or so and their coverings would wear-out within a year.

23. Jenness (1963, p. 99) describes Natives houses even in the high-income tribes of British Columbia as "squalid and often filthy. Rotting meat and fish strewed the floors and the ground outside; dogs, mice, and parasites of every kind shared the interior with its human inmates...ventilation was inadequate, smoke pervaded every corner."

24. Paul Le Jeune, a Jesuit missionary who wintered with Montagnais, observed that from November 1633 to April 1634 the group broke camp 23 times (Leacock 1982, p. 190).

25. Another input affecting the overall consumption of housing was fuel. The cost of fuel was much less to Native Americans than to Europeans, and consumption would have been at least as great. Including fuel in the housing component, therefore, reduces the implied ratio of European to Native consumption of "housing."

26. Ray (1974, pp. 105-06) reports a serious outbreak in 1780/81.

27. Ubelaker's (1992, p.172). population estimate for the whole subarctic region at contact is 103,330 which implies a density of 2 per $100km^2$.

28. What we define as producer and household goods accounted for 52.6% of the trade.

29. In some years Native traders received a substantial share of their alcohol as "gifts" in the ceremonies that proceeded the actual trading. This alcohol would certainly have been consumed at the post. Some of the alcohol obtained through direct trade may have been transported inland.

30. Their per capita consumption of roughly 0.7 lb. compares to an average in England and Wales for the period 1738-42 of 1.65 lb. (Shammas 1990, p. 79).

31. This excludes alcohol and sugar, which contributed little to calorie intake (Feinstein 1998, p. 635). On food shares see also Shammas (1990, p. 136).

32. In 1794-95 the cost per calorie of meat was four times that of oatmeal, five times that of potatoes, twice that of milk and one and a half times that of butter or cheese (Shammas

(1990, p. 137). We estimate the ratio for bread and wheat flour to meat at three (USDA 2005, Beveridge (1939, p.291). The expenditure shares are from Feinstein (1998, p. 635).

33. The poles used in the wigwams might be carried over as well as some of the skins.

34. One factor not considered in this comparison is the possibility that the cost of housing materials differed. Wood was much cheaper in North America, but this was not true of other building materials, many of which would not have been available to Natives.

35. The calorie constraint varied of course with climate and lifestyle. Sub-arctic Native Americans had to meet a much higher constraint than did most western Europeans. Shammas (1990, p. 135) puts the eighteenth-century calorie requirement in England at 2,500 to 2,700 in adult male equivalents. This compares to a (sub-arctic) Native American requirement of perhaps 3,500 to 4,000. Treating calorie consumption as independent of income and prices must be regarded as an approximation. Logan (2004b) finds a positive relation between income and calories in late-nineteenth century Britain and the U.S., with the elasticity declining with income. Logan (2004a) finds much smaller income elasticities of demand for calories in developing countries. Even in the late nineteenth-century, despite the 20% lower price of calories in the U.S. than in Britain, the higher income, and the possibly more active life style, per capita calorie consumption was just 13% greater.

36. It has been suggested by Komlos (1995, II, p. 101) that industrialization may have contributed to lower nutrition (and smaller heights) by inducing substitution away from food and towards those luxury goods whose prices fell. Under the specification of a unitary elasticity of substitution between food and non-foods, changes in non-food prices have no effect on nutrition. In fact, assuming perhaps more plausibly that the elasticity of substitution between these goods was less than one, implies that lower non-food prices would lead to greater meat consumption and, by implication, improved nutrition. On the other hand, as Komlos suggests, higher meat prices would indeed lead to poorer nutrition

37. This is the solution to $m = (a\alpha)^{\frac{1}{1-\alpha}}$, where $m = .5$. Excluding sugar and alcohol, this was roughly the consumption of the top 10% of English households in1688 (Hoffman et al. 2002, p.326).

38. For purposes of estimation, "meat" is assumed to include beef, mutton, pork, milk, butter, and cheese; "grain" includes bread, flour, oatmeal and potatoes. The calories provided by alcohol and sugar were small enough to be ignored.

39. A noted, 70% of food expenditure was on "grain" and 30% on meat. Since the price of a calorie consumed as meat was three times that of grain (ie. $p_m = 3$), consumption of meat, m, was .15, based on the normalization, and the consumption of grain, g, was .85. It follows that total expenditure on food was 1.3 (0.85 + 3x 0.15). Since food consumption was 62.1% of total consumption, it follows that income, Y, was 2.09 (1.3/.621). The

values of β_i can be solved from equations (4) and (6).

40. Natives consumed more than half their calories in the form of meat, but this reflected their preference. Contemporaries reported that Natives refused to eat grain (eg. porridge) whatever the price.

41. This ratio may overstate the difference because the role of land in the overall quality of housing is not included.

42. In England, 1*mb* was equivalent to 5 shillings; at the Hudson's Bay posts it was between 1.5 and 2 shillings.

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Table 1
Value of Goods Received at York Factory in 1740
(made beaver)

	Price (mb per unit)	Value (made beaver)		Price (mb per unit)	Value (made beaver)
PRODUCER GOODS			OTHER LUXURIES		
files	1	317	baize (yd.)	1.5	23
fishhooks	0.071	5	bayonets	1	165
flints	0.083	243	beads (lb.)	2	342
guns	14	3,570	buttons	0.25	12
gun worms	0.25	91	cloth (yd.)	3.5	3,577
hatchets	1	773	combs	1	362
ice chizzles	1	478	duffel (yd.)	2	14
knives	0.25	856	egg boxes	0.33	47
mocotaggans	0.5		flannel (yd.)	1.5	29
net lines	1	226	gartering (yd.)	0.67	264
powder horns	1	185	glasses burning	0.5	16
powder (lb.)	1	3,799	handkerchiefs	1.5	27
scrapers	0.5	109	hats	4	168
shot (lb.)	0.25	2,226	hawkbells (pair)	0.083	42
twine (skein)	1	133	lace (yd.)	0.67	223
TOTAL		13,010	looking glasses	1	120
			needles	0.083	37
HOUSEHOLD GOODS			pistols	7	182
awls	0.125	106	rings (three kinds)	.12-.33	114
blankets	7	1,330	sashes	1.5	84
fire steels	0.25	97	scissors	0.5	30
kettles	1.5	1,018	shirts	2.5	234
TOTAL		2,551	shoes (pair)	3	
			spoons	0.5	12
TOBACCO AND ALCOHOL			stockings	2.5	64
brandy (gal)	4	1,830	sword blades	1	5
rundlets	1	350	thimbles, thread		56
tobacco (lb)	2	4,735	trunks	4	164
tobacco boxes	1	168	vermillion (lb.)	16	328
tobacco tongs	0.5		worsted (yd.)	.5-.67	59
water, strong (gal)	4	144	miscellaneous[a]		68
TOTAL		7,227	TOTAL		8,607
			GRAND TOTAL		29,657

[a] Brass collars, earrings, feathers, medals, pumps, and razors.

TOTAL	
Producer Goods	13011
Household Goods	2550.75
Alcohol&Tobacco	7227
Other Luxuries	6867.31
GRAND TOTAL	29657.06

SHARES (%)	
Producer Goods	43.87150985
Household Goods	8.600818827
Alcohol & Tobacco	24.36856519
Other Luxuries	23.15573425

Table 2
Consumption and Real Income:
Low-Wage English Households / Native American Households

Housing	Clothing	Luxury Goods	English weights		Native weights	
			Utility	Income	Utility	Income
3	0.1	4	1.095	1.045	0.814	0.861
3	0.33	4	1.144	1.066	0.918	0.927
2	0.1	3	1.044	1.022	0.771	0.840
2	0.33	3	1.069	1.032	0.868	0.893

Note: Based on equation (3) with $\alpha = .5$. English weights: $a = 1.41$, $\beta_1 = .093$, $\beta_2 = .037$, and $\beta_3 = .104$; Native weights: $a = 1.79$, $\beta_1 = .10$, $\beta_2 = .10$, and $\beta_3 = .05$.

Table 3
Daily Calorie and Protein Consumption of Low-Wage English Workers
(adult males)

	Expenditure Share	Calories / £ (meat = 1)	kCalories	Protein (grams)
Bread	0.2	2.9	554	22
Wheat Flour	0.27	3	784	32
Oatmeal	0.13	4.6	567	19
Potatoes	0.05	5.2	248	5.4
Beef	0.03	1	29	3.9
Mutton	0.03	1	29	4.1
Pork	0.07	1	67	4.9
Milk	0.05	2.3	110	5.9
Butter	0.04	1.7	64	0.1
Cheese	0.03	1.7	48	5.8
TOTAL			2500	103

Sources: Feinstein (1998, p. 135); Shammas (1990, p.137); USDA (2005).

Figure 1
Price, Income and the Demand for Meat

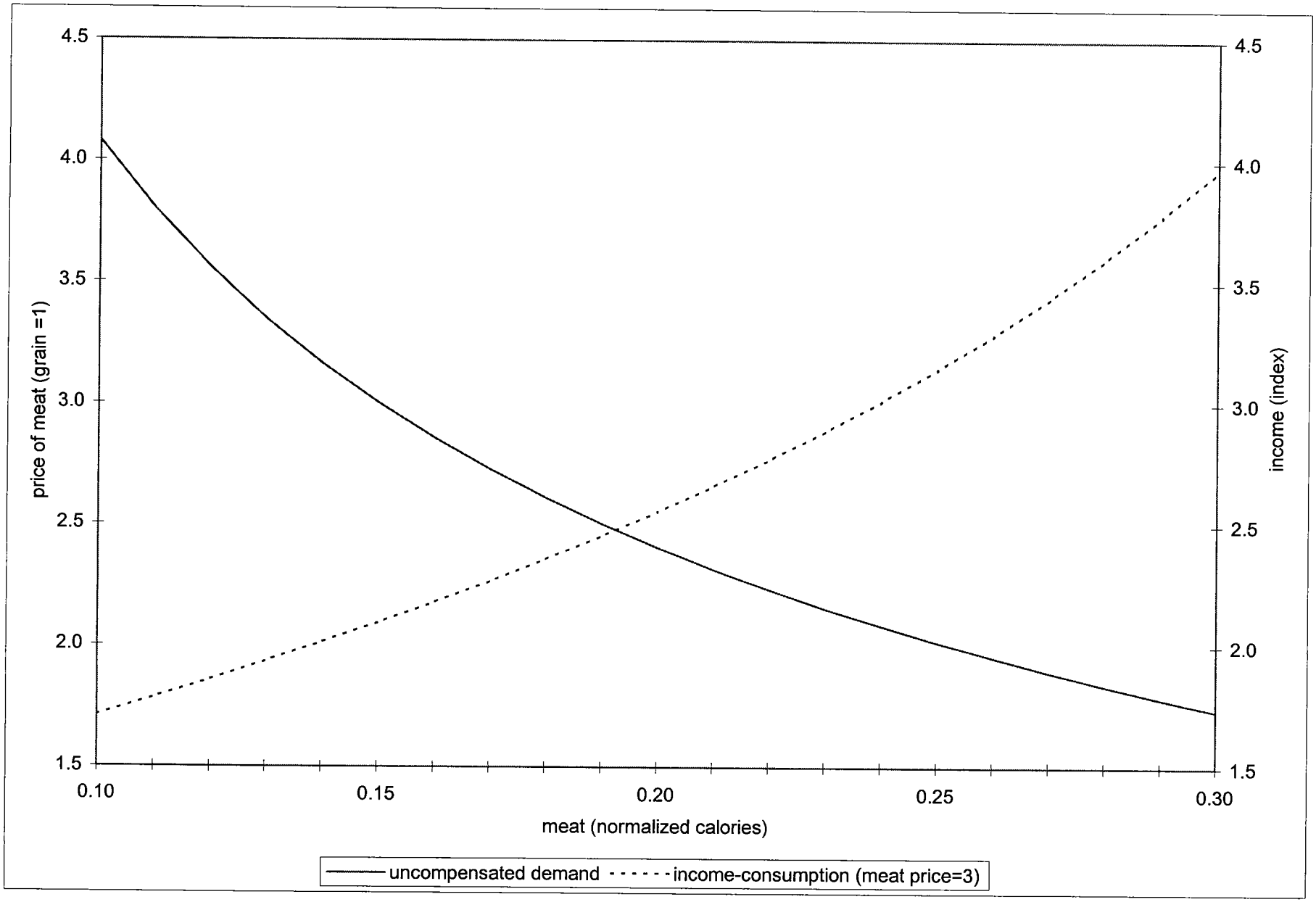

Figure 2
Height of 16-year olds and the Price of Bread / Price of Pork