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A Three-Decade “Kuhnian” History of the Antebellum Puzzle: Explaining the shrinking of the US population at the onset of modern economic growth

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A Three-Decade “Kuhnian” History of the Antebellum Puzzle:

Explaining the shrinking of the US population at the onset of modern economic growth

John Komlos¹

Abstract

In 1979, when anthropometric history was still in its infancy, Robert Fogel and collaborators reported that the height of the US male white population began to decline quite unexpectedly around the birth cohorts of 1830. This was quite a conundrum on account of the fact that according to conventional economic theory nutritional status was not expected to diminish at the outset of modern economic growth, i.e., at a time when incomes were growing robustly. Although many hypotheses were offered, not until 1987 was the comprehensive solution to the puzzle offered that the height decline was due primarily to a decline in food consumption: agricultural productivity did not keep pace with rapid population growth and urbanization. However, it took a third of a century for a Kuhnian paradigm shift to occur until most of the participants in the debate accepted the model elucidated by Komlos in 1987.

JEL: B20, B25, N00

Keywords: Anthropometric history, Heights, Thomas Kuhn, Paradigm shift, USA, Antebellum Puzzle, Living Standards

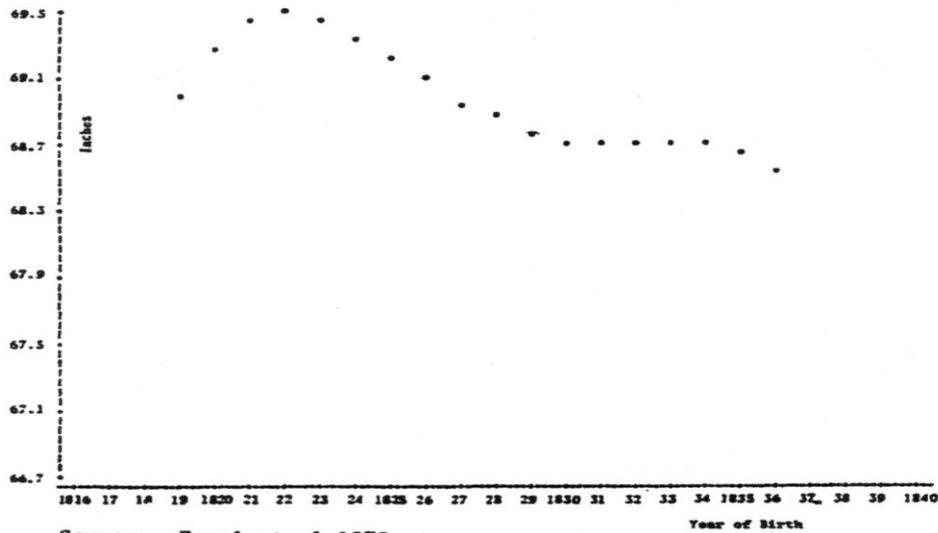
Introduction

The “Antebellum Puzzle” refers to the finding, first reported in 1979, that the height of the male US population declined during the decades preceding the Civil War , although they still remained the tallest in the world at the time (Fogel et al. 1979) (Figure 1). This was quite an

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anomaly insofar as the US economy was growing robustly in this period and one would not expect that the physical stature of a population would decline during periods of prosperity (Figure 2). In reflecting upon this finding Richard Steckel wrote some years later that the shrinking of the population in a growing economy “challenged firm beliefs that the quality of life was improving unambiguously after 1830...” (1998, p. 808). The explanation of this anomaly turned out to be stubbornly challenging, took many twists, turns, and detours, and no less than 32 years passed before a consensus was finally reached. While the initial finding was reproduced in many samples, agreeing on the cause required a Kuhnian paradigm-shift away from the mainstream neo-classical paradigm.

Figure 1. An index of the trend in the mean final heights of US Native-Born Whites, by birth cohort, 1819-1836 (estimated from data on recruits into the Union Army who were between ages 25 and 44 at the time of measurement)

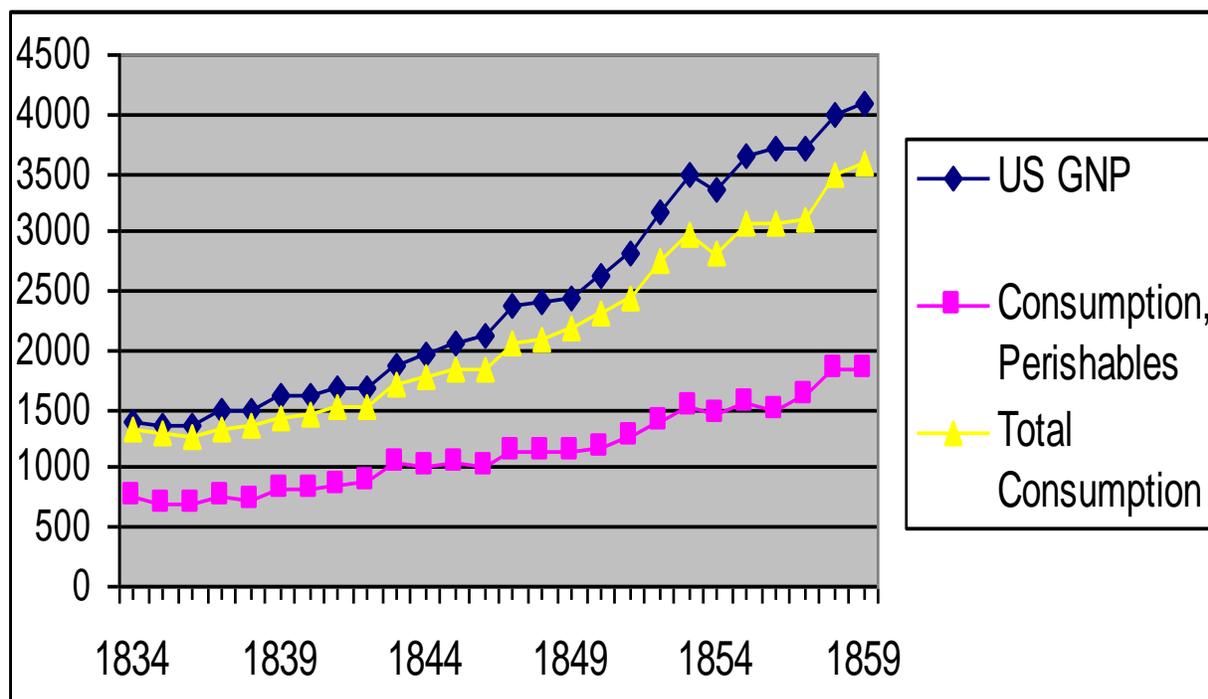


Source: Fogel et al 1979.

Source: Fogel et al., 1982.

Note: Graph was subsequently published in Fogel et al. 1983.

Figure 2. GNP Increased during the antebellum decades



Source: Rhode (2002)

From a theoretical perspective, we know that height is a positive function of income and in every single data set examined we do find that wealthier parents have taller children, everything else equal. There is absolutely no exception to this generalization as long as there are no simultaneous offsetting effects. Thus, we can infer that there must have been some offsetting effects which counteracted the increases in average income during the antebellum period. But what were they? Research trying to answer this question took a generation. This overview describes the history of this research program between 1979 and 2011.

The controversy revolved around the issue to what extent were the causes of the declining heights endogenous to the developmental process and to what extent were they exogenous. The former were those factors that were brought about by economic development such as increase in

food prices both relatively and absolutely, while the latter were factors that exerted an influence on nutritional status by outside forces such as the importation of diseases from the Old World, and were not directly linked to the ongoing economic transformation. The latter needs to be qualified to the extent that increases in population density that accompanied the onset of modern economic growth, as well as increased movement of people and goods brought about by a declining cost of transportation also facilitated the spread of diseases. Hence, the disease explanation is not entirely exogenous.

The plasticity of Homo sapiens provided them with an evolutionary advantage insofar as their size could adapt to the availability of nourishment (Bogin 1994). In other words, their body could expand in good times and take advantage of being larger, stronger, and hence more productive, while their size could shrink in bad times and require fewer nutrients for survival. That was a beneficial adaptation to the environment that fostered survival and the propagation of the specie. Similarly, the population became shorter in the course of the Neolithic agricultural revolution as the diet changed in such a way that less animal protein was consumed and more grains (Cohen and Armelagos, 1984; Mummert, et al., 2011). Likewise, the Industrial Revolution witnessed an identical pattern as people became shorter as an increasing share of the population was separated from the source of food supply (Komlos 1985, 1998). Whether the economic change reflected the transition from hunting and gathering to settled agriculture or the transition from agriculture to industry and the onset of modern economic growth, the biological system adapted to the new economic system by first becoming shorter. Hence, perhaps we should not have been so surprised that the onset of modern economic growth in the US which bore obvious similarity to the Industrial Revolution in Europe had the same consequences: a shrinking in the physical size of the population experiencing this momentous socio-economic change. This is the history of that puzzle to its resolution a third of a century later.

The Kuhnian framework

The narrative is organized along Thomas Kuhn's framework for incorporating anomalies into normal science (1962). His insights on the sociology of knowledge are useful insofar as his observation that knowledge does not emerge from research in a straightforward manner applies quite well to the Antebellum Puzzle. The discovery of declining heights during prosperous times was clearly an anomaly in the normal science of neo-classical economics and as such quite disturbing to the conventional wisdom. Growth was supposed to have all-around positive effects. Exceptions were not welcomed. Hence, the neo-classical paradigm was defended by repeatedly stretching it to its very limits – attempts that I refer to below as the creation of “Ptolemaic epicycles”. There was considerable resistance to changing the mainstream view into thinking that progress might be multidimensional and that all dimensions of well-being may not move in the same direction at crucial junctures of the developmental process. As Kuhn suggested, reaching consensus took a very long time. In his view, the weight of evidence accumulates until a tipping point is eventually reached which, in turn, provokes a paradigm shift. In the case of the antebellum puzzle, that shift took nearly a third of a century.

Steckel also applied Kuhn's framework to the inception of anthropometric history:

“The intellectual history of the new anthropometric history... demonstrate(s) that new methods often meet scepticism if not outright resistance. Those who challenge the status quo face a large body of literature that has already defined important research questions and acceptable approaches. New methods requiring unfamiliar data sources must address important topics in which there is already an established interest, confirming some beliefs that are well established while providing new, plausible results on others” (2009, p. 16).

The Antebellum Puzzle

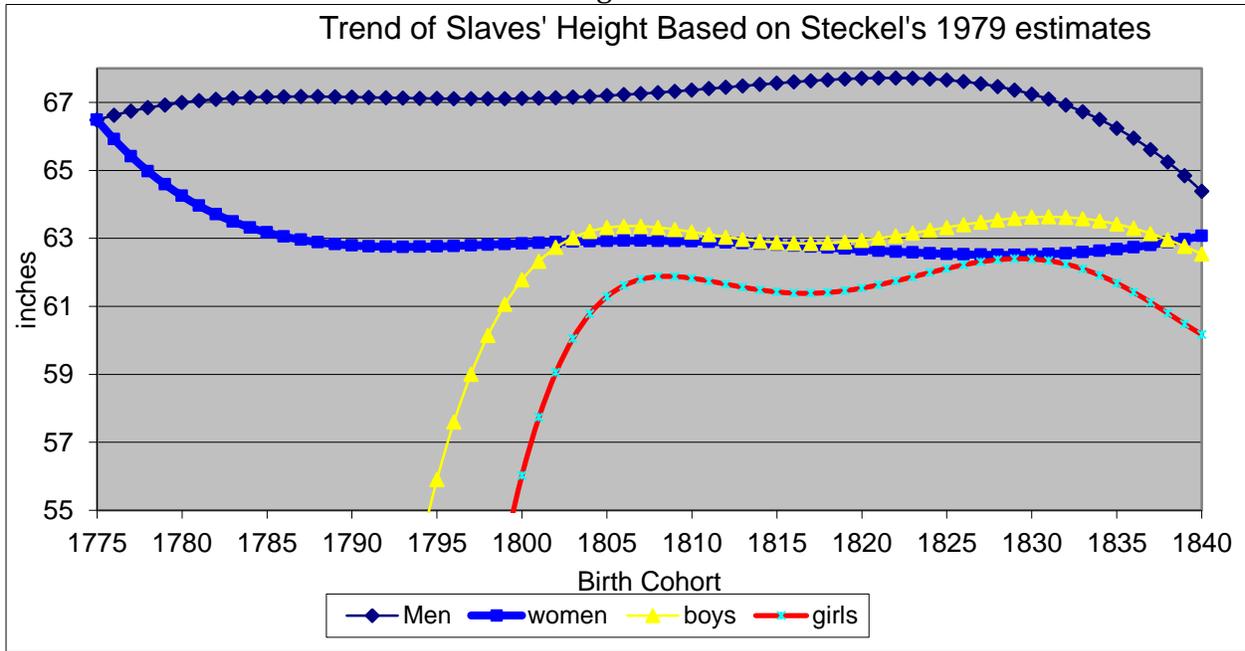
The very first to come across the evidence of declining heights prior to the Civil War was the anthropologist Benjamin Gould. He observed astutely that the height of Union Army recruits increased with age but drew the wrong inference that U.S. men continued to grow physically until the age of 30 (1869, p. 104). However, we know that even in populations with a lower nutritional status growth ceases by age 23 at the latest (Komlos, 1989). Hence, he confused birth cohort effects with age effects which is easy to do in cross sectional data.

The pattern was rediscovered 110 years later when Fogel et al. reported their preliminary finding, still based a tiny sample of Union army soldiers, that their result "...suggests that both black and white cohorts born during the late antebellum era may have experienced deteriorating nutritional and health conditions¹ (Figure 1) (1979, p. 27). The study raised practically all the possible causes of the puzzle that were to occupy researchers for a generation. It suggested that the decline in heights was possibly related to the increase in inequality, to immigration, the intensification of labor, and the increase in urbanization (1979, pp. 36, 38, 42). The authors also asserted that the "conditions of life" in the urban areas deteriorated, by which they probably meant that the disease and sanitary environment of the rapidly growing cities worsened. While it did raise the possibility of declining food consumption, it did not consider it very likely: "It should not be assumed that the decline in stature after the mid-1820s necessarily implies a reduction in the per capita consumption of calories and nutrients" (p. 42).

The working paper also repeated Steckel's finding that the height of teenage slaves born in the 1830s declined (Steckel, 1979, p. 377). However, this assertion was based on the estimate of a 5th-degree polynomial trend which is sensitive near the end of the period under consideration to the estimated coefficients, when the number of observations was likely small. Steckel found a decline of 2-3 inches in slave adolescent height that would have implied famine-like conditions

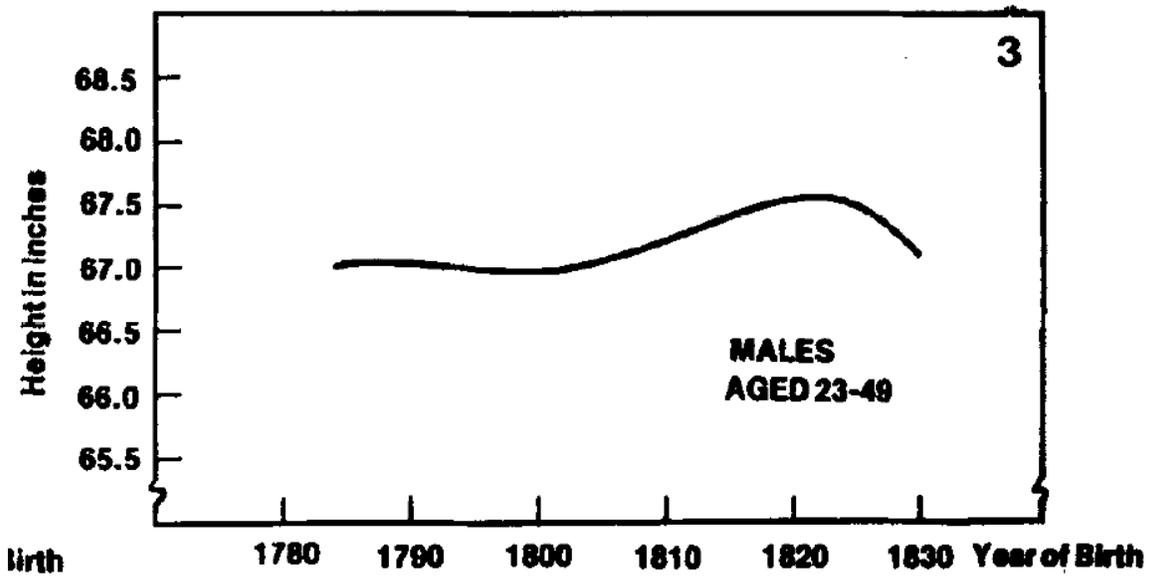
in the U.S. This is just one indication that these estimates were not accurate at the ends of the dates considered (Figure 3). Unfortunately these trend estimates were not repeated by Steckel after his sample size was substantially increased. However, Steckel did also estimate trends of both male and female adult slaves again using 5th-degree polynomials but reported height fluctuations rather than a declining trend although men's height do appear to decline slightly (Figures 3 and 4).² However, the subsequent republication of the trend in the height of slave men depicted the trend quite differently: this time the decline in heights in the 1830s was replaced by an uptick and that of the females was dropped (Figure 5). This graph was republished in 1983 and also appeared in Margo and Steckel (1982). In short, there tended to be ambiguity with regard to the trend in slave heights in the first years of anthropometric history. The height of youth appeared to be declining in the 1830s while that of men and women tended to be constant, declining or increasing depending on which perspective one preferred: "the data on blacks taken from the Union Army muster rolls, which mesh quite well with the results from slave manifests for overlapping cohorts, indicate that cohorts born in the late 1830s and early 1840s may have experienced a decline in final heights..." (Fogel et al., 1982, p. 17 and Fogel et al. 1983 p. 465).

Figure 3



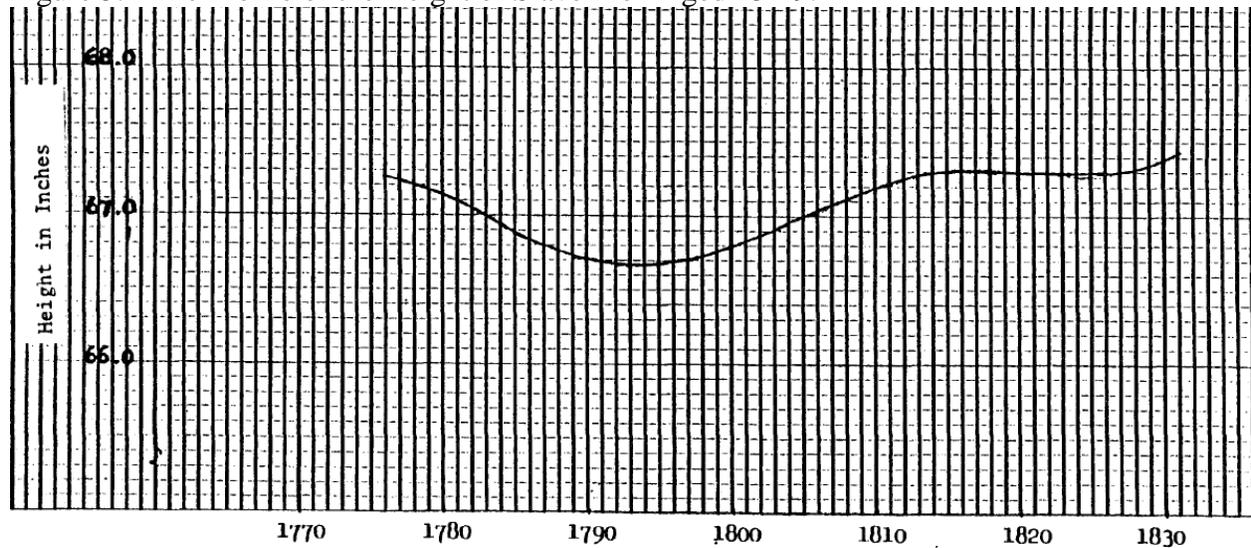
Source: Graph is based on regression coefficients reported in Steckel, 1979.

Figure 4. Trend in the Height of Slave Men



Source: Steckel, 1979, p. 377

Figure 5. Time Profile of the Height of Slave Men Aged 23-49.



Source: Slave manifests.

Fogel et al. 1982, p. 16. Published in Margo and Steckel 1982.

Three years after the initial publication of the Antebellum Puzzle, Fogel et al. (1982a) reasserted the decline in height of union army soldiers of about 1 inch³ (2.54 cm) (Figure 1). The paper was subsequently published in 1983. The authors also reported, quite astonishingly, that Americans reached modern levels of height and nutrition by the time of the American Revolution, but “there were long periods of declining nutrition and height during the 19th century.” As far as causes for the decline in heights were concerned the authors mentioned a number of endogenous forces accompanying economic development that were subsequently intensely debated: “A variety of factors, including crop mix, urbanization, occupation, intensity of labor, and immigration affected the level of height and nutrition...” (1982a, p. 27). It repeated the assertion of three years earlier that food consumption should not be implicated in the decline in heights in general, but this time added a caveat: “...it is possible that the food consumption of the urban laboring classes did decline between 1825 and 1860” (1982a, p. 31, 1983, 476). “It seems likely... that most of the ...decline was due to a rise in the intensity of labor, a *decline in*

meat consumption, a rise in morbidity...” (1982a, p. 28, 1983, p. 473), bringing meat consumption into the discussion for the first time. Furthermore, the “...sharp rises in the cost of shelter could have led to decreases in the amount of food consumed, particularly in the consumption of such relatively expensive foods as meats and fish, even in the face of constant or declining food prices” (1982a, p. 32, 1983, p. 476). However, there was little mention of disease as a possible exogenous offsetting element to the growth in average income. Instead there was a hint that diseases were not likely to be the cause of the height trends observed: “Major diseases... delay growth, but recovery leads to catching-up and... do not cause permanent stunting” (p. 40). Subsequent research divided sharply among the endogenous and exogenous causes of the decline in heights, but initially at least Fogel et al. appeared open to the nutritional endogenous explanation of the puzzle.

1982 was an important year for anthropometric history. Not only did the above significant working paper see the light of day but a special issue of *Social Science History* was devoted to anthropometric history (Fogel & Engerman 1982). In the introduction Fogel & Engerman reiterated the major finding that “there were long periods of declining nutrition and height during the nineteenth century. ...A variety of factors, including crop mix, urbanization, occupation, intensity of labor, and immigration affected the level of height...” (p. 395), and also that “...there were cycles in the final heights of native-born whites and of U.S. blacks...” (Fogel et al. 1982b, p. 416).

An important article in the special issue was devoted to the height of slaves (Margo and Steckel 1982). The trend in the height of male slaves (Figure 5) which differed from the one reported in 1979⁴ (Figure 4) appeared in it. In addition, the trend based on the coefficients reported in their regression estimates (Figure 6) differed from the trends depicted in Figure 5. According to the regression, male slave heights increased by 0.97 inches between 1790-1800

and 1830-40, while the increase in the graph is 0.77 inches. While this seems like nit-picking, the 0.2 inch difference is substantial insofar as the visual image makes it appear as though slave heights were not increasing at all on account of the tall men in the 1770s and 1780s in the graph, (much greater than that suggested by the regression). Thus, in the graph the visual impression is that the height of slave men fluctuated but did not increase at all as implied by the regression estimates (Figure 6 and Table 1). Although they report that “adult heights increased by 0.4-0.7 inches per generation for post-1810 cohorts...” (p. 521), they do not discuss the fact that the graph in the same article is quite different from the regression results; nor do they discuss the differences with the earlier finding of 1979 which showed a decline in height, or the contrast with the trend in the height of whites. As a consequence, the presentation of the results draws attention away from this anomaly within the Antebellum Puzzle and was consequently ignored

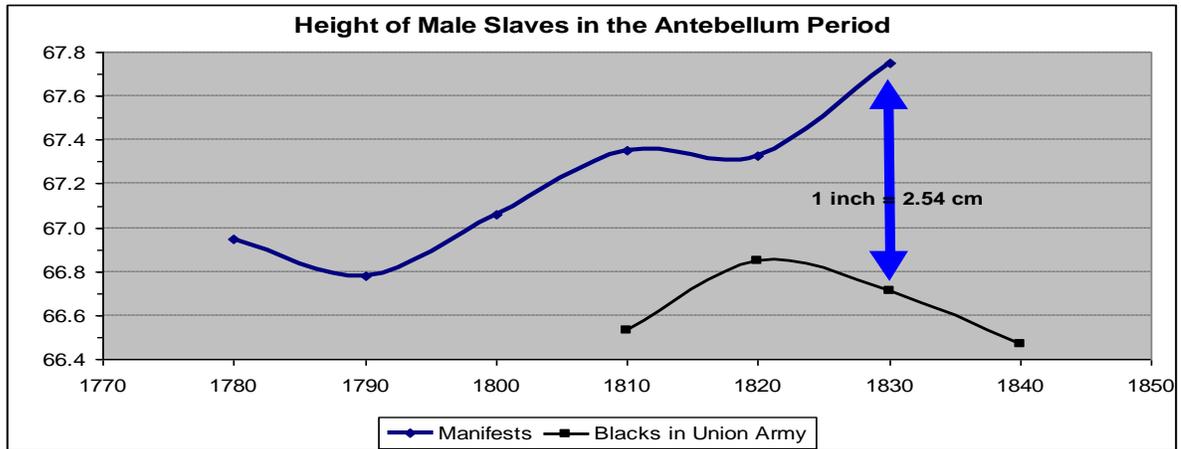
Table 1. Regression Results of Adult Height for Male Slaves: Manifest Sample

Born 1790-1800	-0.17
Born 1800-1810	0.11
Born 1810-1820	0.40
Born 1820-1830	0.38
Born 1830-1840	0.80

Source: Margo and Steckel 1982, p. 520.

by the literature for longer than a decade, even though it would have been a significant contrast to the decline in male white heights. It would have cut short the disease explanation of declining heights, insofar as a general deterioration in the epidemiological environment probably would have affected the slaves as well as rural southern whites. Why would the slaves be immune to a worsening disease environment, if indeed, it was worsening?

Figure 6.



Source: Margo & Steckel, 1982, p. 527.

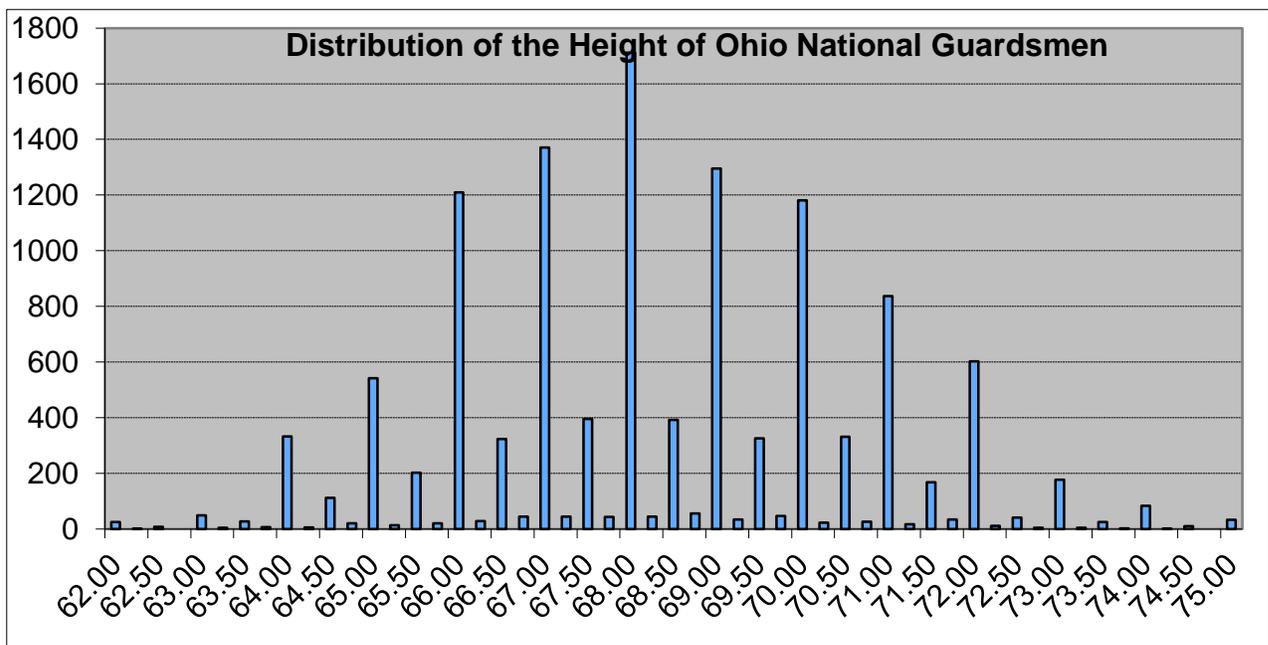
They do, however, contrast the trend of the height of the slaves transported in interregional trade and those of the black union army soldiers: “The apparent reduction in height for 1830s cohorts compared to 1820s cohorts is puzzling in light of our results for the manifests, which show an increase in height for 1830s cohorts⁵” (Margo & Steckel, 1982, p. 527). 27 years after the 1979 publication Steckel published the trend in the height of adult slaves without the dip in the 1790s, and with a trend that stopped abruptly in 1800, hence did not address the controversy of the antebellum period (2006), with an obvious suppression of evidence.

As noted above, 1982 was a busy year. It also marked the appearance of a working paper on the height of Ohio guardsmen (Steckel and Haurin). It documented a decline in height of birth cohorts of the 1850s. This was not quite pertinent to the Antebellum Puzzle as these cohorts could have been affected by the Civil War and nutritional status and heights were expected to decline among those who experienced the turmoil and dislocations of the Civil War. The Antebellum Puzzle actually pertains primarily to the birth cohorts of the 1830s who reached adulthood prior to the outbreak of war. Nonetheless, had it been published immediately it would have supported the view that the trends that began prior to the Civil War actually continued well into Reconstruction. As it turned out, the paper was not published until a dozen years later,

consequently did not have much influence on the development of research on the Antebellum Puzzle.

We should note that the trend was not estimated correctly, because Steckel and Haurin used ordinary least squares to analyze the Ohio data, whereas there was a minimum height requirement to become a guardsman. The height distribution indicates that about 5.6% of the observations are missing in the left tail, i.e., below 66 inches (Figure 7), implying that average height is overestimated and the trend itself is biased in as much as it is not at all evident that the minimum height requirement was enforced uniformly over time. As a consequence, truncated regression would have been the correct approach. This is a pity, because subsequently the falsely estimated trend was used extensively, actually until today, in order to extrapolate the trend in height at the national level for which a national sample was until recently unavailable. This

Figure 7.

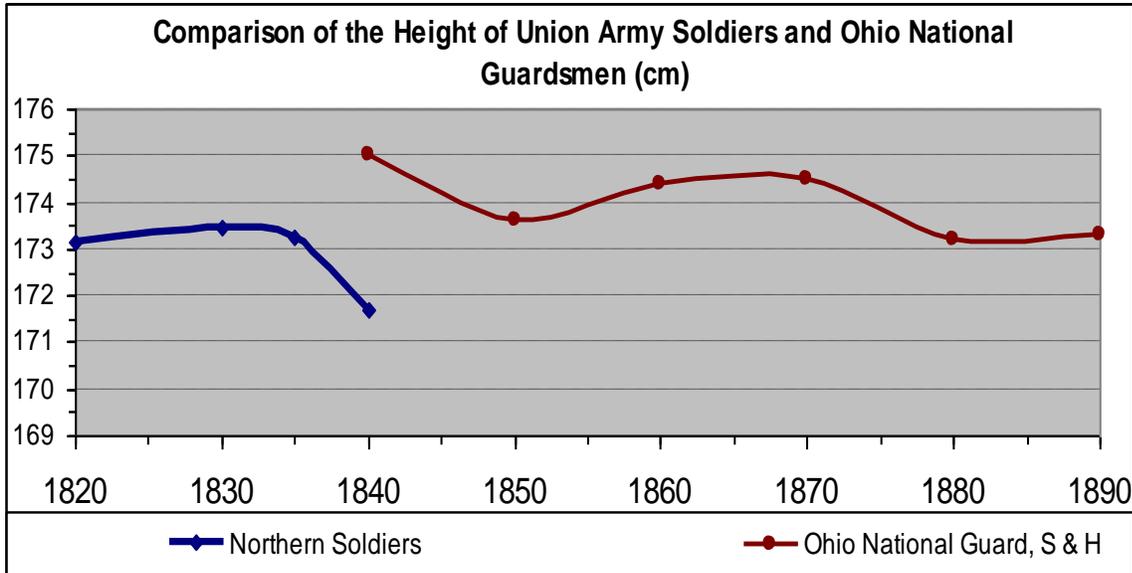


Source: author's calculation based on data published in Steckel and Haurin 1982.

strategy was quite risky as the levels of the two estimates are quite different, and there was no warrant for supposing that the height trends in Ohio were close to being representative of that of

the nation at large (Figure 8). A quarter century later, the strategy was shown to be quite inaccurate (Zehetmayer 2011).

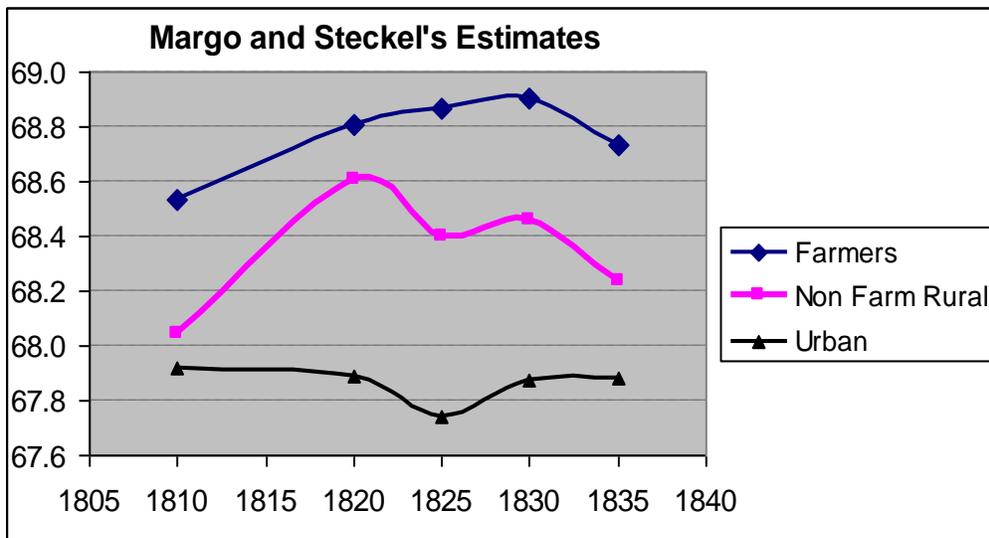
Figure 8.



Source: Steckel and Haurin 1982.

Next, Margo and Steckel analyzed the height of white Union Army soldiers more thoroughly than was done earlier⁶ (Fogel et al. 1982, 1983; Margo and Steckel, 1983) but unexpectedly did not even mention the decline in heights at all, even though the coefficients of the time dummy variables were significant and negative in their regressions (Figure 9). As a

Figure 9



Source: Margo and Steckel 1983, p. 170.

consequence of not noting the decline in heights, they do not discuss their possible causes either as did Fogel et al (1982, 1983). Instead, they emphasized the increase in height of the rural population before 1835 and the stagnation of urban heights throughout the period. Hence, their publication was somewhat impervious to the significance of the Antebellum Puzzle in stark contrast to Fogel et al. (1982, 1983). They did, however, suggest that the cause of the stagnant urban heights might have been a decline in food consumption: the rise in incomes was possibly offset by the increases in urban rents: “a reduction in food intake cannot be readily dismissed: the rapid growth of cities between 1820 and 1860 appears to have caused severe housing shortages, and thus possibly a sharp rise in the price of shelter... [which] could have led to a reduction in food consumption, particularly among the urban poor” (p. 173).

In 1983 Steckel documented that the income distribution affects average height of the population. The reason is that there are diminishing returns to the consumption of nutrients and the income elasticity of demand for nutrients (calories, protein, micronutrients) declines with income. While not immediately applied to the Antebellum Puzzle, the result was relevant insofar as Fogel et al. (1982) already brought up the possibility that an increase in income inequality could have contributed to the Antebellum Puzzle.

In the 1983 publication Fogel, et al. Mentioned for the first time that a deteriorating disease environment might have contributed to the antebellum Puzzle: “...changes in the ethnic composition of the native-born population, increased claims on food intake as a consequence of increased intensity of labor or a deteriorating disease environment, and shifts in the urban-rural composition of the population” (p. 480). In 1979 the disease explanation was confined to the urban population. Furthermore, Fogel et al. provided more detail about the possible decline in

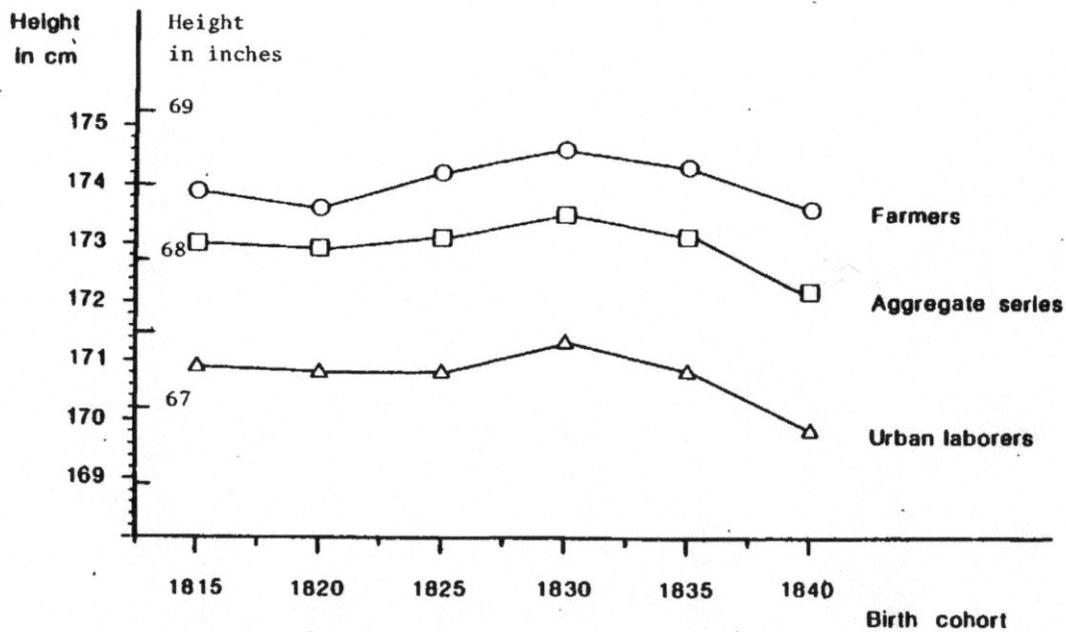
food consumption among the urban population: „This possibility cannot be ruled out either because of the slight downward trend in food prices or because of the upward trend in some of the currently available indexes of real wages.... the series on money wages may confound urban with rural wage rates and is not adequately standardized for locational and occupational mix. Another part of the problem is that the current measures of consumer prices do not include data on the cost of shelter, which may have accounted for a quarter or more of the total expenditures of urban laborers during this period.... Consequently, it is entirely possible that an index of consumer prices that included the cost of shelter would show a decline in the real wages of urban laborers between 1825 and 1860... sharp rises in the cost of shelter could have led to decreases in the amount of food consumed, particularly in the consumption of such relatively expensive foods as meat and fish.”

In sum, very early on into the anthropometric research program, that is to say by 1983, Fogel et al. identified many of the main developments accompanying the onset of modern economic growth in the U.S. in the antebellum period that could have had an impact on the height of the population. The list included the possibility of a decline in food consumption among the urban population; meat consumption was mentioned a couple of times; deteriorating living conditions in the urban areas and disease in general were mentioned several times. These assertions were made in terms of hypothesis rather than evidence. However, Margo and Steckel (1983) was more reserved in this regard and failed to mention the Antebellum Puzzle. The issue of the trend in slave heights remained more opaque than that of whites.

In 1984 Fogel published another working paper (the first time without co-authors) in which he boldly reiterated previous findings pertaining to the Antebellum Puzzle: “Native-born farmers who were born c.1860 were about 1.5 inches shorter than those who were born three decades earlier.... the final heights of urban laborers declined by about 0.8 inches. Thus,

although deteriorating conditions in the cities and the shift of population from the countryside to the cities played a role, they explain only about one-fifth of the decline in the aggregate series... About four fifths of the decline was due to a deterioration of conditions affecting growth in the rural areas” (p. 78). This was an important step forward insofar as it concluded that the phenomenon was not confined to the urban population. Moreover, it was more forthright than Margo and Steckel in identifying the Antebellum Puzzle as a national pattern. It also contradicted Margo and Steckel’s finding with regard to the urban population by showing that urban heights, at least those of laborers, did, in fact, decline (Figure 10). Furthermore, he presented for the first time height estimates from colonial times until World War II confidently interpolating for period from the mid- to the late-19th century on the basis of the Ohio evidence (Figure 11). This interpolation, while acceptable as an obvious temporary measure, became permanent insofar as it was taken over and repeated until to the very present, and therefore of lasting importance. In the most recent versions, the interpolations are sometimes not even indicated as such. It basically assumed that heights continued to decline until the cohorts of the 1880s and 1890s so that not until the turn of the century would have heights begin to increase. It was not revised until Zehetmayer (2011).

Figure 10.. The Trend in the Height of Native-Born White Farmers, Urban Laborers and Average for the Union Army Sample

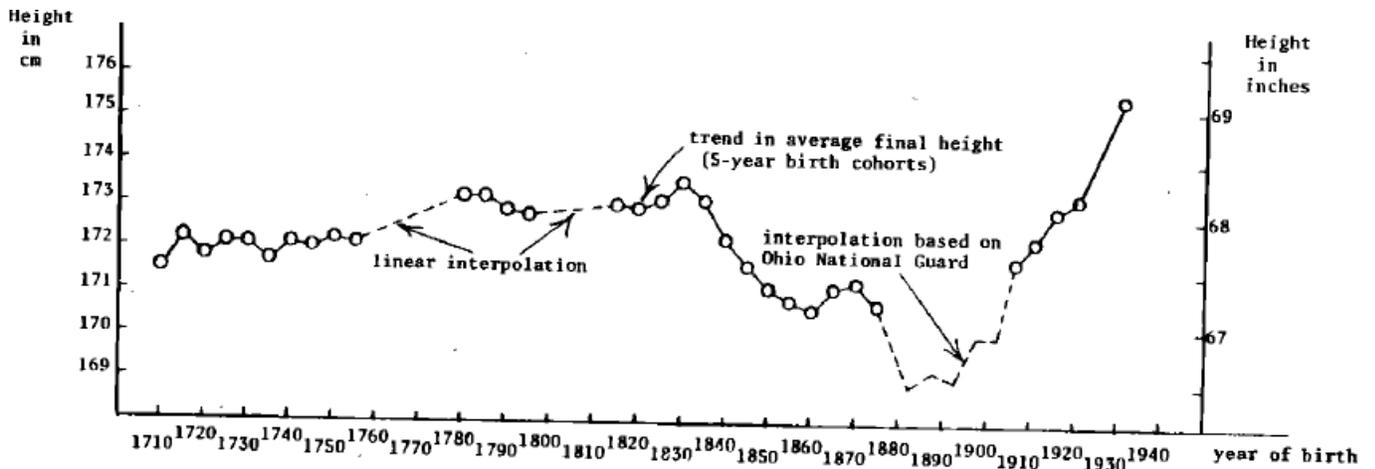


SOURCE: Fishman and Walker (1984)

Source: Fogel 1984 p. 79 and 1986, p. 95.

Fogel continued by suggesting that immigration was probably not the cause of the decline in heights: “One possibility is that an increasing proportion of the native-born rural males were children of foreign born parents.... Support for this hypothesis is found in a subsample of the Union Army recruits which has been linked to the manuscript schedules of the 1860 census. This subsample reveals that in the rural areas native-born males of foreign parents were 0.4 inches

Figure 11. Trend in the mean Final Height of Native-Born White Males



Source: Fogel, 1984, p. 44; 1986 p. 41; Steckel, 1991, p. 56; 1995 p. 1920; Costa and Steckel, 1995, p. 5; 1997, p. 51; Fogel, 2004, p. 17.

shorter in final height than native-born males of native-born parents. The effect of parental ethnicity was even greater in the cities, with children of foreign-born parents averaging 1.2 inches less in final heights than children of native-born parents....[However,] the ethnic effect could only have accounted for a small share of the rural decline.” More importantly, he mentioned the possibility of a disease explanation again, this time for the rural population: “Another possibility is that exposure of farmers to disease increased as farming pushed into swampy areas in the northern States...⁷” (p. 80).

He thought that a general decline in food consumption was not too likely: “it is difficult to believe that per capita food consumption was declining during the last two-thirds of the nineteenth century since there is so much evidence pointing in the opposite direction. Yet there could have been more unequal distribution of food products, especially of meat, which adversely affected the nutritional status of the poor. This appears to have been the case with blacks whose nutritional intake apparently declined, and whose mortality increased, between 1860 and 1880” (p. 84). Hence, he was somewhat open to an explanation based on the decline in meat

consumption but especially in terms of changes in its distribution, less so in terms of aggregate output.

In 1986 Fogel estimated the amount of the decline that was attributable to a population shift to urban areas: “Deteriorating conditions in the cities and rural to urban shift of the population account for 1/5th of the decline in heights” (1986a, p. 97; 1986b). He also pointed to the simultaneous decline in life expectancy: “Life expectation of US Native Born White Males declines by 3.4 years in the 2nd quarter of the 19th century” (1986a, p. 43; 1986b), and reiterated the conundrum in the decline of rural heights: “The decline of heights in the rural areas is particularly puzzling. The ethnic effect could only have accounted for a small share of the rural decline... the evidence on the growth of per capita income in the Midwest between 1830 and 1860 is so compelling, and midwestern farmers as a class seem to have prospered so much during this era, that it is not easy to accept the hypothesis that their food consumption declined...”

Thus, seven years after the discovery of the Puzzle, normal science of cliometrics failed to provide a coherent and comprehensive solution to the problem. There were many plausible possibilities discussed and almost exclusively by Fogel. His students remained more cautious, and furthermore the height of slaves was not brought into a unified discussion of the Antebellum Puzzle in a convincing way.

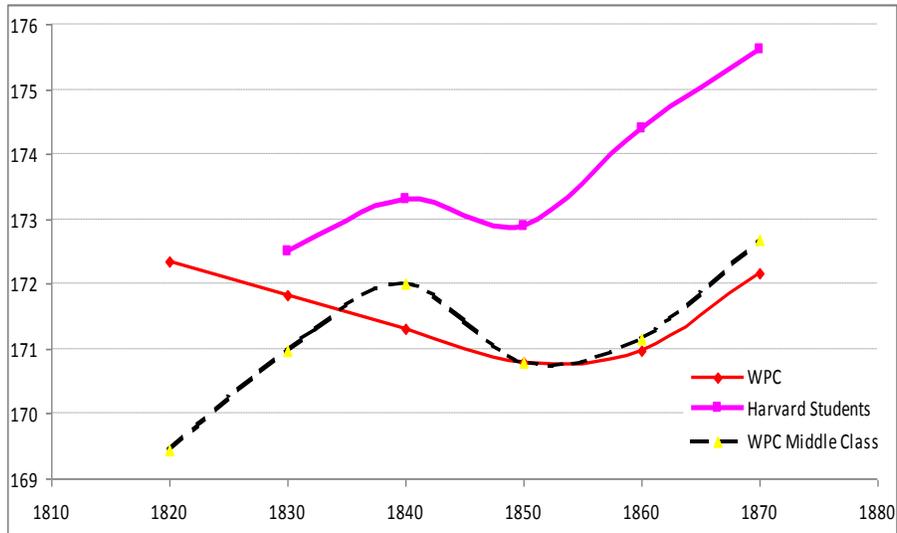
1987 – An endogenous solution is offered to the Antebellum Puzzle

Until 1987 the evidence was confined to Union Army soldiers so a sample anomaly could not be ruled out entirely. However, a new sample drawn from the West Point Military Academy did corroborate the general decline in heights beginning with the cohorts born in the 1830s, i.e., those who reached adulthood prior to the outbreak of the Civil War and therefore whose height would not have been affected by the war (Komlos 1987). So it became evident that white male

heights did, in fact, decline during the prosperous antebellum decades and did so nationally. This paper was a milestone insofar as it put forth a comprehensive endogenous explanation for the decline in heights in terms of the internal logic of a modernizing society in which industrial production was growing rapidly along with urbanization and consequently, the share of the labor force in agriculture was declining markedly. Moreover, it presented statistical evidence that per capita food consumption, did, indeed, decline in terms of calories as well as proteins but also in terms of dollar amounts even without taking the rise in inequality into consideration⁸ (p. 914). In other words, technological change and productivity growth in the agricultural sector did not keep pace with the growth of the population: “The nutritional status of a population can decline even during prosperous times at the early stages of economic development, while the economy adjusts to sectoral shifts in production⁹” (p. 898).

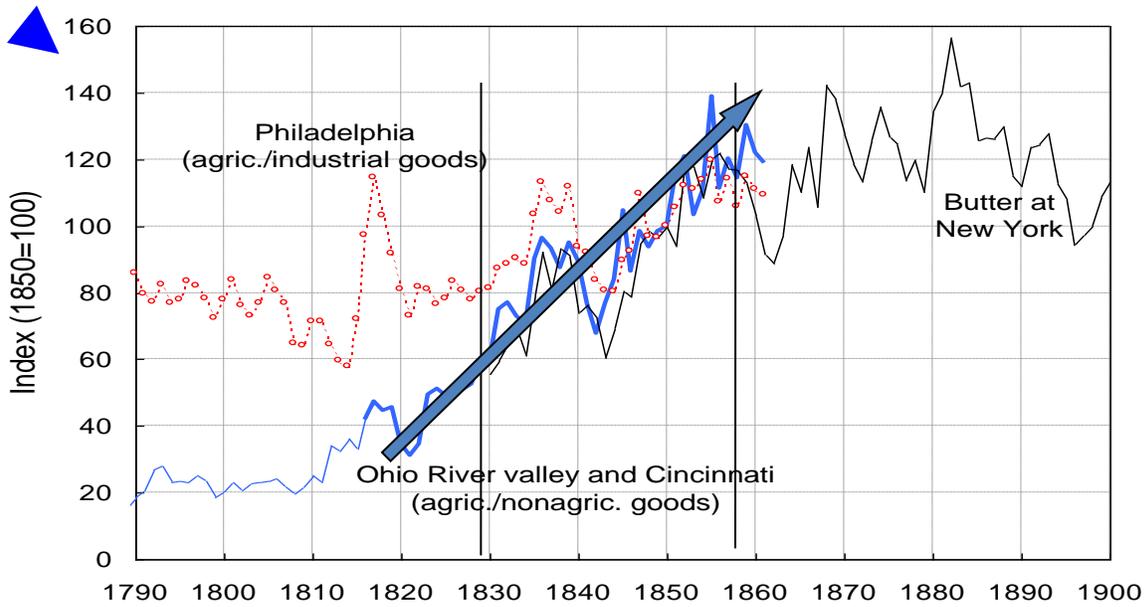
Another key innovation in this paper was that it suggested that there were segments of the population whose heights did not decline. These exceptions were exceptionally important because they pertained to the economic elite: the sons of professionals as well as Harvard students (Figure 12). This finding contradicted the disease explanation directly, inasmuch as the height of this segment of the society would also have been affected if the epidemiological environment had deteriorated generally¹⁰ (p. 902). Rather, these groups were more able to afford the rising price of nutrients¹¹ (Figure 13) (p. 915). Moreover, the paper argued that heights could decline with increasing incomes provided the relative price of nutrients increased, as they in fact did, insofar as people substituted away from food consumption toward industrial products (Figure 14). Hence, income and utility can increase even as food consumption and height diminish (Figures 14 and 15). This distinction is important because it enables us to clarify that heights do not fully capture what we usually mean by living standards.¹² Inequality also increased, contributing to the decline in heights (Figures 16 and 17).

Figure 12. Height of West Point Cadets, Middle Class West Point Cadets, and Harvard Students



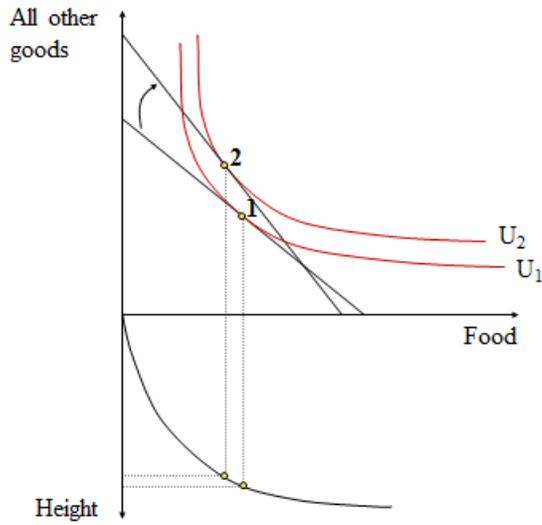
Source: Komlos 1987.

Figure 13. Increase in the relative price of food in the Antebellum Period



Source: Sunder, 2007.

Figure 14. A rise in the relative price of food can lead to a decline in heights even if income increases



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Figure 15. Utility can increase even if food consumption decreases

Utility and Food Consumption of an Individual before and after Market Integration

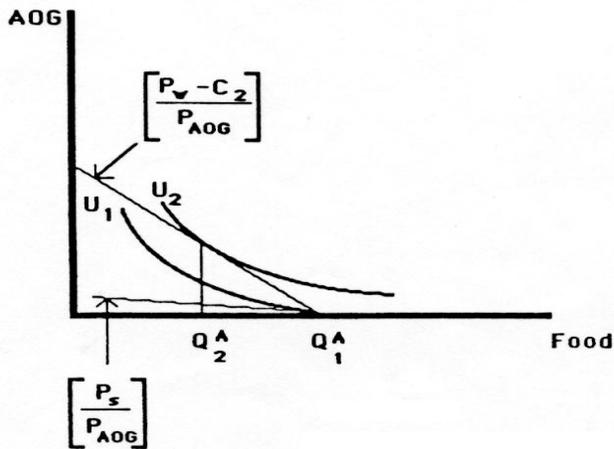
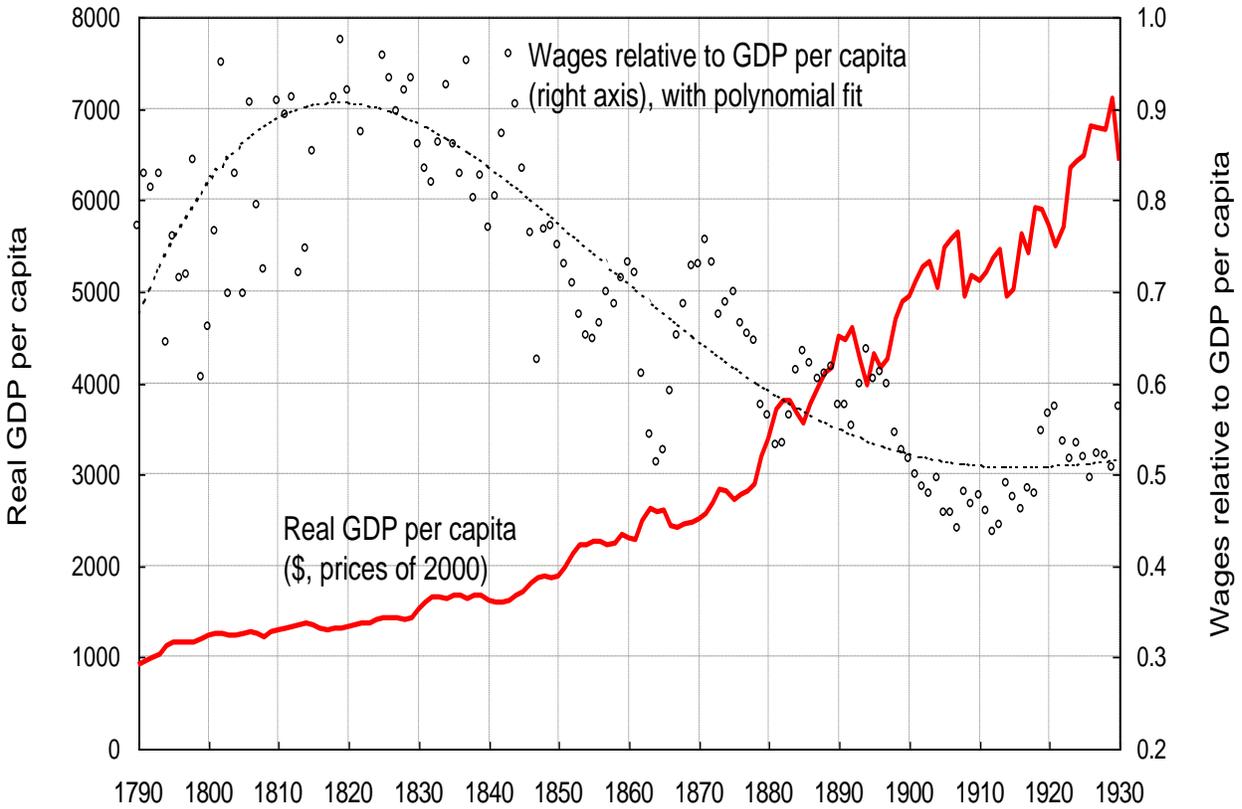


Figure 16. Inequality increased in the Antebellum Period



Source: Sunder 2007.

Another advantage of the West Point data set was that it also contained information on the weight of the cadets (Figure 18). Average weight of 20-year-old cadets born in the 1850s was 131 pounds (60 kg) with a BMI value of 20.4 (Cuff 1993). This implies that nutritional status was low relative to their work and disease loads: “evidence on the weight of the cadets contradicts the notion that they had unlimited access to food supplies. In fact, they were quite underweight: many weighed between 100 and 120 pounds... the weight of the cadets is the only incontrovertible evidence on the contemporaneous nutritional intake of the cadets relative to the claims on those nutrients, and for the period no estimate of caloric consumption can be raised to

the same level of accuracy” (p. 919). This pattern could not have been caused by episodic epidemic disease encounters, because weight loss is easier to make up than that of height.¹³

Figure 17. The Effect of Income Inequality on the average height of a population (stylized)

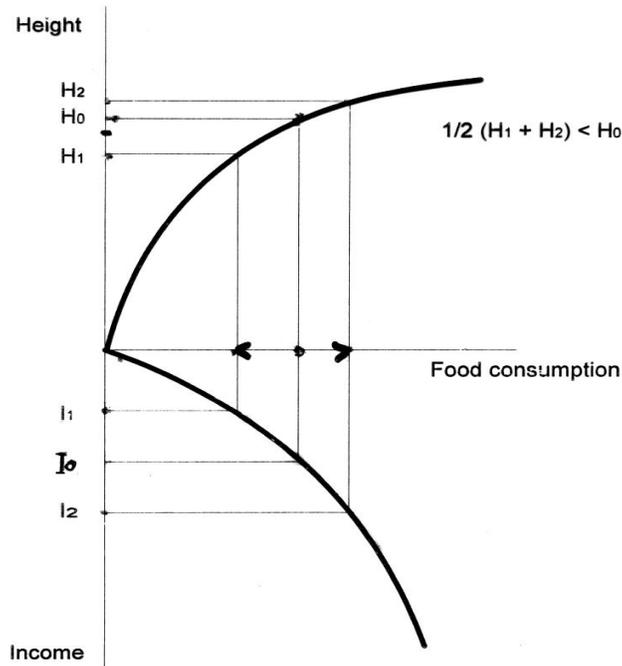
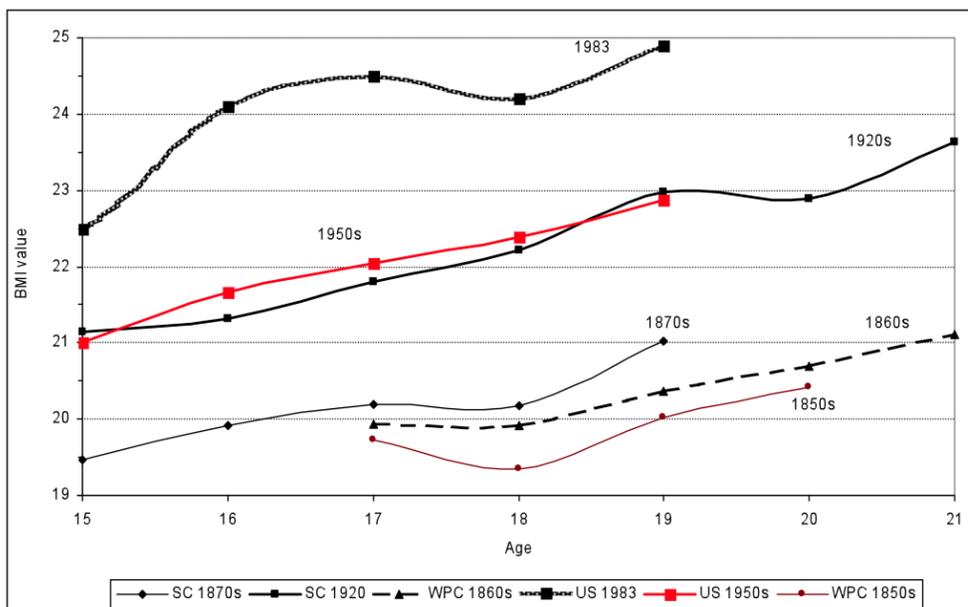


Figure 18. BMI values of 18-year-old White Americans



This paper became controversial, because it pointed out that the internal dynamics of economic growth had hitherto unknown negative externalities which were difficult to integrate into the mainstream “whigish” view of American economic development: one would have to acknowledge the possibility that economic growth brought with it not only progress but, for one or two generations, interfered with the biological growth process of children and youth. However, there was supporting evidence as well: Goldin and Margo showed that the birth weight of poor children in Philadelphia prior to the Civil War was in the 10th-25th percentile of modern standards¹⁴ (1988, p. 10). Their research on wages and prices also showed that unemployment rose in the periods 1839-42 and 1854-55 at a time when real wages were rising. Thus, nutritional status could have declined even as real wages were increasing (Goldin & Margo, 1989, p. 18; 1992). Moreover, the panic and recession of 1837 was accompanied by labor unrest and strikes: “Nominal wages lagged behind when prices soared in the mid-1830s and early 1850s, contributing to a wave of strikes and labor agitation. In the late 1840s and early 1850s labor markets in the North were glutted by the increased supply of immigrants” (Margo & Villaflor, 1987, p. 889). Importantly, nominal wages stagnated throughout the antebellum period until 1853 when they rose slightly. The point is that real wages fluctuated considerably depending on the price of food, but variability is in itself detrimental to the nutritional status of fetuses or subsequent to birth if it occurs at a sensitive moment in the growth process. In other words, one should consider variability of income as an independent causal factor in the decline in heights (Komlos 1998). While real wages might increase, they did so only because the price of manufacturing was decreasing, but insofar as food prices were increasing it would have been difficult to maintain the level of food intake at the level of the 1820s with constant nominal wages (Margo & Villaflor, 1987, p. 880). As a consequence, the value of nominal wages in terms

of food declined throughout the period. So it was slowly becoming apparent that not all developments were favorable to welfare in the antebellum economy.

In his next in a series of working papers, Fogel reiterated that "...pressure on the food supply does not seem to be a likely explanation for the U.S. decline in heights and in life expectation.... Calories available for human consumption appear to have increased between 1840 and 1860. In any case both average calorie and protein consumption were high throughout the period of decreasing stature and life expectation, exceeding 3,600 calories and 120 grams of protein per consuming unit daily.' These levels are in excess of current recommended daily allowances..." (1990, p. 41). Of course, today's recommended allowances are not made for 19th century energy expenditures or disease loads. Furthermore, the above assertion did not consider that the West Point Cadets were underweight and also that middle class cadets and Harvard students were immune to the declining heights. Most importantly, Fogel also disputed vigorously the evidence presented in the West-Point paper that food consumption was decreasing. The argument was placed in two footnotes: "Komlos (1987) has argued for a slight decline in caloric intake between 1839 and 1859, but this result is based on the assumption that human corn consumption was just 4 bushels per capita throughout the period, despite the rise in output per capita and in output per consuming unit (including livestock) of about 56 percent (Fogel 1965, p. 206). An increase of human corn consumption by about half a bushel per capita annually between 1840 and 1860 wipes out the small decline in calories postulated (*sic*) by Komlos. The large increase in corn feed per consuming unit also casts doubt on his assumption that the slaughter weight of livestock remained constant."

For the record it should be noted that Komlos did not *postulate* a decline in calorie intake. Rather, the conclusion of a decline in the calorie and protein content of food consumption was based on considerate weighing of all the available evidence. Indeed, Komlos devoted a whole

section to the discussion of corn production (1987, p. 924) and pointed out that all scholars who studied the issue of food consumption in the U.S. including Town and Rasmussen and Strauss and Beane – familiar names to historians of the period - assumed that human consumption of corn was less than 20% of production. None of them suggested that human consumption was increasing over time. Indeed, there is no reason to think that: on the contrary by 1910, - the first time actual numbers are available, corn consumption was down from about 4 bushels to 1.0-1.5 bushels per capita per year. So the long-run tendency was for corn consumption to be declining.¹⁵

In the next footnote, Fogel continued: “It should be kept in mind that corn, peas and other widely consumed vegetables are major sources of protein. Consequently, contrary to Komlos's (1987) assumption (sic) that average protein consumption per capita declined between 1839 and 1859, it **may have** increased slightly not only because average meat consumption **may have** increased but also because of an increase in the availability of vegetable sources of protein.” (Fogel 1990 p. 52). “May have” is not a very strong argument. That the increase in peas would have offset the decline in meat consumption is implausible and that meat consumption would have increased is purely speculative. The evidence contradicts it, insofar as slaughter weights were not increasing at all (Cuff 1992), and while the amount of corn fed to animals did increase, this was a substitute for prairie grasses, which were declining on account of the expansion of the arable, so did not lead to greater slaughter weights.

Nonetheless, the criticism was obviously powerful because of Fogel's standing in the profession and influence on his students. The fact that Komlos' 1987 article did not even appear in the list of his references was also a bad omen. This response demonstrates how powerful priors – preconceived notions of the normal science - are in determining the shape of a debate for decades to come.

In a working paper in 1991 and then in its published version in 1992 Steckel alluded to the puzzling nature of the secular decline in heights "...because it clashes with firm beliefs that the mid-nineteenth century was an era of economic prosperity" (p. 2) but again eluded reference to the trend in adult slave heights and instead referred to the trend among slave adolescents that was estimated imprecisely a dozen years earlier (1991, p. 26; 1992, p. 286). There is also no mention of trend in the height of slave children which appears to be a continuation of selective reporting. He suggested that urbanization alone does not explain fully the decline in heights and reiterated that "...it seems plausible that growth in inequality could have contributed significantly to the secular decline in stature" (p. 37).

Steckel was the first to take Komlos' (1987) argument seriously and concluded that "If this line of argument is correct then stature should have diminished in response to a higher relative price of food.... consistent with the height decline, the relative price of food rose from the 1820s through the 1830s. However, the relative price reached a peak in the late 1830s, declined in the early 1840s and fluctuated moderately thereafter. This evidence suggests that higher food prices may have prompted a decline in nutritional intake during the early phase of the secular decline but other factors were involved thereafter" (1991, p. 38; 1992, p. 295). There are a couple of problems with this calculation and interpretation. He calculated the price of food relative to the wholesale price of all commodities, which is a problem because all commodities include food itself (p. 54). He should have calculated the price of food relative to all industrial products. And moreover, the index does not "fall" at all for longer than a quinquennium throughout the antebellum period: it increases by 12% from 1.01 in 1821 to 1.13 in the late 1830s and while the index does decline thereafter it was still at 1.07 in 1851-1860 so relative prices did increase according to his numbers throughout the antebellum period relative to the base year of 1821. In other words, the decline in the relative price of food after the late 1830s did

not bring it back to its original level of the 1820s. In the 1850s it was still 7% above 1820s level. Hence, the dismissal of the food-price argument was hardly warranted. Furthermore, his price data are not all the ones available for the period. Others show an increase in the price of grain and meat products relative to industrial products of not less than 37% during the antebellum decades in Philadelphia, and in Vermont by as much as 173%. So the assertion that relative food prices did not increase is clearly not borne out by the available evidence.

Steckel did bring up another point in the published version of the paper: "... the most recent survey of research in this area suggests that dietary deterioration did not occur after 1825, though more research is clearly needed (Lorena Walsh 1992)" (1992 p. 296), but Walsh (1992) suggested no such thing: instead she asserted that there is a good chance that the diets of the urban poor might well have deteriorated after 1825, so it is difficult to ascertain how Steckel derived this conclusion that was repeated verbatim in a subsequent publication (Steckel 1995, p. 1928). On the contrary, Walsh suggests that "...in the early nineteenth century many Americans maintained the levels of consumption of household goods and of foods that they had achieved at the end of the colonial era. Moreover, for wealthy and middle classes in both rural and urban areas, household amenities, variety in diet, and the means to prepare foods increased, while seasonal variations in the foods available diminished. Among the groups that we know the least about - those at the bottom of the income distribution, and especially the urban poor - living standards most likely did not improve, and may have declined. Unfortunately, evidence about levels of consumption among households of varying wealth are firmest for the late colonial period. Thereafter, results become increasingly more tentative, and the years after 1830 are truly a "dark age"¹⁶ (1992, p. 217). She adds that the "true consumption patterns remain undocumented"¹⁷ (p. 225) and "a Middle Atlantic cookbook of 1845 included advice on making cheap stews to be given to poor neighbors, suggesting hunger continued to be a problem among

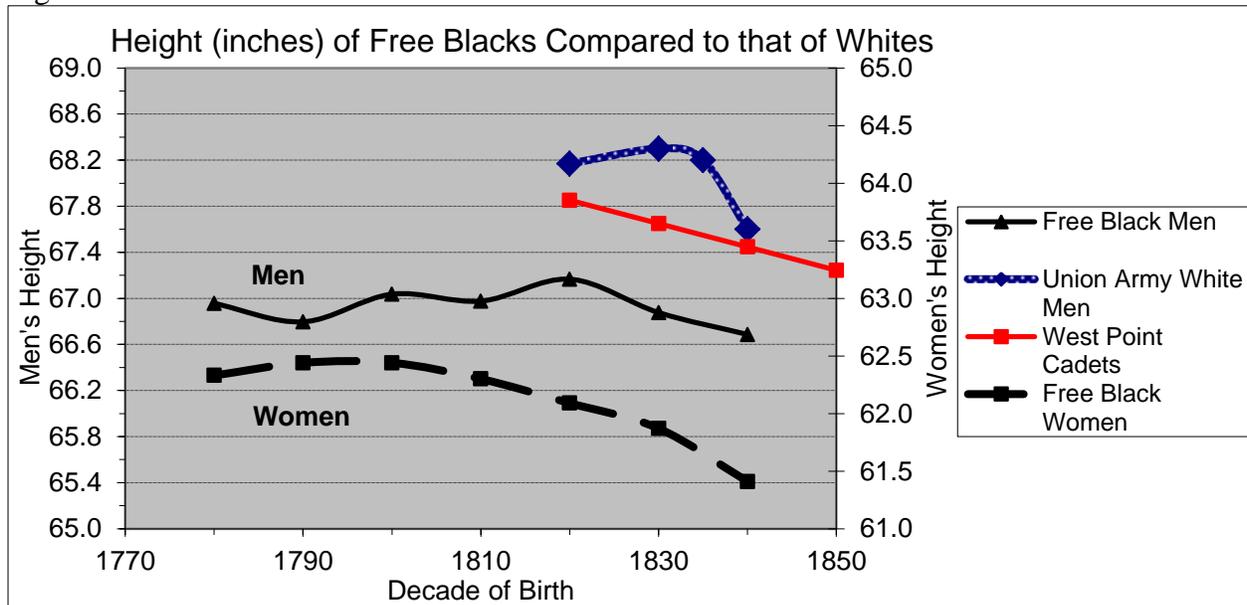
some groups” (p. 234). Furthermore, “by the 1830s larger cities were better supplied, but they began to impose marketing regulations that worked to the disadvantage of both the urban and rural poor. Restrictions on keeping livestock in town proliferated. Butchers were not allowed to vend quick-spoiling offal. Instead, heads, feet, and tallow were increasingly put to industrial uses. Such measures may have improved sanitation, but poor consumers were also deprived of a source of cheap protein. Similarly, regulations curtailing the activities of strolling hawkers and peddlers, and requirements that vendors rent market stalls both raised food prices and excluded the poorest producers, especially slaves and free blacks. Qualitative sources assert that before the Civil War urban residents (except perhaps in major cities) could purchase milk, fruit, and vegetables only within a limited season” (p. 251). In other words, there is nothing at all in Walsh’s study that would contradict the decline in average food consumption argued in Komlos (1987). On the contrary, Walsh’s findings support Komlos’ contention rather than oppose it.

Steckel (1991) also referred (without attribution) to the argument first advanced in Komlos (1987) that commercialization also contributed to the decline in heights: “It is conceivable that new opportunities for trade reduced nutritional intake in rural areas. This could happen if the transportation revolution made manufacturing goods available at low cost, tempting farmers to trade so much of their products that nutritional intake diminished. If rural residents placed extraordinarily high value on manufactured goods, their utility could have increased while their diet deteriorated. The abundance of land and growth in agricultural productivity in the mid-nineteenth century suggest that this effect, if it existed, was weak. However, it is a line of argument that is probably worth exploring” (p. 41; Steckel, 1995, p. 1930). But he does not present evidence on agricultural productivity which was in reality growing much slower than needed to maintain the nutritional intake of the population. And of course, land abundance is insufficient to guarantee production. Land also needed capital and

labor to produce food, and labor in the agricultural sector declined from 74% in 1800 to 56% in 1860 or by 18 percentage points (or by 24% of its initial size). It would have been difficult if not impossible to substitute land and capital for that much decline in labor input given the level of technology. Increase in the price of nutrients is missing from the conclusion but Steckel did reiterate causal mechanisms that were mentioned earlier: “greater inequality in the distribution of income or wealth, more work effort, and increased exposure to infections disease” (p. 43). Parenthetically, Steckel and Haurin (1982) now became Steckel and Haurin (1990).

In order to counter the skeptic reception of the West-Point paper and to gain further insights into the causes of the Antebellum Puzzle, Komlos and his students adopted the strategy of analyzing the height trends of various groups in the population. The hypothesis was that through the experience of different groups, one would gain insights into the causal mechanisms that brought about the puzzle. The strategy did pay dividends: it was next demonstrated that the Antebellum Puzzle also pertained to the free blacks of Maryland (Komlos 1992). The trend in the height of free black men was well synchronized with that of whites, but that of females started to decline much earlier, opening up the possibility that girls were discriminated against within the those households (Figure 19). In addition, this finding was important also insofar as it demonstrated definitively for first time that the Antebellum Puzzle was widespread. Until then heights trends pertained mainly to the military and to slaves.

Figure 19.



Source: Komlos 1992.

Fogel received the Nobel Prize in economics in 1993. The committee cited his research in anthropometric history though did not call it that: “Fogel's third area of research has been economic demography, and in particular the changing rate of mortality over long periods of time and its relation to changes in the standard of living during recent centuries. This project is less controversial than the other two, and is both interdisciplinary and international, with fellow workers from many countries. His conclusion is that less than half of the decrease in mortality can be explained by better standards of nourishment, before the breakthroughs of modern medicine. This leaves the greater part of the decline unexplained. According to Fogel, a systematic analysis demands an integrated study of mortality rates, morbidity rates, food intake and individual body weights and statures.”¹⁸

In the same year Costa continued to speculate on the causes of the Antebellum Puzzle: “Though the findings suggest that an increase in the percentage of the population with foreign-born parents cannot account for the decline observed in rural areas, foreign parentage might matter in urban areas and might have contributed to the decline”¹⁹ (1993, p. 375). She continued by asserting: “...there is little evidence of a decrease in the supply of food (Steckel 1991)” (p.

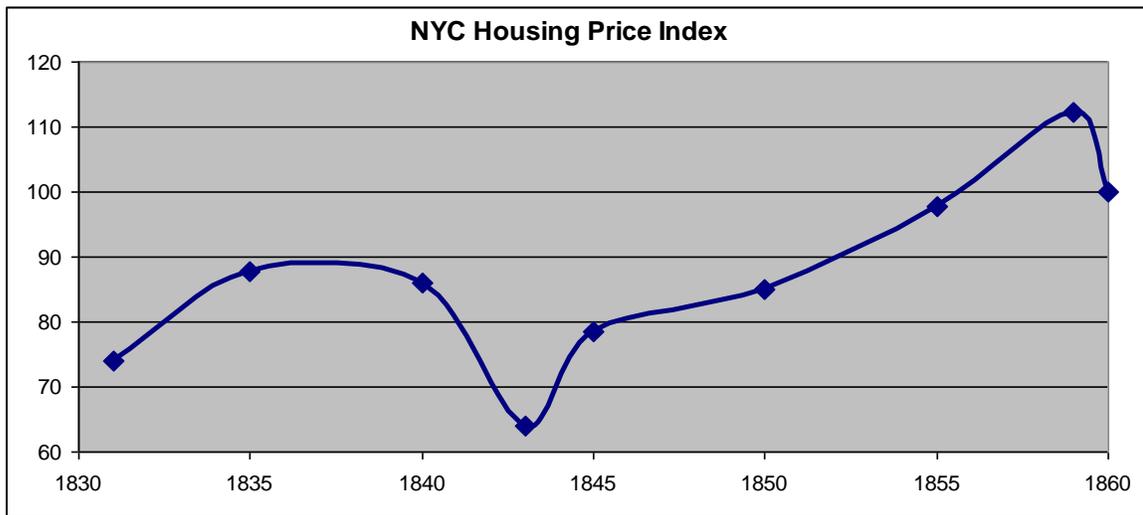
375). This is hard to follow, because Steckel did not present any evidence on the supply of food. So it appears as though scholars were citing phantom evidence in a “Kuhnian” defense of the normal science of cliometrics.

In addition, she reiterated Fogel’s argument about the “...the push of Midwestern farming into malaria-ridden areas (Fogel 1986; Steckel 1991; Komlos 1987). Fogel argues that the last hypothesis is the most likely factor accounting for the decline in heights. Steckel finds no evidence of a decline in the per capita food supply and shows that an increase in epidemic disease and in wealth inequality were probably the most important factors” (1993, p. 358). But where were these malaria-ridden areas supposed to be? And Steckel did not “show” at all that an increase in epidemic diseases was probably the most important factor. The closest he came to it is in an assertion that the fact that “...malaria was a substantial seasonal health problem in the Midwest until the late nineteenth century.... is consistent with the timing of the height decline, its recovery near the end of the century, and its rural character” (Steckel 1991, p. 39). The increase in disease incidence is not corroborated by Haines’ evidence that life expectancy increased in the U.S. between 1850 and 1860 by 4.8 years among white men (1998b, p. 151).

In 1994 Robert Margo contributed to the debate by showing that the cost of living indexes have not been calculated correctly: “Incorporating the new housing price indices into existing antebellum cost-of-living deflators (which generally exclude housing) suggests that economic historians have over-estimated real wage growth before the Civil War.” For New York City the overestimate might have been as high as 22% (Margo, 1994, pp. i, 18). In the published version he reiterated: “the price of housing rose relative to other goods between 1830 to 1860, indicating that the urban cost of living rose more over the antebellum period than some previous attempts to measure it have indicated” (Margo, 1996). Between 1830 and 1857 the housing price index in New York City increased by some 52% (Figure 20). This became another

building block in support of the endogenous causes of the Antebellum Puzzle. If workers had to pay more for housing than it became more plausible that they spent less on food. This was important insofar as it made the anomaly of decreasing heights less of an anomaly: the cost of living was increasing faster than theretofore supposed.

Figure 20.



Source: Margo, 1996.

1995 saw the first anthropometric history publication in a major economic journal in which Steckel reiterated many of the arguments found in his 1992 article. In the same year Steckel presented a working paper at the meeting of the Social Science History Association in which he showed that the height of slave men (but not that of women) transported in interregional trade was increasing in the Antebellum period thereby confirming the finding of Margo and Steckel (1982) (Figure 7). This finding disappeared thereafter insofar as Steckel never published it and in subsequent publications on the height of slaves he failed to report the height of adult slaves in the antebellum decades (Table 2) even though the increase in the height of slave adult men is an important part of the Antebellum Puzzle. Rees et al. actually showed that

on the basis of the trend in the prices of cotton, food, and slaves one would expect that profit-maximizing slave owners would have increased the nutritional status of their slaves (2003).

Table 2. Estimates of the Height of Slaves

Birth year	Slaves	
	Age 23–49	
	Males	Females
	Bd669	Bd670
	Centimeters	Centimeters
1710	—	—
1720	—	—
1730	—	—
1740	—	—
1750	—	—
1760	—	—
1770	169.4	159.6
1780	169.7	159.3
1790	169.5	159.3
1800	170.4	159.9
1810	—	—
1820	—	—
1830	—	—
1840	—	—

Source: Steckel (2006, p. 2-502).

Still in 1995 Costa and Steckel circulated a working paper in which dietary deterioration was listed prominently as one of the factors contributing to the decline in heights: “We argue that changes in the disease environment, among other factors, can partially account for the decrease in well-being in the nineteenth century and the increase in well-being in the twentieth. In the nineteenth century, higher rates of interregional trade, migration, and immigration exposed a previously isolated population to disease. Other contributing factors included the rise of public

schools, which spread diseases among children; hardships caused by the Civil War; urbanization; growing inequality; and **dietary deterioration associated with relatively higher food prices**“ (1995, p. 41; 1997, p. 77). Slave heights were also mentioned in passing: the height of slave women declined by 1 cm while that of slave men increased by 1 cm 1820-1830 (1995, p. 6; 1997, p. 51) but there was no mention that Margo and Steckel (1982) reported a 2 cm increase in height of slave men. In addition, another exception to the Antebellum Puzzle was found: the height of American Indians did not decline during this period (Prince 1995).

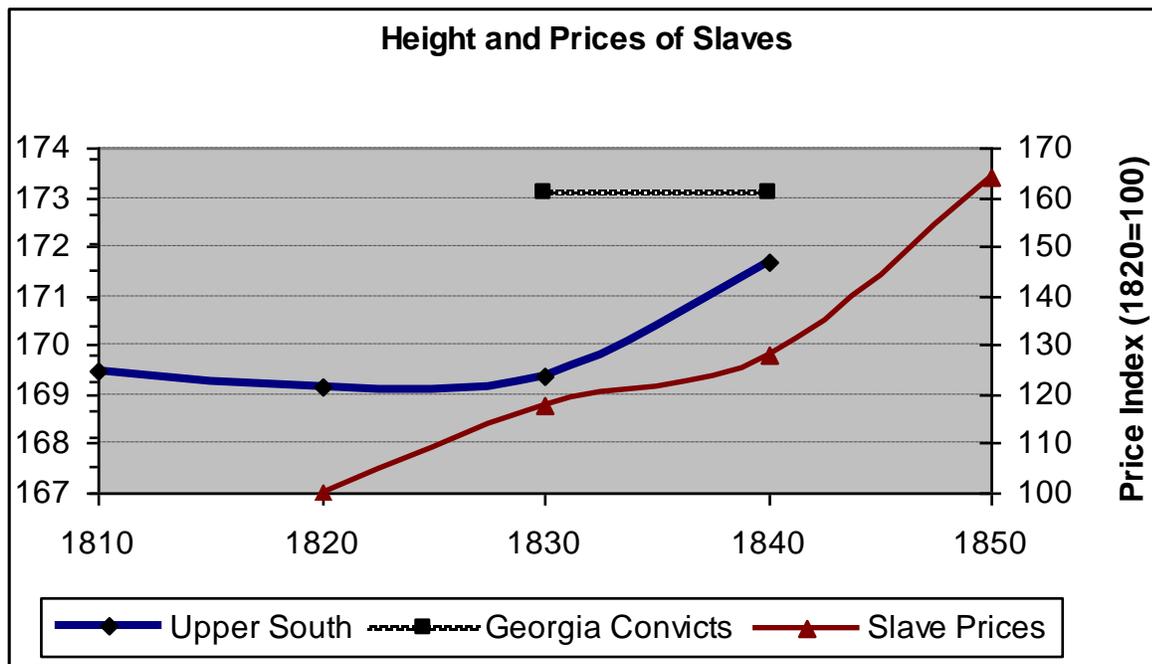
1996: the height of mainstream resistance

In 1996 Robert Gallman published the first and only full-fledged critique of the West-Point paper nine years after its appearance. His critique was the high point of the defense of the mainstream view. Thereafter the criticisms began to wane. Gallman's main critique was that Komlos did not consider inventories (p. 196). In his response Komlos (1996) pointed out that inventories must have been second order effects and it is impossible to tell how inventories might have changed over time.²⁰ Furthermore, inventories were essentially immaterial for the nutritionally important protein-rich perishables such as dairy products.

Komlos also introduced the distribution of nutrient intake into the argument. In addition to the decline in the mean values there was a leftward shift of the distribution implied that the left tail increased disproportionately: “...in 1839, 13.7 percent of the male population probably consumed below 2,700 kcalories, which would not have been adequate for heavy work at a sustained level. However, in 1849 this proportion of the male labor force would have increased ...by some 89 percent...! Obviously, even a small change in average nutrient intake meant that an increasing proportion of the bottom segment of the income distribution was falling below a minimum threshold level of consumption that made the attainment of the heights of the 1820s increasingly difficult” (p. 208).²¹ Inasmuch as there were segments of the society whose

nutritional status did not decline at all, the most parsimonious explanation is that the parents of these groups had sufficient income to pay for the increased price of nutrients. “That the decrease in heights was associated with economic processes is also suggested by the fact that not everyone was affected. Disease, by contrast, would not have discriminated to the same extent by social status. Therefore, the finding that the height of middle-class West Point cadets did not diminish in the 1830s or in the 1840s contradicts the disease explanation of the height decline. The families of these cadets were sufficiently wealthy to maintain their nutritional status in spite of the increase in the price of nutrients. Furthermore, ..., in contrast to the diminution in the height of free men, neither the height of black Georgian convicts who were slaves in their youth nor of adult male slaves who were transported to the Lower South from the Upper South diminished, contradicts the notion that the deterioration of the disease environment is solely to be blamed for the decline in heights. In other words, free men who themselves chose their consumption bundle

Figure 21.



Source: Steckel (1995), Komlos and Coclanis (1997).

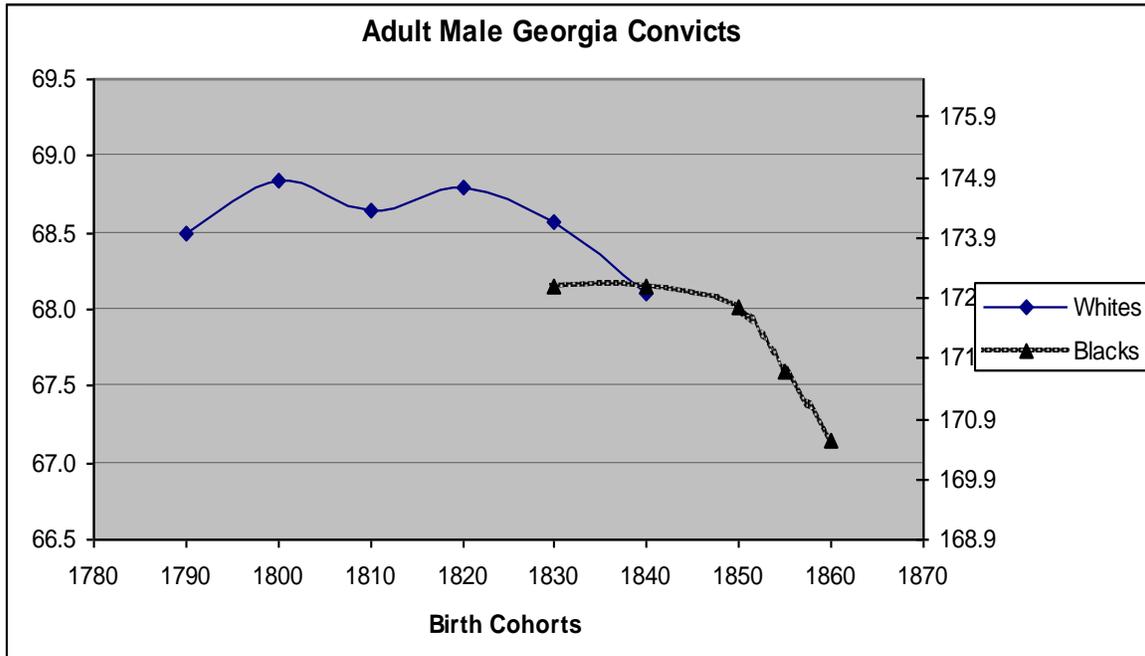
in the 1830s and 1840s responded to the changes in relative prices, whereas slaves who were not allowed to do so, did not” (Figure 21) (p. 211).

Thus, Komlos’s reply concluded “...the "antebellum puzzle" is not such a puzzle after all” (p. 211). The pieces of the puzzle fit together quite well: “during the early stages of modern economic growth, progress was not uniform in all dimensions of human existence. For the common man, the standard of living as conventionally conceived diverged from the other standards of biological well-being. The human organism did not thrive as well in its newly created socioeconomic environment as one might be led to believe on the basis of purchasing power at the aggregate level” (p. 212). The explanation of the ‘antebellum puzzle’ is most easily understood in terms of endogenous economic forces that were unleashed by the onset of modern economic growth. The increased income inequality, the increased variance of income, the rapid rate of urbanization, and the increase in the relative price of nutrients, all impinged on the biological standard of living of the common man, a rise in average incomes notwithstanding. “Thus, anthropometric history gives us a more nuanced view of the welfare of the American population living through the rapid structural changes of the antebellum years” (p. 212).

The next study pertained to southern convicts; until then there was not much research on white Southerners (Komlos & Coclanis 1997). It documented that the trend in the height of Southern whites followed the northern pattern, so that the Antebellum Puzzle pertained to them as well. However, the main finding was that the height of slaves did not decline at all (Figure 22). In other words, this pattern was similar to the ones reported in Margo and Steckel (1982) and in Steckel (1995): slaves were an exception to the Antebellum Puzzle. This reinforced the anomaly within the anomaly, but the distinction was not between whites and blacks insofar as the height of the free blacks of Maryland (Komlos 1992) had the same trend as that of the whites. Rather, it was evidently a distinction between free and unfree: slave heights did not respond to

relative food prices because their nutritional status had a different dynamic, a different internal logic, as it depended on efficiency wage considerations (Komlos & Coclanis, 1997, p. 452; Rees et al 2003).

Figure 22.



Source: Komlos and Coclanis, 1997.

Slaves were not integrated into a market for food, i.e., they were not exposed to the vagaries of food-price fluctuations. They were constrained to consume their allotment: and were not allowed to substitute manufactured goods for food. “Moreover, because slaves were assets whose value declined if their nutritional status was allowed to diminish, masters attempted to sustain the material well-being of their human property over time despite rising food costs” (Komlos & Coclanis, 1997, p. 452) “Economic processes associated with the onset of modern economic growth exerted a downward pressure on the nutritional status of the free population. The competing hypothesis, an increase in disease incidence, in all likelihood would not have caused the above patterns by itself inasmuch as disease would not have systematically spared

specific segments of the society such as the well-to-do, or the enslaved.... an increase in disease incidence has not been actually documented.... the rising value of slaves associated with a substantial increase in the value of their marginal product induced owners to maintain (or even improve) the slave diet, despite the rising relative price of food” (Komlos & Coclanis, 1997, p. 456).

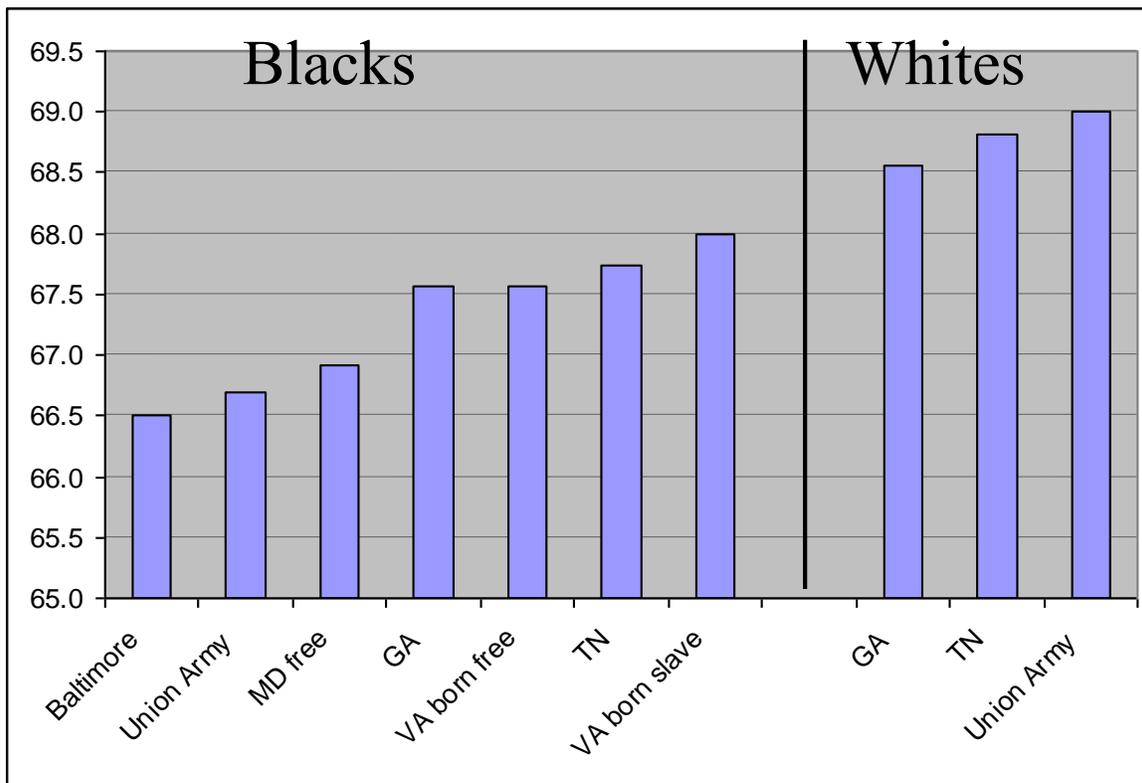
The tide begins to turn

The dietary explanation was gaining more currency with Costa and Steckel reporting the West-Point results in more detail even if without approval: “Yet another explanation for the height decline is provided by Komlos (1987), who argues that the height decline may have been caused by a deterioration in the diet created by the sectoral shift in production that occurred during industrialization. According to this view, urbanization and the expansion of the industrial labor force increased the demand for food while productivity per worker and the agricultural labor force grew slowly, causing a decline in food production (especially meat) per capita. A decline in per capita meat consumption could lead to maternal malnutrition and anemia and therefore to fetal malnutrition” (Costa and Steckel, 1997, pp. 65-66). However, in the conclusion the exogenous disease explanation is still favored: “Our findings suggest that the adverse health consequences noted for the United States in the nineteenth century were significantly a matter of timing. The changes associated with industrialization and modernization occurred before substantial knowledge of effective mechanisms of disease prevention or cure were available...But the failure of the United States to implement public health measures earlier cannot be blamed on poor policy decisions.”

While the pieces of the puzzle were slowly coming together in spite of mainstream resistance, the trend in the height of the black Civil War soldiers did not fit into the pattern at all. As mentioned above, the height of slaves did not decline at all and tended to increase. This was

confirmed once again by Bodenhorn (1999) who showed that the height of ex-slaves was increasing. However, the soldiers' heights were not calculated correctly insofar as they were subject to a minimum height requirement and in such a case ordinary least squares estimates are biased. The proper procedure in such cases is truncated regression. Hence, Komlos re-estimated the trend of the black Union Army soldiers using truncated regression (1998). However, the new estimates confirmed previous results reported by Margo and Steckel (1982): their average height did indeed decline, contrary to expectations. This is one finding that still does not fit well into the general pattern of increasing ex-slave heights. It just might be a quirk in this particular sample. The evidence to this effect is that at 66.6 inches the black soldiers in the Union Army were unusually short for slaves (Figure 23). Their height was closer to those of the free blacks of Maryland than to the slaves who were transported to the Lower South and whose height was recorded on the manifests, the latter were about 67 inches tall (Margo & Steckel 1982, p. 520). One would not expect the height of a random sample of Southern ex-slaves to be so short.

Figure 23. Comparison of the Height of Black and White Men in Antebellum U.S.A.

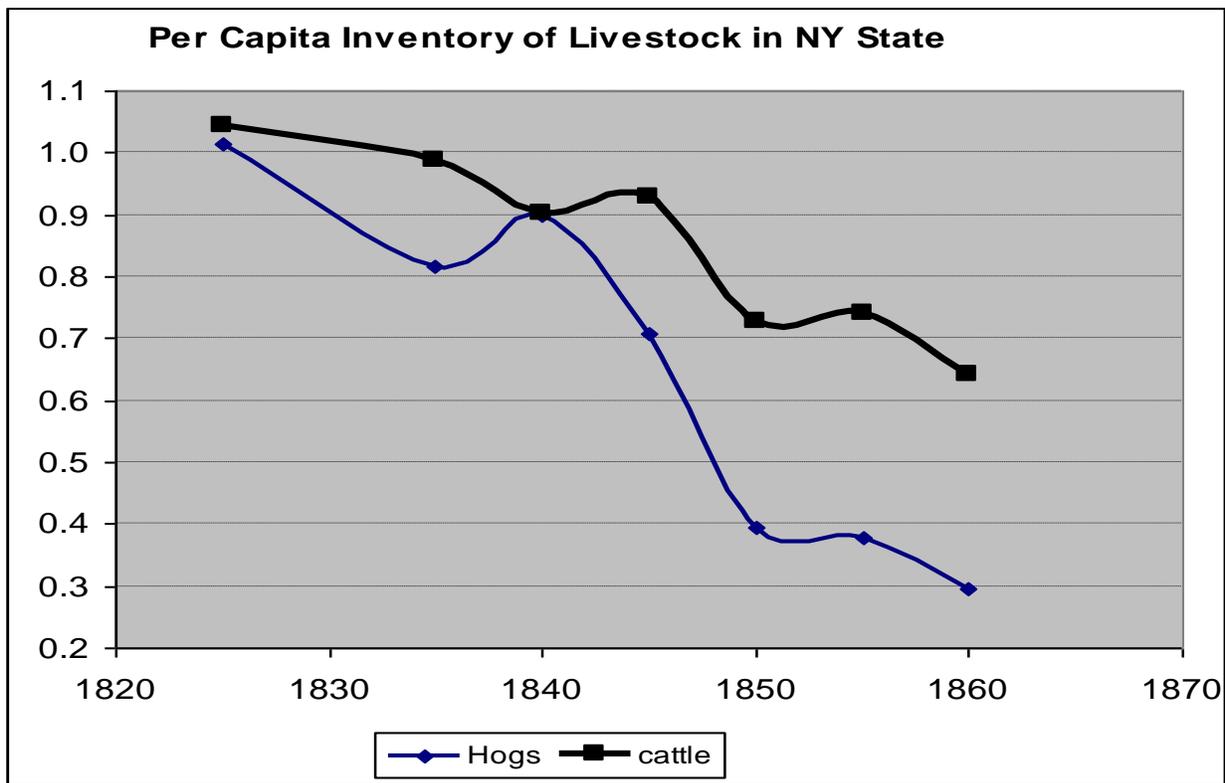


The height of the white Union Army soldiers was also only estimated using ordinary least squares regression which is inappropriate for military samples with a minimum height requirement. Thus, A'Hearn re-estimated the height of the Union Army soldiers using truncated regression (1998). He also found that heights were declining everywhere and concluded that the disease explanation was hardly convincing: "The uniformity of results across occupations, regions, and birthplace categories... is the key to discriminating among various explanations of the antebellum puzzle...while the effect of changing disease environment might conceivably be the same for all occupations, it is quite unlikely to have affected cities and rural areas equally, or to have affected all regions over an area as large as the United States. Similarly, increasing workloads for growing children and for expecting and nursing mothers, due for example to employment in textile mills, should have been a phenomenon which varied by region or occupation" (p. 259). The increase in inequality should also not have had such uniform effect: "...to the extent that income changes are correlated with occupation, we would expect this to show up in different trends for different groups, which instead are fairly similar. ...it seems more plausible to appeal to one factor which linked all these groups: the market. An increase in the relative price of food raises the opportunity cost of home consumption for the rural farmer just as it impacts the budget of the urban laborer. Market integration links the destinies of occupations, birthplaces, and regions" (p. 260). "Komlos has shown that the relative price of food was rising in these years, inducing... households to substitute out of expensive, protein-rich foods such as fresh meat and dairy products, and into cheaper but filling grains. The reduction in protein intake adversely affected growth" (p. 260).

Michael Haines confirmed the decline in heights in the early 1830s (as did A'Hearn), and put forth the important conclusion that the "Antebellum Puzzle seems to have resulted from a complex of factors... [usual list] and deteriorating nutrition. It seems that the growing prosperity

of the United States in the antebellum period was partly purchased at a price of some deterioration of the biological standard of living” (1998a). The suggestion that there was a trade-off between economic growth and biological standard of living was important at the time, because Haines had not contributed to the Antebellum Puzzle literature previously – and he could therefore be considered a neutral observer – that is to say, not one of Fogel’s or Komlos’ students. Thus, in a way he signaled that Gallman’s criticism had not really taken hold. Haines also showed that crude death rates did not increase at all in New York State outside of New York City, thereby implying that the disease explanation did not suffice to explain the decline in heights in the rural areas. In addition, he documented the sharp decline in livestock production in New York State²² (Figure 24).

Figure 24.



Source: Haines 1998.

Another important “neutral” contribution showed that height correlated positively with protein and calorie production in the county in which the recruit was born even after controlling for diseases (Craig and Weiss, 1998, p. 199). This implied that food prices did, in fact, matter, i.e., propinquity to nutrients lowered food prices which had a positive impact on the nutritional status of the population. However, - and this is just as crucial – this relationship did not hold for the black Union Army soldiers. In fact, for them the relationship was exactly the opposite: height correlated negatively with local production. This fit well into the “Komlos model”, because the logic of “efficiency wages” implied that slave food allotments should not have been made entirely on the basis of food prices only, but on the value of slave output. The less food produced locally the more cotton was produced and the more important it was to provide protein as an “efficiency wage”. This was later confirmed in Haines et al. (2011).

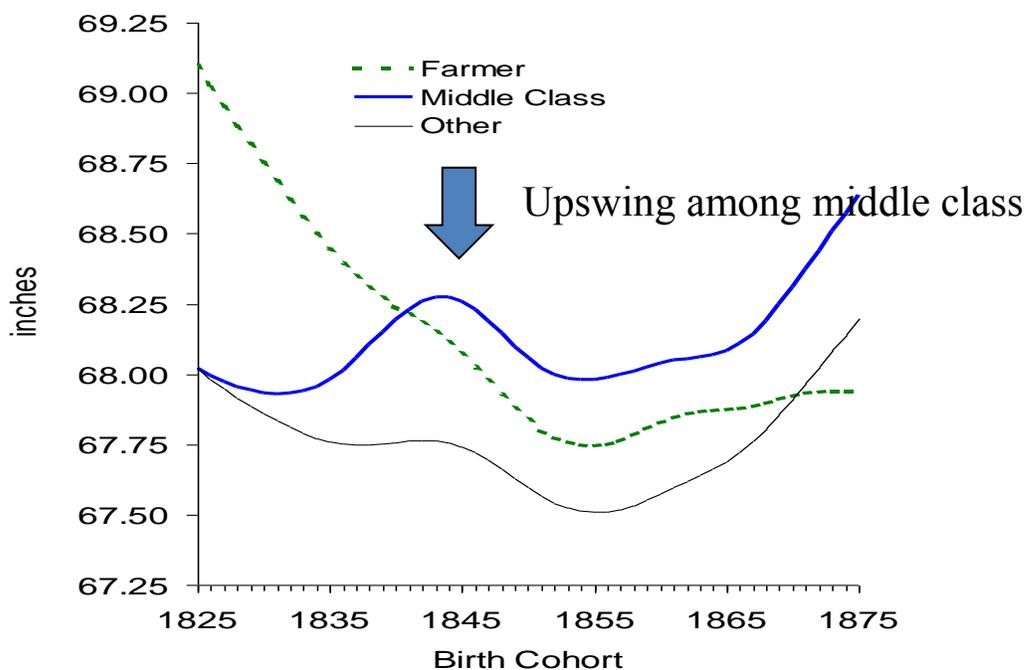
There were two overview articles in 1998 (Komlos, Steckel). Steckel alluded to the difficulties of interpreting the Antebellum Puzzle: the finding pertaining to “...American heights challenged firm beliefs that the quality of life was improving unambiguously after 1830, which has sparked a debate over the aspects of life that were deteriorating, such as greater exposure to disease, higher food prices, and perhaps additional work effort” (p. 808). However, he misreported the discovery of the Antebellum Puzzle by not attributing it to Fogel et al. (1979). Instead, he suggested: “In the United States, Steckel and Donald Haurin, and Robert Margo and Steckel found a half-century height decline which began for those born in the early industrial period (circa 1830) and affected many occupational categories” (p. 808). The reason this is problematic is that Steckel and Haurin’s data started in the 1840s so they could not document a decline in height in the 1830s. Furthermore there is no mention at all of a decline in heights in Margo and Steckel (1983) and the data used for that paper stopped in 1840 so they could not have documented a half-century decline either. Instead, they suggested that “the secular rise in

the heights of farmers and the non-farm rural born is consistent with increases in rural incomes” (Margo and Steckel, 1983, 173).

In 2000 Margo continued to argue that the increase in wages is not as certain as once was thought: “Could movements in real wages per se have been responsible for the decline in antebellum heights?...for certain subperiods the answer to this question is maybe” (p. 151). He also indicated that poverty rates rose substantially: “poor relief increased by 76% during the 1850s” (p. 152). He gave a boost to the endogenous explanation of the Antebellum Puzzle by estimating that the slower growth of wages accounted for about 46% of the decline in heights (p. 4, 150-151).

Lang and Sunder analyzed the height of West Point Cadets again in order to obtain a more accurate estimate of the trend of the height of middle class cadets and demonstrated the differences between their height and those of farmers and all others (2003). Their height rose in the late 1830s just as the height of the general population was decreasing, confirming again the fact that income provided immunity to the adverse effects of economic growth (Figure 25).

Figure 25. A Comparison of the height of Middle Class West point Cadets with that of Farmers’s sons and all others.



Source: Lang and Sunder, 2003.

Haines, Craig and Weiss returned to the issue of the local disease environment and of the local availability of nutrients – first raised by Craig and Weiss (1998) in order to attempt to distinguish between the strength of the two effects²³: “Between 1830 and 1860 the United States experienced rapid economic growth but declining stature and rising mortality. Debate has centered on whether the American diet deteriorated in the mid-nineteenth century. Employing census and muster records,... [we test] the hypotheses that adult height was positively correlated with local production of nutrient in early childhood and negatively correlated with local mortality conditions, urbanization, proximity to transport, and population mobility” (2003, p. 382). “In effect, we investigate whether economic development itself might have had unintended negative effects on health, stature, and longevity” (p. 385). In the beginning of the paper they intimated that disease explains all of the Antebellum Puzzle: “Results indicate that antebellum economic growth was accompanied by an increasing nationalization and internationalization of the disease environment, which affected the health and longevity of the population” (p. 382). In the following mention the disease explanation became more prominent: “The results confirm the importance of both factors in explaining stature; however they suggest that the changing environmental conditions, as manifested in the spread of disease, probably better explain the trend in decreasing stature” (p. 383). However, they did estimate for the first time since Komlos (1987), that protein and calorie consumption did, in fact, decline in the 1850s (p. 386): “In addition to the deteriorating mortality and stature data, figures on agricultural production suggest that the quality and quantity of protein and calories in the average American diet deteriorated in the decades following 1830” (p. 383). Thus, it could not have been only the disease environment that deteriorated and toward the end of the article they do suggest that “the nutrition variables are positive and statistically significant. Our protein variable... indicated that an individual who

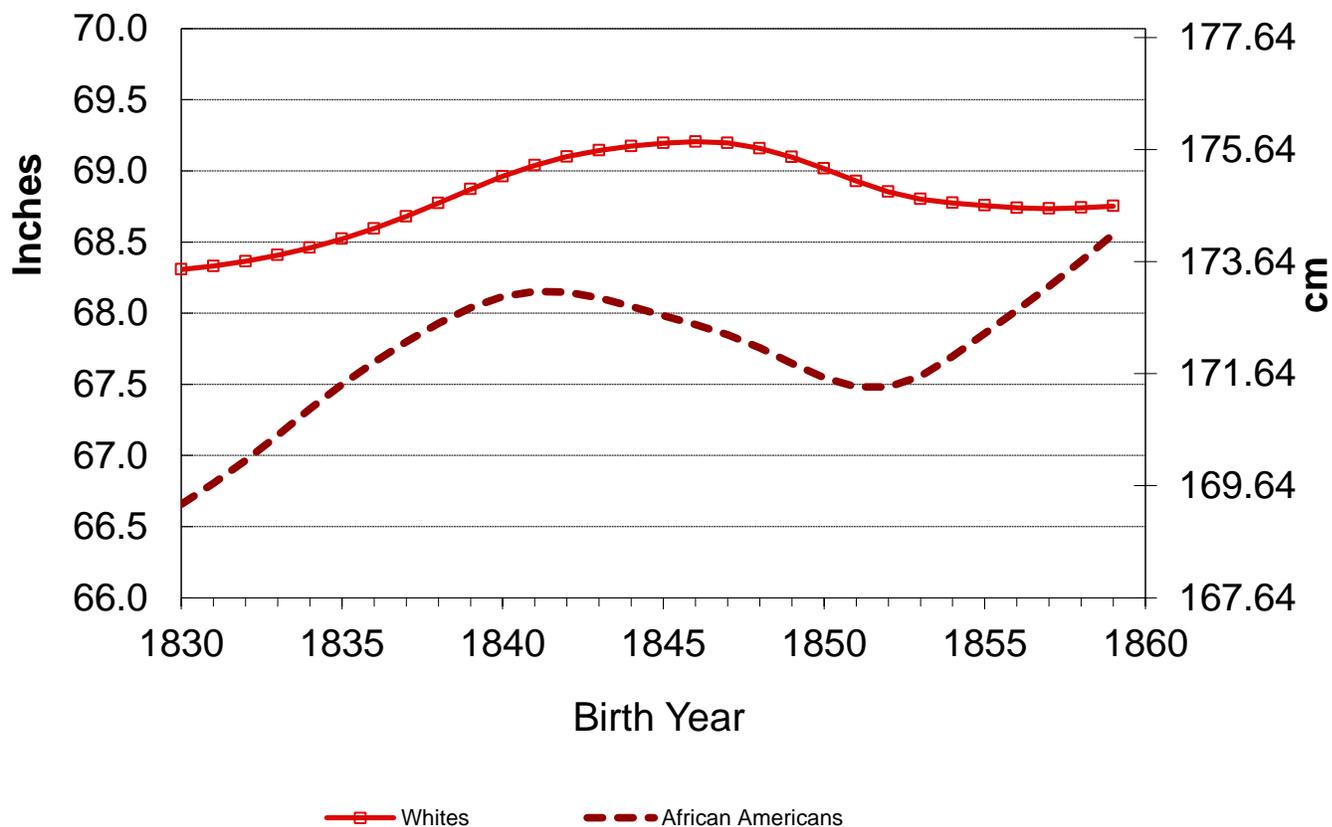
spent infancy in a county that produced a net protein surplus one standard deviation (138 grams) above the mean would have been about one- to two- tenths of one inch taller as an adult, *ceteris paribus*, than someone from the average county. Similarly, a surplus of one standard deviation (2.950 calories) above the mean in calorie production would have yielded an additional 0.06 to 0.16 inches in adult height” (p. 404). This is after controlling for crude death rate, wealth, and occupation and transportation access. So given these findings the emphasis in the conclusion is uncannily different than in the abstract and introduction: “The possibility that deteriorating nutrition contributed to reduced stature also receives support here. The reduced nutrition could have been a consequence of increased commercialization and the loss of a varied subsistence diet...” (p. 409). “Overall, the ‘Antebellum Puzzle’ seems to have resulted from a complex set of factors, including urbanization, increased population mobility, worsening mortality conditions, greater contact via improved transport infrastructure, and **deteriorating nutrition**. It seems that the growing prosperity of the United States in the antebellum period was partly purchased at a **price of some deterioration of the biological standard of living**” (p. 409). We moved closer to the paradigm shift, but were not yet quite there because of the inconsistency between the introduction and conclusion.

In an analysis similar to Haines Craig and Weiss (2003), Wilson and Pope (2003) tested the effect of local conditions on height, but in addition to using county level variables, they used household-level data from the county of residence in 1850 instead of the county of birth as do Haines et al. (2003). In contrast to the latter paper they find that calorie output did not affect height (p. 116). The difference in the two results stems from the fact that economic conditions in the birth county is likely to have a larger impact on adult height than those of residence, because of the importance of nutrition early in life. They reiterated the usual explanation for the Antebellum Puzzle and then suggested that “A lingering question in the field’s current

understanding of the health advantages accrued to the farming class is whether the story is one of access to food or remoteness from population centers and, hence, exposure to communicable disease. The analysis here points to the importance of both explanations...., (p. 142).

In 2003 Ulrich Woitek demonstrated for the first time that there were short – business-cycle-like – cycles in the 19th-th century US which correlated with economic variables such as grain prices. Corroborating evidence was published two years later (Sunder & Woitek, 2005). These supported the view that height cycles were endogenous to economic cycles.

Figure 26. Estimated Trend in Height



Source: Sunder, 2004

In 2004 another exception was found to the Antebellum Puzzle, i.e., that the heights of Tennessee convicts, both black and white, rose during the 1830s (Figure 26). This was the third major group which did not conform to the main trend: “several groups were immune to the effect, including members of the middle class, whose income was high enough, and increased

enough to overcome the adverse developments and maintain their nutritional status. Although at the opposite end of the social spectrum, the height of male slaves also increased, as it was in their owners' interest to raise their slaves' food allotments. The height of Tennessee convicts, analyzed in this article, also increased in the late-1830s, being the third exception to the "antebellum puzzle." Mid-19th century Tennessee was integrated into interstate commerce in cotton and tobacco and experienced considerable movement of people who would have brought with them diseases from elsewhere. Hence, it would have been integrated into the US disease pool, and the fact that heights did not decline in the 1830s is therefore an indication that the Antebellum puzzle cannot be explained exclusively by the spread of diseases. Yet, Tennessee's economy was quite different to that of the rest of the country. Although it did export live swine to the South, these exports did not increase during the antebellum decades. Hence, Tennessee remained self-sufficient in pork, and consumption of pork did not decline. Thus, the evidence presented here is consistent with the economic interpretation of the "antebellum puzzle": self-sufficiency in protein production protected even the members of the lower classes of Tennessee from the negative externalities associated with the onset of industrialization" (p. 75). Thus, the evidence supporting the endogeneity of the Antebellum Puzzle was accumulating.

In 2005 Cuff pointed out that the onset of modern economic growth brought with it negative health externalities that were hitherto unknown: "The "optimists" viewed modern economic growth and its boon companion, industrialization, as unambiguously good -- led as they were by good things like the market.... But before they [the optimists] could secure final victory, there emerged a research agenda that yielded a new set of weapons.... Rather than GDP per capita, the Hectors of this war hurled biological indicators like mortality rates, stature, and body-mass indices... the 'antebellum puzzle,'... breathed new life into the pessimists' case"

(Craig 2005). "What mattered was that they likely were less healthy adults and probably lived shorter lives as a consequence" (Cuff, 2005, p. 215).

In 2006 Steckel republished the graph of American heights in the 19th century without indicating that a substantial portion of the graph is based on interpolation. The graph was first published as a temporary measure in 1984 (Figures 11 and 27).

Figure 27. The new version of the height of Americans in the 19th century no longer indicates interpolation



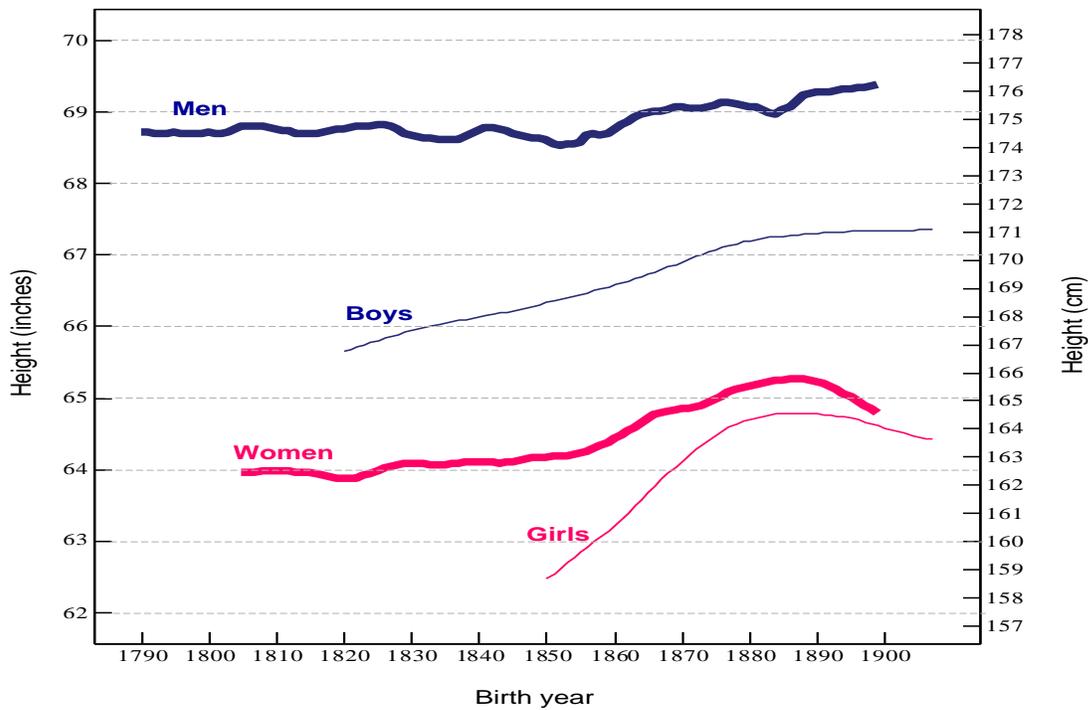
FIGURE Bd-B Height of native-born men and women, by year of birth: 1710-1970

Sources
Series Bd653-654.

Source: Steckel 2006, p. 2-501, 2-584; Floud et al. 2011 p. 299.

In 2007 Marco Sunder completed his dissertation analyzing the height of the US elite in the 19th century. It was a major step toward the paradigm shift insofar as it showed again – and this time with a much larger sample - that high-income people were not affected by the Antebellum Puzzle: their height did not decline (Figure 28). In other words, income was protective of height. The height of elite boys and women increased continuously, while that of men increased in the late 1830s precisely at the time when the height of middle-class West Point cadets also increased (Figure 29) (Sunder 2007, 2011). Although their height declined slightly (by 0.2 inches in the 1840s that was connected the dislocations of the Civil War and not with the Antebellum Puzzle). That the society was becoming more unequal was evidenced by the divergence between the trend in average height and that of the elite men: the difference between the two was merely 0.4 inches in 1830 but by 1860 it was closer to 1.7 inches (Figure 28). The

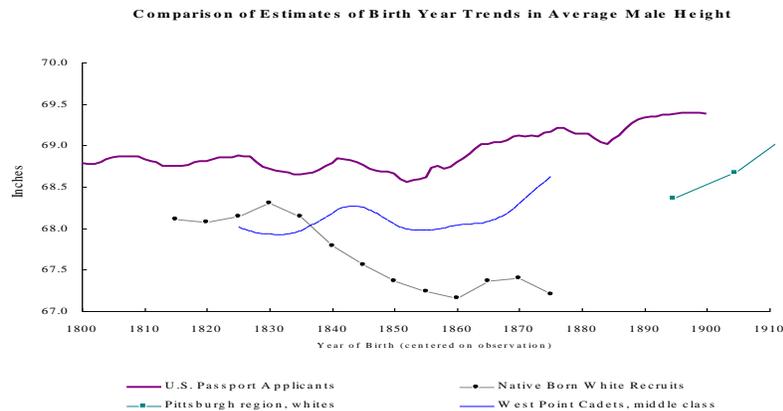
Figure 28. Height of wealthy Americans



Source: Sunder 2007.

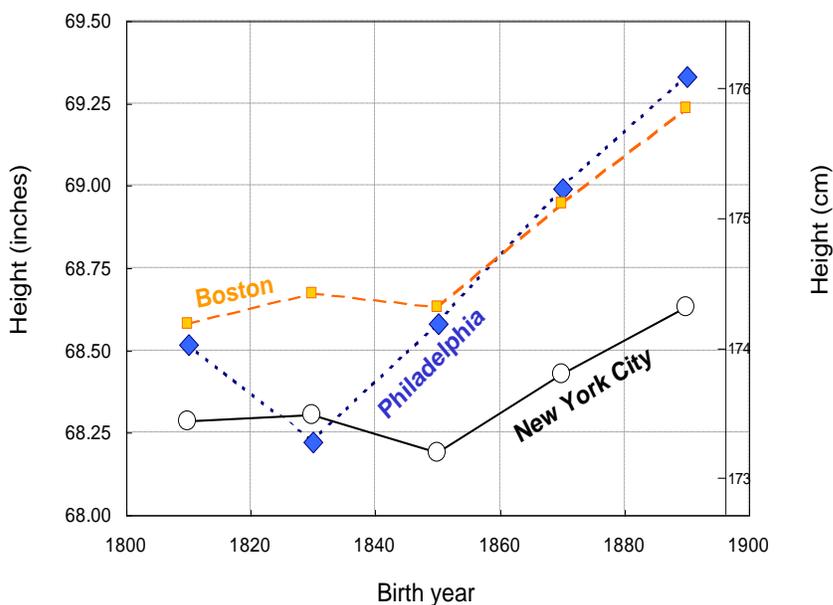
pattern among women was similar: their height also did not decline at all; on the contrary, it increased rather rapidly (Sunder 2011) and the difference between them and the average increased from 0.2 inches to 0.5 inches (Figure 29). Furthermore, the height of wealthy men in two of the three major towns examined, New York, and Boston remained unchanged in the

Figure 29. The Increase in US inequality during the Antebellum Period



Source: Sunder, 2007.

Figure 30. Height of Elite American Men in three cities

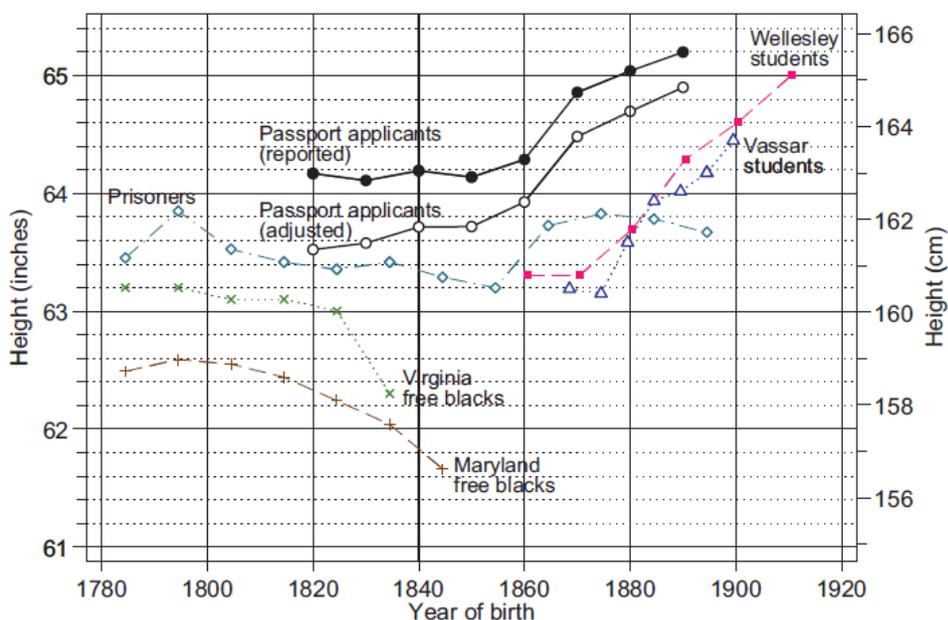


Source: Sunder, 2007.

1830s, implying that the disease explanation was contradicted (Figure 31). Another important pattern evident is that decline in the height of non-wealthy females began earlier than the 1830s as it did among men in (Figure 31). The height of white convicts, as well as that of free blacks in both Maryland and Virginia began to decrease shortly after the turn of the 19th century (Carson 2011). This is also important, insofar as it make the disease explanation less likely if different segments of the society experienced the onset of the decline in nutritional status at different times. Hence, by 2007 the disease explanation seemed all but implausible: how could the height of the rich increase or remain unchanged if the epidemiological environment had deteriorated? The paradigm shift was virtually complete.

Nonetheless, Steckel (2008) still did not accept the endogenous explanation and disregarded Sunder's finding although it received the prize for the best dissertation in 2008 from the American Economic History Association. Instead, he continued to mention the usual suspects

Figure 31. Comparison of Adult female height Trends in the 19th Century



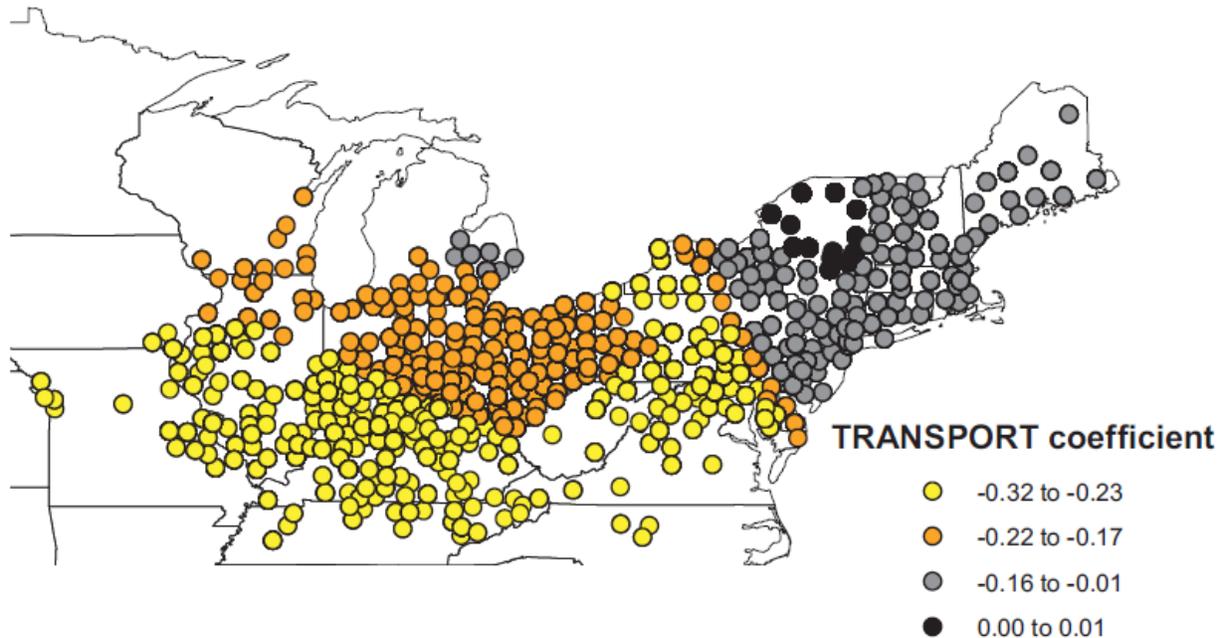
Source: Sunder 2011.

for the Antebellum Puzzle adding another “Ptolemaic epicycle”: “(diseases might have [also] spread via... the rise of public schools that brought more children and pathogens together)...” (p. 144). In 2009 Scott Carson showed that the heights of blacks were increasing in the 1830s and 1840s while that of whites was decreasing, a pattern that has been systematically disregarded by the proponents of the exogenous disease argument.

As late as 2009 Steckel wrote, “Margo and Steckel, who discovered [sic] that heights declined after 1830 in the United States, initially questioned whether the cycle was genuine, as did Robert Gallman some 15 years later (Gallman, 1996). Several independent sources of evidence have verified what is commonly called the ‘antebellum paradox’ [sic: puzzle] (Komlos, 1996; Komlos and Coclanis, 1997; Carson, 2008b; Maloney and Carson, 2008), or the decline in height and life expectancy in the midst of vigorous economic growth, and research now focuses on its possible causes. Candidates include migration and the spread of disease; growing inequality; the appearance of business cycles that increased the nutritional vulnerability of the

poor; rising food prices; the emergence of public schools that exposed young children to dangerous pathogens; the rise of commercial farming, which tempted farm families to trade farm surpluses for manufactured goods; the Civil War; and urbanization” (p. 12-13).

Figure 32. The effect of transportation on height in the Antebellum United States

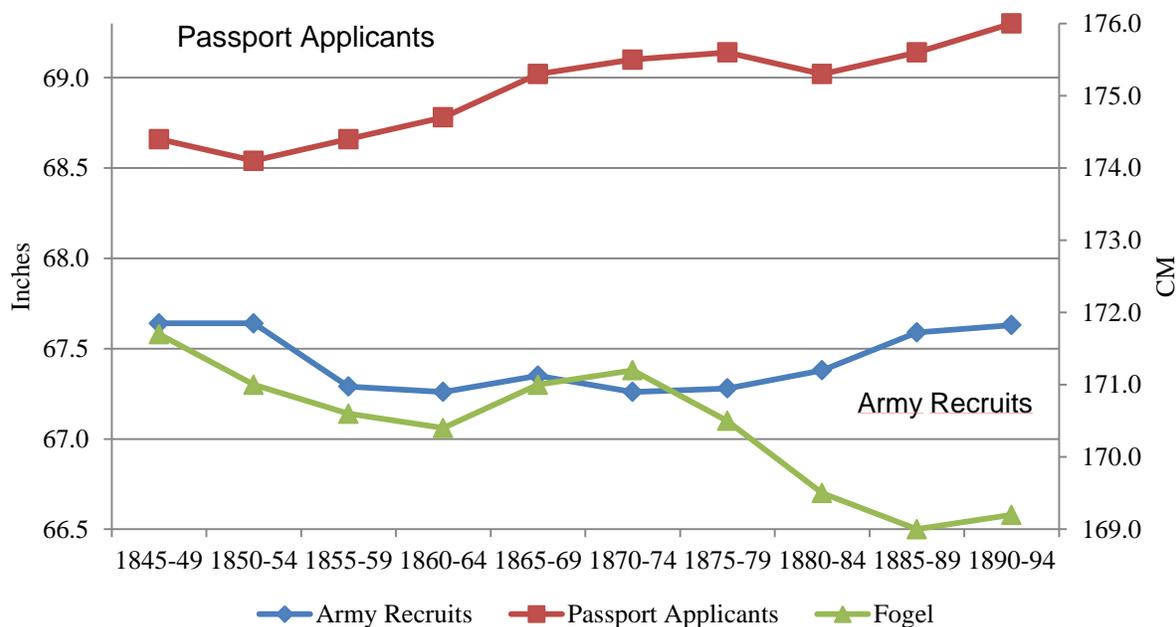


Source: Yoo (2011)

Yoo argued that by taking spatial variation into consideration, one has a new and powerful evidence for the endogenous explanation of the Antebellum Puzzle (2011). Most studies have found a negative relationship between the availability of transportation networks and height. However all previous studies used OLS regression analysis. In contrast, Yoo demonstrated that a more nuanced analysis using a new technique, geographically weighted regression, indicates that the nutritional consequence of being near water transportation differed depending on whether the region in question was a food importing or food exporting one (Figure 32). Insofar as waterways were used to transport both people and goods, they facilitated the transmission of diseases as much that of goods. Hence, his result is important because

conventional analysis could not disentangle these two effects, but his method could: “while the coefficients for the Midwestern farming area are highly negative,... the coefficients for the industrialized Northeast tend to be positive or slightly negative. This implies that access to water transportation was associated with a decrease in height in the Midwest, but with an increase in height in the industrialized Northeast as we expected on theoretical considerations.” Diseases would not likely have had such a spatially differentiated effect as did the flow of goods. In other words, the availability of waterways enabled farmers to export their food surpluses and had a negative effect on the height of their children. In contrast, waterways need food deficit areas had an ameliorating effect on the height of the population as one would expect.²⁴

Figure 33. Height of American Men in the Second Half of the Nineteenth Century



Source: Zehetmayer, 2011

Finally, after some three decades of guessing about the height of American men during the second half of the 19th century, Zehetmayer analyzed a national military sample and concluded that the decline in heights during the period of post-Civil War Reconstruction was

shallower than the one based on interpolation from the Ohio National Guard (2011). The difference between the interpolated and actually estimated results was a full inch (Figure 33).

And the paradigm does shift

Thirty-two years after the discovery of the Antebellum Puzzle (Fogel et al. 1979) and 24 years after Komlos (1987) elucidated its explanation, the paradigm did finally shift. Komlos’ estimates of a diminution in protein and calorie intake at the onset of modern economic growth were vindicated when Fogel re-estimated food intake of the U.S. population and came extremely close to those of Komlos (Table 3).

Table 3. Comparison of Estimates of Dietary intake by Komlos and Fogel 21 years later

	Calorie intake			Meat consumption		
	Komlos	Fogel	Diff.(%)	Komlos	Fogel	Diff.(%)
1840	3,021	3,013	+0.3	213	225	-5.6
1850	2,696	2,585	+4.1	194	205	-5.7
1860	2,892	2,826	+2.3	181	197	-8.8

Sources: Komlos 1987 p. 909 (lower bound estimates of calorie intake); Floud et al. 2011, p. 314.

Fogel concluded, “The estimates... indicate a considerable decline in diet after 1840; the 1840 level was not recovered until 1870. A large decline in per capita production of wheat, rye, pork, and beef accounts for this big deficit in American dietary history. The lack of nutrients was demonstrated by the soaring prices of those foodstuffs, another downside indicator of food consumption” (Floud et al. 2011, p. 316). In the footnote he does mention that, “A similar pattern is also found in Komlos (1987).”

“...the increase in agricultural productivity did not keep up with the rapid growth of the population and its food demands” (Floud et al. 2011, p. 298). “...food output did not keep pace with the demands of the urban-industrial sectors whose population increased approximately ten times during the first half of the nineteenth century.... Per capita crop consumption may have declined throughout the antebellum period. Excess demand had increased grain prices by 1860,

and the change in food availability contributed to the decline in the population's nutritional status in the first half of the nineteenth century" (Floud et al. 2011, pp. 306, 308). Furthermore, Fogel also showed that work intensity did not increase in the antebellum decades in manufacturing: instead, it declined from 69 hours/week to 62 hours/week (Floud et al. 2011, p. 319).

So it took a long time. Not less than a quarter of a century transpired between 1987 and 2011 before the dietary explanation was accepted: "This paradox [of declining heights] was first examined from the aspect of diet,... as a major factor in the height decline of West Point cadets in the antebellum period. Komlos (1987) pointed out that meat production did not keep pace with population growth, emphasizing reduced caloric intake. Although his argument was disputed among researchers... the general trend of food production prior to the Civil War was not favorable. Rapid population growth by urbanization and immigration had fettered food supplies per capita for major foodstuffs, though their gross levels were increasing. The increased food price also led to disparities in food consumption stemming from increasing income inequality." Furthermore "...height increased with food intake from the early nineteenth century to the late twentieth century. Under this long-run trend, as Komlos suggested, a considerable decline in adult height prior to the Civil War - especially for the 1850-1860 cohorts - seems to be highly related to reduced caloric intake" (Floud et al. 2011, p. 330, 332).

Conclusion

As Kuhn posited, ideology played a substantial role in the way research unfolded. The 32-year history of the Antebellum Puzzle was hardly an inevitable (linear) progression of the accumulation of evidence leading to its eventual resolution. In other words, it was by no means only a question of discovering facts and their scientific interpretation. If it had been, the disease explanation for the decline in heights would have been eliminated very early on. By 1983 we knew that the height of adult slaves did not decline (Floud et al 2011 p. 335). That should have

eliminated the disease explanation: why would white rural populations be affected by diseases when slaves were not? By 1987 we also knew that the middle-class was unaffected. Why would diseases have spared this segment of the population as well? We also knew that the tallest people were in the South where malaria (and other fevers) were most frequent and shortest in the Northeast where these diseases were absent or of low intensity. Given these facts, most scientific rules of hypothesis testing would have eliminated the disease explanation on the basis of these findings. Yet, it lingered for another quarter century. The sharp debate that ensued was subject to significant omissions, inaccurate citations, and mistakes in favour of the “whiggish” view of American economic development. There were even inconsistencies within the same paper. In other words, the level of discomfort with the anomaly rose.

Komlos’ argument that economic development even in the resource-rich US could bring about a decline in food consumption endogenously as part of the internal logic of the functioning of the free-market system led to a prolonged acerbic debate. There was determined resistance to revising the neo-classical whiggish view that 19th-century economic growth was a linear progression – simply put - from less income to more income. The stiff resistance obviously came also from editors as well as from referees. That growth in income could have negative health externalities was not part of the tool kit of conventional economic theory. But children did not decide for themselves what they would eat and their parents made many uninformed decisions on their behalf. To be sure, the income pertained to adults whereas height pertained to children and youth. But, they were also part of the society. Hence, their welfare should also matter to the interpretation of the standard of living.

The mainstream view of the economic history of the period included neither imperfections of information, nor transaction costs that would impose unforeseen hindrance to the biological development of children and youth of the antebellum decades. Indeed, children

and youth seldom appear in conventional texts of American economic history. Market processes such as commercialization was supposed to be good for everyone, so there was no reason to place children's welfare under the magnifying lens. There was not supposed to be a downside to the expansion of internal trade, market integration, commercialization, and to the loss of self-sufficiency. Industrialization was an integral part of economic growth and the increased opportunities that it afforded. It was not supposed to hurt the children experiencing it.

So the solution to the Antebellum Puzzle indicates that progress was far from linear at the onset of modern economic growth. Research resolving the puzzle took many twists, turns and detours until most of the participants in the debate accepted the model elucidated in Komlos (1987). In the end the paradigm did shift, but it took nearly a third of a century to resolve the controversy surrounding an ingrained perspective.

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Endnotes

Bold script in quotations are that of this author and not found in the original citation.

¹ The timing of the peak was revised subsequently but the essence of the Antebellum Puzzle was already evident.

² “The profile of adult male cohorts was relatively flat until 1805, rose by approximately 1 inch over a period of about 15 years, but then returned to nearly the beginning height by 1830. The adult female profile fluctuated, but is not statically significant” (p. 376). He thereby overlooked the decline in female height in the late 18th century and the trends of the 1830s are not reported.

³ They also republished the same graph that appeared in 1982.

⁴ The trend in the height of female slaves was not reported.

⁵ “Further analysis not reported here revealed that recruits born in 1835 were unusually short...”

⁶ This was the first publication on height in the flagship journal of the Economic History Association.

⁷ Other possibilities were discussed: “There is also the possibility that part of the decline is a statistical artifact. It may be that children of the farm families who enlisted during the peacetime years of the early 1880s came on average from poorer families than those who enlisted during the wartime years” (p. 80-81).

⁸ This was subsequently corroborated by Cuff (1992).

⁹ “An accounting of the average calorie and protein consumption per capita suggests that nutritional intake was declining in the late antebellum period. The availability of nutrients declined because food output did not keep pace with the demands placed upon it by the rapid growth of the urban industrial sector” (p. 908). Protein consumption declined by 10% 1839-1849 (p. 909). “Between 1800 and 1820 one agricultural worker produced enough food for about four individuals. ... by 1870 one agricultural laborer supported almost six people...” (p. 910).

¹⁰ “Middle-class cadets maintained or increased their stature throughout the 1830s and 1840s, and there is no reason to think that they would have been immune to a deterioration in the disease environment” (p. 907).

¹¹ The paper also dismissed the immigration hypothesis as not particularly compelling: “The influx of immigrants in the 1820s was only 1.3 percent of the white population and in the 1830s only 4.0 percent. Thus, the decline in stature started at a time when the share of immigrants in the population was still very low. By 1850 the share of immigrants in the total population had risen to 12.9 percent. Yet the rise of this share could not have been the primary factor determining the decline in stature because the trend reversed in the 1870s, even though the share of immigrants in the population continued to grow. Hence, if the decline in stature were attributed to the increased share of the foreign born in the population, one could not explain the

turning points in the 1830s and 1870s. Another reason for discarding the immigration hypothesis is that the decline in stature was pervasive across all regions of the United States but immigration was not. In 1850 only 4.5 percent of the white population was foreign born in the South in contrast to 18.5 percent in the Northeast” (p. 908).

¹² “...the human biological system can experience periods of stress even as aggregate output per capita grows significantly. Thus anthropometric measurements do not appear to be perfect proxies for the material well being of a population. Rather, they might be considered a component of the biological standard of living, which under certain conditions might diverge in significant ways from such conventionally defined standards as output per capita. ... There is nothing counterintuitive about the supposition that even in otherwise prosperous times the per capita consumption of meat decreases. Of course, to the extent that the dietary change had unforeseen health effects, one must consider this a hidden cost of economic development” (p. 921).

¹³ “The decline in stature was geographically widespread. It is not likely that the disease environment would have changed so dramatically across such a large area...” (p. 906). “Nor is it likely that the deterioration in nutritional status was caused by epidemics, because they were episodic: cholera struck, for instance, in 1832, 1849, and 1866. Could such sporadic events give rise to a long-term trend? Besides, when it did strike, cholera affected relatively few individuals, and because of the high mortality rate, not many of those who contracted the disease would have enrolled in West Point” (p. 907).

¹⁴ Birth weights declined markedly during the war years.

¹⁵ In any event, a half the bushel increase in corn consumption that Fogel advanced as an offset to the declining food consumption would not have been sufficient to counterbalance the total decline in calories. It would have meant an increased intake of barely 1.2 ounces (34 grams) per

day or just 40.6 calories per day. This would have been far from “*wiping out*” the decline in consumption of 267-325 calories per day calculated by Komlos (1987 p. 909), and would have made even less of a dent in protein consumption: accounting for a mere 1.1 gram of protein intake per day. Compared to the 11 gram decline estimated by Komlos this would have been miniscule. In short, the arithmetic of the criticism did not add up.

¹⁶ “Living standards, as measured by quantity and variety of household equipment, appear to have improved for the urban middle classes and for farmers who had access to hired or bound labor between 1790 and 1830. The situation of urban poor, of farmers without extra labor, and of landless rural residents is uncertain; there were clearly no major improvements” (Walsh, 1992, p. 218).

¹⁷ “Inventory studies for the period after 1830 are even fewer in number and almost ... none have been published. No general conclusions about living standards for various groups are yet possible” (Walsh 1992, p. 228).

¹⁸ In the paper published on the basis of his Nobel Prize he does cite some height data calculated by Komlos without attributing the source to him (Fogel 1994, p. 372).

¹⁹ “In this sample, foreign parentage was not a significant determinant of adult height...” (Costa, 1993, p. 370).

²⁰ Komlos named the conundrum the “Antebellum Puzzle” in this article.

²¹ The argument continued by suggesting that the “percent of teenagers receiving less than adequate amount of protein increased 1839-49 by 60%” (p. 210).

²² The per capita figures do not include the population of New York City, which increased by a factor of 8 between 1830 and 1860 to reach 1.88 million.

²³ “Taken together, these two sets of information—the former offering an ‘optimistic’ view and the latter a more ‘pessimistic’ view of the economic development of antebellum America—form the ‘Antebellum Puzzle’” (p. 384).

²⁴ Yet, a referee at the *Journal of Economic History* did find a counterargument with a “Ptolemaic epicycle: “Central to the paper is the finding that the water transport coefficients are essentially different for the Northeast and the Midwest and Mississippi Valley with respect to mortality and heights. The author then concludes that the only way to explain this is the rise in commercial farming in the Midwest and Mississippi Valley, which became a food exporter, and the import of more foodstuffs in the Northeast. The result, the paper contends, was a deterioration of diet in the West and an improvement in the Northeast. I would think that the Northeast gains would have been most important in cities, especially the large ones. But the results do not rule out the deterioration in mortality. First, it might have been an effect of dietary change. But, more importantly, the Northeast had had water connections of some sort for a long time, while the Midwest was only recently experiencing the steamboat and its capabilities. It is interesting to speculate that the mortality environment worsened much more in western areas because of the end of relative geographic isolation in the West that came about due to the opening of the western rivers.... I think that the interpretation remains ambiguous and that the paper has not made its case.”²⁴ The paper was rejected.