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# Height, Nutrition, and Labor: Recasting the "Austrian Model"

In recent years, the use of height data as an indicator of well-being has become increasingly widespread. The anthropometric research project has been successful in shedding new light on such controversial issues as the development of living standards during the Industrial Revolution and long-term factors determining mortality change. The most audacious hypothesis to be generated by this new line of research was advanced by Komlos, who suggested a new interpretation of the Industrial Revolution. This comment attempts to provide a different interpretation of the trends in height data found by Komlos, using a combination of regression analysis and qualitative accounts.[1]

Komlos' model is based on the changes in Austrian heights during the second part of the eighteenth century. The evaluation of 150,000 individual records of army recruits constitutes the empirical core of Komlos' study. Although average heights were rising throughout Europe,[2] recruits in the Habsburg lands were becoming shorter by the decade (57, 80ff.) According to Komlos,

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1 Robert Fogel, "New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health, Mortality, and the Process of Aging," *Historical Methods,* XXVI (1993), 5–43; John Komlos, *Nutrition and Economic Development in the Eighteenth Century Habsburg Monarchy: An Anthropometric History* (Princeton, 1989) (hereinafter cited in text); Stephen Nicholas and Richard Steckel, "Heights and Living Standards of English Workers during the Early Years of Industrialization, 1770–1815," *Journal of Economic History,* LI (1991), 937–957; Roderick Floud, Kenneth Wachter, and Annabel Gregory, *Height, Health and History: Nutritional Status in the United Kingdom, 1750–1980* (Cambridge, 1990); Fogel, "Second Thoughts on the European Escape from Hunger: Famines, Chronic Malnutrition, and Mortality Rates," in Siddiqur Osmani (ed.), *Nutrition and Poverty* (Oxford, 1992), 243–286.

2 Fogel, "New Sources," 20. For a dissenting view see Komlos, "The Secular Trend in the Biological Standard of Living in the UK, 1730–1860," *Economic History Review,* XLVI (1993), 115–144.

the decline in nutritional status, as evidenced by diminished stature, was caused by falling real incomes. Komlos notes that nutritional status is the result of both energy intake and the claims made by such factors as disease environment and housing conditions (26ff). But his further interpretation makes it clear that he regards income as the decisive variable. Indeed, his work on the Habsburg monarchy is remarkable in that it all but disregards the possibility of a changing disease environment or worsening housing conditions: "Insofar as height may be used as a proxy for the nutritional status of a population, and food consumption correlates with real income per family, the analysis of the secular trend in stature may well provide a new perspective on the relationship between the standard of living and the industrial revolution" (433; cf. 26 and especially 116).

Komlos then goes on to describe the Austrian population as being on the brink of starvation. In addition to time-series analysis, Komlos employs cross-sectional data. Areas with a low level of market integration like Hungary initially had a much better fed and considerably taller population. As market orientation and the number of inhabitants grew, average height began to fall, and a general trend toward convergence among the different Austrian territories emerged (106f. The obvious alternative interpretation is that the spreading of disease through trade was responsible).

The most original aspect of Komlos' research is his "Austrian model" of the Industrial Revolution. The initial rise and subsequent decline of heights are causally linked with high population growth and the initial stages of the Industrial Revolution. First, good general economic conditions lead to high reproduction rates, and the subsequent upswing of population brings about the threat of an approaching Malthusian crisis. The latter, however, is averted by government intervention. Reform measures taken by the state in response to the Malthusian threat enable long-term economic growth to proceed. In combination with the supposed benefits of higher population size, the Industrial Revolution begins to gain momentum. However, the reasons that induced the Habsburg state to embark on a program of economic reform, thereby countering the threat of starvation, can only be understood historically and cannot be deduced from the model itself.[3]

Komlos' result, that heights in the eighteenth-century

3 Komlos, "Secular Trend," 143.

Habsburg empire declined, is particularly puzzling since previous scholars regarded this period as a particularly prosperous one. Good, for example, dates the beginning of the economic rise of the Habsburg Empire at 1750, the era when new housing was being constructed everywhere, and Austrian diets were remarkably nutritious. Average consumption of meat was even higher than in north Germany. Tentative estimates of nutritional intake provided by Komlos and other scholars also speak strongly against the hypothesis that the population of the Habsburg lands was on the brink of starvation. Per capita calorie intake was almost 18 percent higher in the Habsburg monarchy than in France (101, Table 2.21). Since Frenchmen at the time did not starve, however dismal their nutritional status may have been, there must have been at least a 20 percent margin that separated Austrians from a truly Malthusian crisis.[4]

Even if this horseman of the apocalypse—hunger—was not riding in the Habsburg monarchy, heights were falling precipitously. How can these two contradictory trends—falling heights, pointing to a declining standard of living, and an economic boom—be reconciled? The economic rise of the Habsburg lands in the second half of the eighteenth century has been associated with additional work effort in general, and extra work on abolished holidays in particular.[5]

As was often the case with other rulers, military reverses caused Empress Maria Theresa to usher in a new era of economic policy. The early 1750s are normally regarded as the decisive turning point. After suffering defeat, and the loss of Silesia, at the hands of the Prussians in the War of the Austrian Succession, the empress initiated three kinds of reform, leading to an era of administrative, social, and economic change that continued under her son Joseph II. The first element of reform, a redistribution of income from the nobility to the peasants, introduced maximum rent levels and partial emancipation of the serfs. It improved the legal position of tenants and reduced their labor obligations (*Robot*)

4 David Good, *The Economic Rise of the Habsburg Empire, 1750–1914* (Berkeley, 1984); Roland Sandgruber, *Die Anfänge der Konsumgesellschaft. Konsumgüterverbrauch, Lebensstandard und Alltagskultur in Österreich im 18. und 19. Jahrhundert* (Vienna, 1982), 114, 134, 153. Fogel, "New Sources," 10.

5 Sandgruber, *Anfänge,* 376, 75f. An alternative critique of Komlos' analysis has been offered by Hermann Rebel, "Österreich und die Weltwirtschaft. John Komlos' neoklassisches Modell. Eine Kritik," *Österreichische Zeitschrift für Geschichtswissenschaften,* IV (1993), 43–72. Rebel suggests that changes in sample composition during the period covered by Komlos explain the changes in average height, but he is unable to point to any data supporting his claim.

(120). The second, which fostered the growth of the bureaucracy, allowed the data necessary for effective policy measures to be collected for the first time and censuses to be conducted at regular intervals (122). The third element promoted direct state intervention in the economy to subsidize new enterprises, limit the power of the guilds, and import skilled laborers.[6]

The abolition of holy days formed an integral part of these new policies. Intensive diplomatic contacts with the Vatican had enabled the empress to secure Benedict XIV's consent to publish an edict on 9 March 1754 that twenty-four holidays be abolished. Attendance at church was still compulsory, but everyone was free to work afterward. These measures were not well received at first. Clergymen agitating against Maria Theresa's policy were sentenced to imprisonment, and the mob of Vienna attacked builders who came to work on an imperial building in the Burgplatz. Nonetheless, the government insisted, and even required, that shopkeepers open at 11 A.M. on the formerly sanctified days. Mounted police patrolled the cities on 24 April 1754, the day of St. Georg, to ensure that compliant shop owners did not fall victim to outraged masses. These incidents demonstrate on the one hand that opposition to Maria Theresa's abolition of holy days was strong and widespread and on the other hand that the government was not willing to compromise on the issue.[7]

Annual workloads were still inadequate from Maria Theresa's point of view. Consequently, on 11 March 1770, she convened her council on ecclesiastical affairs to discuss further steps. The basis of discussion was a memorandum by Paul Joseph von Riegger, a distinguished professor of ecclesiastical law, who made some introductory comments about the moral dubiousness of holy days as an occasion of much license but then argued that the common man was unable to feed himself and his family because he could earn a living only on a few days. Perhaps even more importantly, he felt that Catholic countries in general and the Habsburg empire in particular could not hold their own if men

6 Cf. Hermann Freudenberger, "An Industrial Momentum Achieved in the Habsburg Monarchy," *Journal of European Economic History,* XII (1983), 339 f.; Good, *Economic Rise,* also regards 1750 as the watershed after which sustained growth sets in; Matthew Anderson, *War and Society in Europe of the Old Regime, 1618–1789* (London, 1988), 171–172, 176–177; Karl Pribram, *Geschichte der österreichischen Gewerbepolitik von 1740 bis 1860* (Leipzig, 1907), *passim;*

7 Alfred Ritter von Arneth, *Maria Theresia nach dem Erbfolgekriege* (Vienna, 1870), 58, 59.

continued to be so idle. After extensive discussion, the council agreed to seek the Holy See's permission to abolish another twenty-three holy days and to waive compulsory church attendance on the old feast days. Pope Clemens XIV tried to avoid making a decision on the matter, but the Austrian ambassador in Rome eventually convinced him that only a reduction in the number of holidays would make it possible for Catholic countries to compete with Protestant ones. The pope implored, however, that his own saint's day, as well as one other, be preserved. On 6 November 1771, a decree was finally issued, reducing the number of feast days by twenty-one, leaving the Habsburg calendar with just seventeen holy days.[8]

The stringency with which the new regulations were enforced strongly suggests that labor input in the Habsburg lands was growing in the second half of the eighteenth century. All sectors of the economy were beginning to show the consequences of additional work effort. Cottage shop manufacturing, requiring additional labor, came to the countryside on a new scale, and new crops and rotation patterns began to appear. Stall-feeding and the introduction of potatoes and maize were responsible for raising the total amount of work to unprecedented levels. The extra work demanded of children, particularly with the potato crop, has received much attention from scholars.[9]

The finding that annual labor input must have increased considerably is relevant to the issues involved. Height is a measure of the cumulative nutritional experience between conception and ages 18–25:

$$H = \int_{t=-0.75}^{t=25} f(N,P,C) \leq H_{\max}$$

($N$ represents energy intake, $\delta H/\delta N > 0$; $P$ represents protein intake, $\delta H/\delta P > 0$; $C$ represents claims on energy intake, $\delta H/\delta C > 0$; $H_{\max}$ represents genetically determined maximum height).[10]

The identification of changes in height and in real income is a fallacy if claims on energy intake change. Komlos does not

8 von Arneth, *Maria Theresias letzte Regierungszeit* (Vienna, 1879), 57–61; Decree No. 1344. *Sammlung aller k.k. Verordnungen* (Vienna, 1787), 411 f.

9 Sandgruber, *Anfänge,* 37, 48ff., 64 ff.

10 Age at which final height is attained is itself a function of nutritional status. Floud et al., *Height,* 242.

discuss this possibility adequately. But height is even a poor guide to well-being in a wider sense if all claims on energy intake are not necessarily harmful. Work effort is a case in point. Although both nutritional status and well-being will diminish ceteris paribus if, say, housing conditions degenerate, the same is not true if work availability increases. As Riegger's comments before Maria Theresa clearly demonstrate, the notion was prevalent at the time that the common man was oppressed by the large number of holy days, and that people would choose to work more days in the year if given the opportunity. Since the extra work is voluntary, well-being increases. Yet heights are likely to fall because of increased claims on energy. Studies of developing countries show that additional work effort has a strong adverse effect on height, which is precisely the structural change witnessed in Austria. The state removed an onerous constraint on the population, the prohibition of work on forty-five days of the year.[11]

We can analyse Komlos' data to test whether levels of work intensity were a more important factor in determining heights than were any long-run trends toward immiseration. Komlos runs a regression of heights on age, place of birth, and decade of birth, as well as two dummy variables, urban and skilled (243, Table B.2). The finding most relevant to his thesis about an approaching Malthusian crisis are the highly significant, and diminishing, coefficients on the decade dummies for 1750–1780. Using his published data, a number of additional regressions were estimated as shown in Table 1, using decade of birth, place of birth, and average number of working days in a year as arguments. Regression 2 attempts to replicate Komlos' initial regression, using published data. Regression 3 includes the number of working days in the year as an explanatory variable. If the decade dummies still remain significant and show a trend toward smaller statures, then long-term tendencies toward impoverishment were probably present. If, however, they emerge as insignificant, with the work variable explaining a large part of the variation, then the Komlos thesis must be rejected.[12]

It should be noted that the data sets are not strictly compa-

11 Margarita De La Paz, "Child Labour: Its Implications to Nutrition and Health in the Philippines," unpub. Ph.D. diss. (Columbia Univ.) (on administrative changes in particular, cf. pp. 630–631 herein).

12 This variable is not affected by the timing of the subsistence crisis of 1770/71, which resulted

rable. Komlos used his own database, giving him access to 97,025 observations, whereas regressions 2 and 3 are based on averages per decade and region (57, Table 2.1). Hence, it was impossible to control for age. A minimum 25 degrees of freedom are still adequate for our purposes. Fit in regression 2 is remarkably good. Both $R^2$ and $F$ increase in regression 3. For the period under discussion, the second half of the eighteenth century, the estimates for coefficient on the individual dummy variables are quite similar. Both the size of these coefficients as well as their standard errors change dramatically as soon as the number of working days in the year is included in the regression. The effect of the decade dummies, the central piece of evidence for Komlos' thesis, emerges as irrelevant in regression 3. Instead, the most significant variable is work effort, explaining the largest fraction of total variation. Regression 4 shows that if only workdays and the province dummies are used as exogenous variables, both the adjusted $R^2$ and the $F$-statistic improve. With a $t$-statistic of 7.7, the impact of the number of working days is established beyond reasonable doubt. Figure 1 demonstrates the similarity of the coefficients estimated from the published data and Komlos' original estimates (correlation coefficient = 0.9773), and the change in the size of the coefficients after controlling for work effort.

The change in $t$-statistics is dramatic. None of the decade dummies for the second half of the century have a statistically significant effect on height. Table 2 compares the $t$-statistics on the decade dummies in regressions 2 and 3.

Our finding that the number of working days, and not a long-term trend toward immiseration, determined the development of heights in the Habsburg monarchy is reinforced if we use a time trend instead of decade dummies, as in Table 3. Regression 5 contains Komlos' set of regressors plus a time trend, and regression 6 adds the number of working days as an exogenous variable.

The first impression given by regression 5 is that a Malthusian

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from a harvest failure, because it remained at a high level after the 1770s. A proper dummy variable for the crisis would introduce an extra shift only for these years (1770s = 1, all other years = 0).

Workdays = 251 for all decades before 1750, 275 for the 1750s and 1760s, and 296 thereafter (365 days in the year minus 52 Sundays minus 17 remaining holy days). Since the first abolition of holy days actually occurred in the middle of the 1750s, we cannot do full justice to the exact timing of changes in workloads. The coefficient on workdays therefore provides a lower bound on the true relevance of this variable.

*Table 1* Regressions on Height

| REGRESSION | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Constant | 170.5 | 169.93 | 176.07 | 179.46 |
| Age | | | | |
| 17 | −2.0(d) | | | |
| 18 | −1.5(d) | | | |
| 19 | −1.0(d) | | | |
| 20 | −0.7(d) | | | |
| 21 | −0.5(d) | | | |
| 22 | −0.5(d) | | | |
| Urban | 0.1 | | | |
| Skilled | 0.0 | | | |
| Place of Birth | | | | |
| Galicia | 0.0 | 0.555(e) | 0.557(e) | 0.783(d) |
| Moravia | 0.0 | 0.643(e) | 0.643(e) | 0.73(d) |
| Bohemia (4 countries) | −0.6(d) | | | |
| Bohemia (12 countries) | −0.1 | −0.051 | 0.177 | 0.067 |
| Hungary | 0.6(e) | 0.687(d) | 0.693(e) | 0.6(e) |
| Decade of Birth | | | | |
| 1730 | 0.6(d) | 0.62(f) | −0.508 | |
| 1740 | 1.1(d) | 1.26(d) | 0.30 | |
| 1750 | 0.9(d) | 0.86(e) | 0.32 | |
| 1760 | 0.8(d) | 0.76(e) | 0.22 | |
| 1780 | −0.1(d) | −0.256(e) | −0.28 | |
| 1790 | 0.1 | 0.244 | −0.219 | |
| 1800 | 0.0 | −1.97(d) | −1.02 | |
| 1810 | 0.3(e) | −0.51 | −0.52 | |
| 1820 | 0.2(e) | −0.75(f) | −0.75 | |
| 1830 | 0.3(d) | −0.9 | −0.14 | |
| 1840 | 0.7(d) | −1.58(d) | −1.58(d) | |
| Working Days | | | −0.0245(d) | −0.032(d) |
| $R^2$ (adjusted) | 0.04 | 0.61 | 0.66 | 0.73 |
| $F$ | 150(d) | 5.33(d) | 5.98(d) | 16.5(d) |

NOTE (d) = significant at the 1 percent level; (e) = significant at the 5 percent level; (f) = significant at the 10 percent level; in regression 1, the intercept refers to a rural unskilled soldier over the age of 22 born in the 1770s; in regression 2 and 3, it refers to the average recruit from Lower Austria born in the 1770s.

*Fig. 1* Coefficients of Decade Dummies

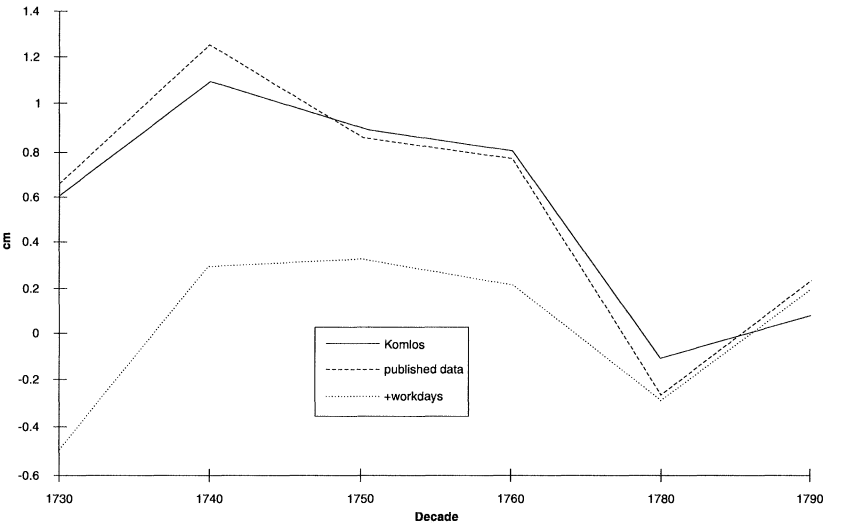


*Table 2* *T*-Statistics on Explanatory Variables

| EXPLANATORY VARIABLE | REGRESSION 2 | REGRESSION 3 |
|---|---|---|
| 1730 | 1.825 | −0.822 |
| 1740 | 3.993 | 0.554 |
| 1750 | 2.68 | 0.827 |
| 1760 | 2.37 | 0.572 |
| 1780 | −2.59 | −0.929 |
| 1790 | 0.757 | 0.726 |

crisis was indeed approaching fast in eighteenth-century Austria. Heights and nutritional standards seem to have fallen by the decade. This interpretation is reinforced by the very strong *t*-statistic, which allows us to reject the null hypothesis (no significant influence) at the 1 percent level of confidence. However, as soon as the number of working days is entered as an explanatory variable, the time trend actually becomes positive and statistically insignificant. The $R^2$ (adjusted for the number of degrees of freedom) and the *F*-statistic increase considerably. Changes in the

*Table 3* Time-Trend Regressions on Height (1730–1800)

| REGRESSION | 5 | 6 |
|---|---|---|
| *Place of birth* | | |
| Galicia | 0.78(d) | 0.78(d) |
| Moravia | 0.73(d) | 0.73(d) |
| Bohemia | 0.066 | 0.066 |
| Hungary | 0.6(e) | 0.6(e) |
| Time | −0.28(d) | 0.0012 |
| Working Days | | −0.32(d) |
| adj. $R^2$ (adjusted) | 0.62 | 0.71 |
| $F$ | 10.3(d) | 13.4(d) |

NOTE (d) = significant at the 1 percent level; (e) = significant at the 5 percent level; (f) = significant at the 10 percent level.

number of working days are sufficient to explain the downward trend in Austrian heights.

This comment has demonstrated how a fresh look at all the factors determining average height in a population can lead to a revision of earlier findings. Once the central importance of physical exertion is recognized, there is no reason to believe that living standards in Austria fell during the second half of the eighteenth century, let alone that a Malthusian crisis was imminent. The first part of this article showed that change in the number of holidays probably led to higher labor input in the economy. Regression analysis demonstrates that these factors explain the peculiar decline of Austrian heights during the second half of the eighteenth century in a new way that contradicts neither previous accounts nor evidence from other indicators—through additional work effort rather than a long-term trend toward immiseration. Declining heights and the early stages of the Industrial Revolution were indeed closely connected, but work effort seems a stronger link between them than the dramatic "Malthusian" one suggested by Komlos.