Three essays on the relationship between the economy and the living standards

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to my mother

for making me eager to learn more

to my father

for teaching me with his example to work hard

to Hanjo and Sarah

for having given a meaning to this effort

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Contents

Introduction

The concept of *living standards* is at the base of economics: as Pigou argues in his *The Economics of Welfare*, 'The social enthusiasm which revolts form the sordidness of mean streets and joylessness of withered lives ' is, in fact, 'the beginning of economic science' (Pigou, 1952, p.5). Since Adam Smith's "*The Wealth of Nations*", several economists tackled questions such as what determines and how to improve the welfare of a society. [1] The long-lasting debate on the effect of industrialization on the living standards has involved, and continues to involve, generations of economic historians.[2]

No agreement exists, however, on how to define *welfare* and therefore on how to appropriately quantify and compare it across countries and/or across time. Economists traditionally identify welfare with material prosperity and monetary measures (such as real wage at the micro level and per capita GDP at the macro level) are used to assess the level of living standard.[3] In the 1960's there was interest among sociologists in so-called social

[1] See for example Kaldor (1939) Hicks (1940) Little (1957) Pigou (1952) de V. Graaf (1957) Sen (1984).

[2] Among the works on the living standard during the industrial revolution see for example Hartwell and Engerman (1975), Lindert and Williamson (1983), Crafts (1997), Feinstein (1998), Komlos (1998)

[3] See for example Pigou (1952) where the terms "economic welfare", "standard of living" or "material prosperity" are used almost as synonyms. On the emphasis put on the monetary measures of welfare such as the GDP see also Lucas (1988).

indicators (quantitative measures of education, health, pollution - to asses the features of the social system)[4] and some scholars stressed the shortcomings of the traditional economic indicators in reflecting the broader concept of quality of life.[5] Amartya Sen's work represents an important departure among economists.[6] He provided a more rigorous conceptualization of the standard of living that stimulated research on new measures of welfare to include aspects as mortality, education, inequality, poverty rates, child health, index of freedom, and even gender discrimination.

Nowadays, the analysis of welfare is multidimensional and a broader set of instruments is used to assess socio-economic well-being. Recent research includes works on happiness (Frey and Stutzer, 2002a,b), the United Nations Human Development Index (UNDP (2004)), poverty or green accounting.[7]

This thesis analyses the relationship between the economy and the standard of living, meant in this modern, broader sense. It focuses on two countries (*i.e.* Italy and Germany) and on time periods (such as the first half of the 19th century) that, despite their intrinsic interest, remained up to now at the margin of the economic debate.

The first two chapters are devoted to the analysis of the effect of socio-economic processes, such as industrialization, market globalization, urbanization, agricultural policies on biological welfare measured using human height.

Physical stature has been used by development economists and cliometrician as an indicator of well-being, inasmuch as it is sensitive to features of

[4]For a review on the origins and the developments in the field of the social indicators Land (1983).

[5]See for example Gross (1966), Carley (1981).

[6]See for example Sen (1976, 1979, 1984)

[7]For a review on the evolution of the measures of 'progress' see Komlos and Snowdon (2005)

the economic environment some of which are not fully captured by monetary measures (such as, work effort and the incidence of diseases). Height reflects the biological standard of living as distinct from conventional concepts, indicating how well the human organism thrives in its socio-economic environment. Individuals who are poorly fed and have recurrent infections rarely grow well in either childhood or adolescence and are unable to achieve a final adult height that is commensurate with their genetic potential. For children and adolescents, height depends essentially on past food consumption and the incidence of diseases. Changes in socio-economic factors that influence the availability of nutrients or of the claims on them (such as changes in the price of food or in public health policies) are then reflected in adult stature.

Anthropometric research has made important contributions to the understanding of the impact of economic processes and institutional changes (such as industrialization and globalization) on the standard of living of social groups usually excluded by traditional statistics (such as self-sufficient peasants, slaves, children, or women). Another important contribution of the research agenda has been demonstrating how rapid economic expansion did not always bring with it an overall improvement in physical welfare (as in the case of the US in the mid of 19th century). Finally, on account of the scarcity or utter absence of conventional economic data, stature proves to be extremely useful in the field of economic history.

Life expectancy was suggested by Hicks and Streeten (1979) as welfare indicator, inasmuch as it measures how basic needs (such as nutrition, housing, access to drinkable water or health care) are met by the society.

The first chapter analyses the development of the living standards in Central and Northern Italy at the beginning of the 19th century. While the debate on the welfare effects of the Industrial Revolution has been up to now focused mainly on Great Britain and the United States, other areas, such as central Italy, deserve attention. As many other European countries, also the Papal states had to face at the end of the 18th century the challenge of modernization. Unprecedented rates of population growth, the increased demand of Mediterranean staples from abroad, the French Revolution and the Napoleonic rule, brought in Italy several elements of novelty in the socio-economic structure.[8] Using newly collected data on soldiers who enrolled in the papal army, the chapter offers a breakdown of the biological living standard and sketches its evolution between the end of the 18th and the beginning of the 19th century using both height and mortality as indicators.

Some results are worth of emphasis. Despite the great economic variety within the Papal states, no significant birth-province effects are found neither in height, nor in the mortality experience. Not only the levels are similar, but also the time trends are almost parallel, highlighting a generalized failure of the agricultural system in keeping the pace with an increasing demand: in contrast with the usual believes, also the Po-plain area, regarded as the most economically advanced part of the Papal states, experienced a decline in the biological standard of living comparable with that of more backward areas within the Papal dominions.

A certain degree of inequality in the distribution of the resources emerges from the analysis, with the agricultural laborers being at the bottom and the educated group being at the top of the height distribution. A significant penalty existed both in terms of height and mortality for inhabitants of big cities: the presumably better access to hospitals and the early diffusions of public health measures in cities, did not compensate for the worse disease

[8]Grab (2000), Davis (2000).

environment (due to the high population density) and the higher food prices.

The second chapter analyses the case of Germany at the beginning of the 19th century. Despite progress in some areas of the German confederation (such as Saxony or the district of Nürnberg), at the beginning of the 19th century the major economic indicators were not far advanced, whereas one century later, the unified German Empire had one of the world's leading economies. The impressive catch-up took place mainly after 1870, but it is during the first decades of the 19th century that important economic and social reforms that set the basis for the subsequent fast growth were implemented. This chapter analyses for the first time the trend and regional variation in height in the German confederation. Furthermore, a separate analysis for the Prussian kingdom contributes to the debate among German economic historians on the welfare effects of the agrarian reforms.

The results show a downturn in height, as in many other parts of Europe and America, particularly substantial for those born at the end of the 1830s. Both an increase in food prices and a deterioration of the disease environment can be at the base of the height decline. The separate analysis of different regions highlights a major North-South differential in height. Interestingly, the height advantage for the northern states is comparable to that observable in contemporary Germany. The different regional height trends reveal how common shocks had different effects on the living standards despite the economic unification achieved with the *Zollverein*. In the Prussian kingdom no significant height differences emerge between districts where the agrarian reforms were implemented - according to the amount of land that peasant lost, in a mild and in a harsh fashion. This outcome, together with an estimated declining height trend in the Western part of Prussia and a stable height trend in the Eastern part, suggests that the agrarian reforms were not so detrimental to the standard of living of the industrial working class. The increase in small and middle size plots in the West, in fact, could have led to a lost of economies of scale so that the agricultural sector may have been not able to satisfy an increasing demand for its products coming from the industrial sector.

Finally, the third chapter explores the relationship between the economy and the standard of living in contemporary Italy, using body size (defined with several measures) as an indicator of welfare. Rather than analysing the effect of economic changes on the biological living standards (as in the first two chapters), the last chapter focuses on the reverse link that goes from biological outcomes (weight) to economic performance: more specifically, the analysis aims at determine if body size affects negatively labour market outcomes, defined as the probability of being employed and the probability of being in managerial position. This part of the thesis adds to the growing body of literature on this issue a twofold contribution. From a geographical point of view, Italy, a country up to now almost neglected, is analysed. From a methodological point of view, the chapter proposes a new set of instruments to deal with the endogeneity problem that may arises in such investigation.

After correcting for endogeneity, the relationship between body size and the probability of being employed appears to be significantly negative for both men and women. In contrast with most of the existing literature, the results highlight the presence of discrimination against heavy workers irrespectively of their sex. Using a Rivers and Vuong two step procedure, endogeneity with respect to body size measures is identified when the occupational status is analyzed: considering body size as an exogenous regressor, therefore, leads to inconsistent estimates that may conduct to underestimate the degree of discrimination that workers encounter on the labour market because of their body size. The relationship between body size and professional position appears to be generally not statistically significant both with and without correction for the endogeneity.

A possible explanation for the results is proposed. It is argued that physical appearance works for employers as an imperfect signal of productivity. Lacking the full set of information concerning the employee's productivity, an employer may chose to hire a normal size individual rather than a bigger one, as a big body size may convey the signal of a lower productivity. However, when decisions concerning career advancements of employees have to be taken, the employer has the opportunity to observe workers' productivity. She has not to rely any more upon imperfect signals such as physical appearance and body size plays no role in determining the probability of reaching top professional positions.

Chapter 1

Biological living standards and mortality in Central Italy at the beginning of the 19th century

1.1 Introduction

At the end of the eighteen century, Italian states, as many other western countries, had to face the challenge of modernization. The heartlands of the industrial revolution were geographically distant from the Italian peninsula. Nonetheless, Italy felt from an early date the effect of the economic changes that were undergoing in Europe at that time. Increased demand for Mediterranean staples placed new incentives on commercial farming, bringing instability and precariousness to the rural world. Furthermore, unprecedented rates of population growth put additional pressure on the agricultural resources, giving rise to an acute land-hunger that became cause of rural discontent. Not all the changes were driven just by market forces: also the most conservative rulers, in fact, realized that in order to sustain their dynastic independence, they needed economic growth, so they tried to drive the change. Their answers to this challenge were dissimilar and had different outcomes.[1]The French revolution and the Napoleonic rule, finally, represented another element of novelty in the Italian panorama at the beginning of the 19th century. During the two decades of the French administration old dynasties were deposed, fiscal and financial administration was rationalized, aristocratic and ecclesiastical privileges were abolished, boundaries were changed and regions aggregated. Italy experienced for the first time in its history a united code of law, one administrative organization, a uniform tax system and, in the end, an integrated market. These innovations accelerated the pace of modernization of the Italian states but brought also social costs.[2]

The goal of this study is to better understand the effects of the socioeconomic transformation on the welfare of the population. In order to address the topic data on height are used. This indicator of well being, widely used in economics because of its sensitiveness to features of the economic environment that are not fully captured by monetary measures, is particularly useful in this context, where the reliability or the representativeness of other measures is under question.[3]Physical stature, in fact, correlates positively with income, allowing us to expand the analysis beyond the limits of GDP or real

[1]Davis (2000)

[2]Grab (2000)

[3]P. Malanima has reconstructed series of per capita GDP and of real wages for Centre-North Italy for the period 1300-1861. However, he uses data just from Tuscany and Lombardy. Given the big regional difference in Italy at that time, the representativeness of the series for the whole Centre North is at least questionable. See Malanima (2003). For the use of height in economics see the review in Steckel (1995).

wages availability.[4] Anthropometric data were already used in the analysis of Italian economic history. The existing literature offers a pretty good picture of the height evolution from the second half of the 19th century to the end of the 20th.[5] Heights were also used in the study of Northern Italy during the Austrian rule (1730-1860).[6] My intent is to extend this analysis also to the central part of Italy, the Papal States, in order to have a wider picture of Italian Development before the unification. The analysis of the mortality experience adds to this picture, a further piece of information.

The papal dominions formed one of the largest Italian states in 19th century, stretching from the frontiers of the kingdom of Naples to the Po valley and from the Tyrrhenian to the Adriatic Sea (see figure 1.1 in the next section). The territories included under the authority of the Popes were various: flat lands in the north (corresponding to the current region Romagna), mountains in the landlocked central region (now called Umbria), hills and access to the see in the coastal regions (todays Lazio on the west and Marches on the east), and a big city, Rome, that was one of the most populous in Europe. The agrarian regimes and the tenure system varied from area to area.[7] Internal tariffs and a substantial lack of infrastructure limited trade among provinces that, in the end, can be considered as separated territories.[8] These features make the Papal State an interesting case of study, giving us the opportunity to analyze how different economic substrata reacted to common, external shocks, as the unification of the market, the increase in agricultural

[4] The correlation is always observed in cross sectional data. In time series there is an important exception: the so called Antebellum puzzle (for more details see Komlos (1998)

[5] For the analysis of the secular trend in heights in later periods see Arcaleni (2006) and Federico (2003)

[6] A'Hearn (2003) used data from the Hapsburg army, covering the regions Lombardy and Veneto.

[7] see Zamagni (1993), Zamagni (2005)

[8] Woolf (1973), Caracciolo (1973), Pescosolido (1994).

prices and in the demand for land and food.

1.2 The data

A sample of soldiers recruited in the Papal state's army in the Restoration years is here analysed. Since 1793, soldiers were enrolled in the army mainly on a voluntary base. The soldier was signing a contract with the State, receiving a certain amount of money for serving the army for at least three years. In 1822, an edit passed the principle of compulsory conscription. However, given the numerous exceptions and the possibility to pay for substitutes, the enrolment was practically still voluntary. After the revolution in 1831, the authorities imposed to local municipalities to provide the army two recruits every 1,000 inhabitants. The net of privileges and exemptions, however, made impossible this forced enrolment, that was in the end limited only to vagrants and unemployed.[9]

Each regiment collected information on the personnel in special registers. When a recruit was joining the regiment, a new file was created on the register where all the relevant information on the military life of the recruit (such as promotions or transfers to other regiments) were recorded. Height was recorded in *Piedi* (feet), *Pollici* (inches: one inch was the twelfth part of a foot) and *Linee* (lines: a line was the twelfth part of a inch). In addition to height, the files report the year and the place (town and region) of birth, the last place where the recruit resided, former profession, the date in which the recruit joined the army and the date when he joined the regiment and his admission status (if as a volunteer, as a convict forced to join the army or as

[9] Ilari (1989)

a readmitted deserter). Grade advancements and the date of the death were also recorded if these events happened during the time spent in the army.[10]

From a sample of these registers (*Matricola sottoufficiali di fanteria, registri n 1433*, *1437*, *1449*, *1459* and *1483*), stored in the Rome state archive,[11] information for 9,855 soldiers was collected. The range of birth year goes from 1752 to 1824, with the best coverage in the years of the French dominion (1790 - 1815) (Table 1.1)

Table 1.1: Composition of the sample by birth cohort

Birth cohort	**Frequency**	**Percentage**
before 1785	580	6.51
1786 - 1790	738	8.28
1791 - 1795	1,363	15.20
1796 - 1800	2,010	22.56
1801 - 1805	1,558	17.49
1806 - 1810	1,516	17.02
1801 - 1815	915	10.27
1816 *and later*	229	2.57
Total	8,909	100.00

The papal dominions formed one of the largest Italian states in the nineteenth century, stretching north from Rome to the lower Po valley, east to the Adriatic and south to the frontiers of the Kingdom of Naples (Figure 1.1, left panel), corresponding to the modern regions of Romagna, Marche, Umbria and Lazio (Figure 1.1, right panel).[12]All these areas are well represented in the sample, although the majority of the soldiers (40%) were born in Romagna, and in particular in the legation of Bologna (Table 1.2).

[10]Unfortunately, information about the death was collected only for 60% of the present sample.

[11]Archivio di Stato di Roma, sede succursale. Via Galla Placidia 93, 00159 Roma.

[12]Before 1815, the papal dominions included also the small enclaves of Benevento and Pontecorvo in southern Italy. Those enclaves were lost after the Vienna settlement.

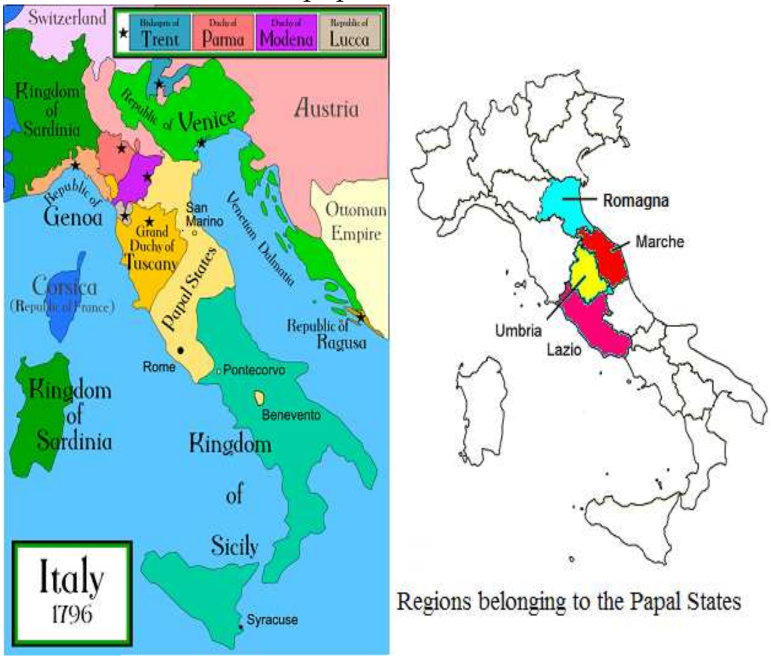
Table 1.2: Composition of the sample by area of birth

Area	Frequencies	Percentage
Romagna		
Bologna	1,647	16.71
Ferrara	858	8.71
Forlì	777	7.88
Ravenna	662	6.72
Total	3,944	40.02
Lazio		
Rome	803	8.15
Lazio (Rome excluded)	728	7.39
Total	1,531	15.54
Marches		
Total	2,842	28.84
Umbria		
Total	922	9.36
Benevento		
Total	168	1.70
Other Italian states		
Modena and Parma§	99	1.00
Other ‡	138	1.40
Total	237	2.40
Foreign States		
Total	211	2.14

§Althoug contiguous to Romagna, Modena and Parma were not part of the Papal territories.

‡Other includes: Kingdom of Naples, Kingdom of Sardinia-Piedmont, Tuscany, Lombardy and Veneto

Figure 1.1: Location of the papal States and of their different regions



More than 400 different jobs were listed in the original registers. They were aggregated in 15 categories according to the degree of skills required, and the economic sector of activity (Table 1.3).[13]The sample is not totally representative of the professional composition of the underlying population. Indeed, although agricultural labourers represent the relative majority of the recruits, their percentage is definitely too low if we consider that in 1911, when the structure of the population was much more industrial than in the period here analysed, in the regions formerly belonging to the papal dominions, individuals employed in agriculture represented on average more

[13]The professional groups are as follows: "Agricultural labourers" (peasants, fishers, shepherd); "Barbers"; "Elite"(practitioners, writers, students, land owners); "Food" (cooks, butchers, bakers, millers, pastry cooks); "Masons"; "Metal Workers" (blacksmiths, armourers, grinders); "Miscellaneous crafts" (hut makers, rope makers, tanners, painters, printers); "Retail" (innkeeper, fruiterer, shopkeeper); "Shoemakers"; "Skilled woodworkers" (carpenters, cabinet makers, turners, ebony carvers);"Soldiers"; "Tailors"; "Textile" (weavers, combers, spinners); "Unemployed"; "Unskilled" (domestic servants, coachmen, rag-and-bone men, launderers)

than 60% of the labour force.[14]

Nearly half of the sample is represented by skilled or partially skilled craftsmen (the professions under the groups “Mason”, “Metal workers”, “Skilled woodworkers”, “Shoemakers”, “Tailors”, “Textiles” and “Miscellaneous crafts”, that include skilled artisans such as blacksmiths, carpenters, tanners or weavers). A not negligible percentage (more than 7% of the total) is made of recruits from the wealthy and/or educated classes (such as land owners, practitioners, writers). Although the sample is not a random selection of the underlying population, it still represents a wide range of social classes. The following analysis, therefore, pertains a portion of the early 19th century society in central Italy that goes beyond the poorest among the poor ones.

Table 1.3: Composition of the sample by profession

Profession	**Frequency**	**Percentage**
Agricultural laborers	2,104	23.18
Barbers	178	1.96
Elite	686	7.56
Food	374	4.12
Masons	461	5.08
Metal Workers	438	4.83
Miscellaneous crafts	719	7.92
Retail	229	2.52
Shoemakers	1,204	13.27
Skilled Woodworkers	431	4.75
Soldiers	454	5.00
Tailors	448	4.94
Textiles	603	6.64
Unemployed, note listed	169	1.86
Unskilled	578	6.37
Total	9,076	100.00

[14]According to the indstrial census of 1911, in Umbria and Marche agricultural workers represented respectively 74.3% and 71.6% of the labour force; in Emilia-Romagna they were the 63.8% and in Lazio the 56.3%. See V. Zamagni (1987, 2006)

The professional composition of the sample does not change a lot over the enrolment years covered, except for a constant decline in the percentage of soldiers over time and an increase in the percentage of shoemakers and textile workers (Table 1.4). The percentage of agricultural laborers enrolled in the sample shows big fluctuations form period to period. As the labor demand in the agricultural sector was subject to wider fluctuations from one year to the other, according to the A look at the composition of the sample by birth cohorts, does not reveal big changes either.

Table 1.4: Professional composition by triennium of enrolment

	1814-1816	**1817-1819**	**1820-1822**	**1823-1825**	**1826-1828**	**1829-1831**	**1832-1836**
Agricultural laborers	17.80	25.05	24.69	18.25	26.72	29.19	16.65
Barbers	2.60	1.76	1.43	1.43	2.08	1.96	2.12
Elite	8.52	10.37	7.11	8.23	5.40	5.95	7.42
Food	3.72	3.52	3.83	5.19	4.89	4.53	4.24
Masons	5.56	6.37	4.72	7.51	5.17	4.05	3.18
Metal Workers	4.84	3.88	3.77	3.04	5.23	6.62	6.36
Miscellaneous crafts	7.75	7.58	7.95	6.98	7.87	7.84	8.87
Retail	2.50	2.18	2.93	2.33	2.87	2.36	1.99
Shoemakers	13.26	10.19	13.15	13.06	12.77	13.24	18.28
Skilled Woodworkers	5.20	3.70	5.56	3.76	3.94	5.27	6.49
Soldiers	7.70	7.70	5.20	5.37	2.70	2.91	1.99
Tailors	5.81	6.25	3.11	5.55	3.49	4.73	5.70
Textiles	7.85	5.76	5.68	7.33	6.41	5.88	8.87
Unemployed	0.66	0.67	3.77	3.22	3.43	0.81	0.93
Unskilled	6.22	5.03	7.11	8.77	7.03	4.66	7.02
N	1,961	1,649	1,673	559	1,778	1,480	755

As many other military samples, also this one has to deal with the problem of truncation from below. Height was in fact used to define physical ability to serve the army. Although information on the official minimum height requirement (MHR) applied is missing, a graphical examination of the data reveals a clear truncation point (TP) for the infantry at 60 inches (5 feet, 0 inches and 0 lines): figure 1.2 plots the height distribution for the whole sample; height distributions for each enrolment year do not differ from this one.[15] About 11% of the recruits aged 18 years or more, however, have a height that is below 60 inches suggesting that the enforcement of the MHR was variable. As a consequence, rather than having a clearly-truncated normal distribution, with the left tail missing below the TP, we rather observe a left tail increasingly deficient. Imposing a normal distribution on the height histogram makes clearer this point: while the right tail fits well the normal curve, on the left frequencies drop off too sharply.

Figure 1.2: Height distribution. Soldiers aged 18 or more. Row data

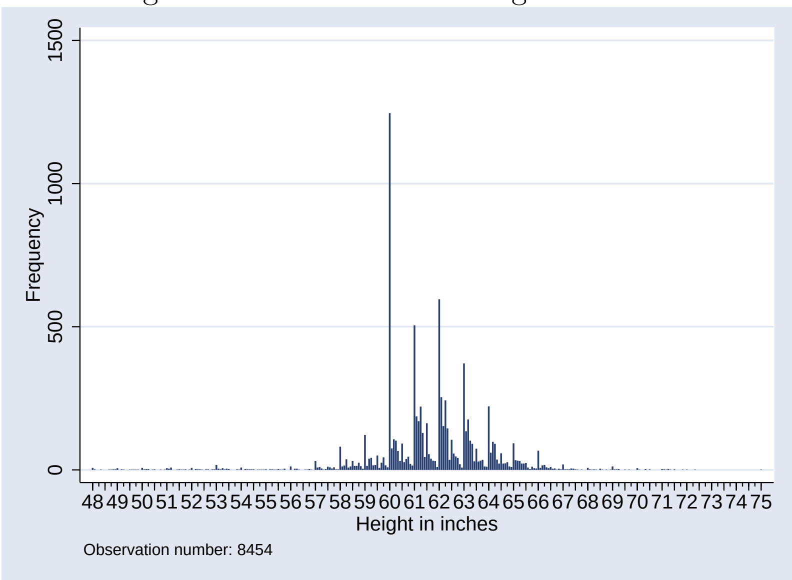
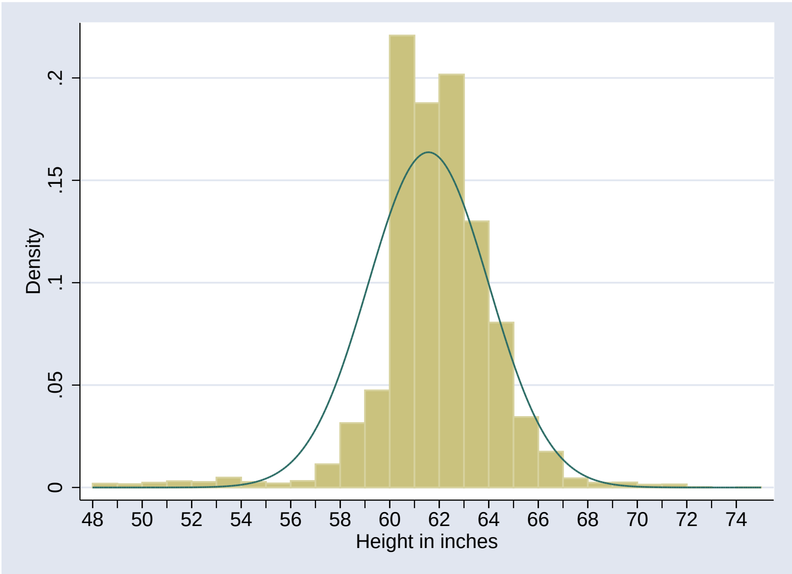


Figure 1.2 and figure 1.3 reveal also that data suffer from rounding to the nearest whole-inch and from heaping. The latter problem is particularly evident inasmuch as the observations at 60 inches are abnormally frequent.

[15] For the enrolment year 1814, the graphical examination does not show a clear TP: height distribution in this case appear to be pretty normal or with a TP set at 62 inches. The resulting distribution, however, can be the outcome of the small number of soldiers enrolled in that year (only 158) rather than in an application of a higher MHR, especially in a war year as 1814.

This feature of the distribution may exert a confounding influence on the attempt to estimate sample moments.[16] A'Hearn (2006) propose to model heaping as a form of heteroskedasticity. His correction consists in allowing the standard deviation (σ) to differ between observations with heaped height measurements and the rest, imposing a different value of sigma (based on simulations) to the heaped group. The results obtained after this correction are close to those obtained without correction, although with uniformly smaller standard errors, therefore a simpler strategy is here applied, consisting in analyzing only the observations above 60 inches and imposing a fixed value for σ.

Figure 1.3: Height distribution. Soldiers aged 18 or more. One-inch bin histogram with normal curve

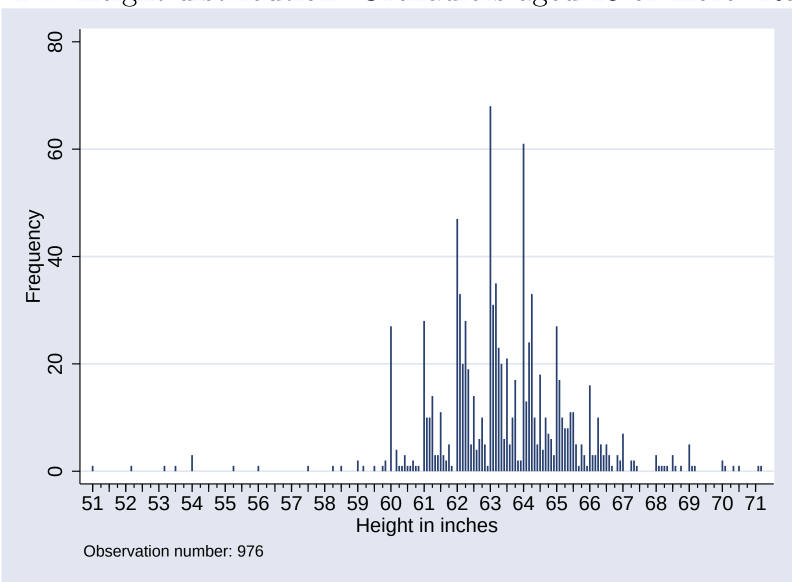


It does not seem that different TPs are applied to different corps. For

[16]Due to this peak, in fact, the data exhibit a negative skewness (whereas, given the truncation from below, a positive one would be expected) and an extreme excess kurtosis. The mode at 60 inches that coincide with the MHR makes particularly difficulty to estimate both the mean and the standard deviation. Similar features are not uncommon to military samples: see also Cinnirella (2006) and A'Hearn (2006).

example grenadiers are, as expected, generally taller than infantrymen, that is, their height distribution is shifted to the right. However the truncation appear to be always at 60 inches, indicating that this corp was made with the tallest among the recruits that were accepted into the army (Figure 1.4). The same applies for the hunters the other special corp of the papal army.

Figure 1.4: Height distribution. Grenadiers aged 18 or more. Row data



Due to sample truncation, a standard OLS approach fails to give consistent and unbiased estimates. Among the several methods that have been proposed to correct for this problem, truncated maximum likelihood (TML) regression has proven to be the most effective, and it will be used to in the following analysis.[17]

Given that the reported heights appear to be rounded to the nearest whole-inch, the TML estimator requires adjustment, as long as the *effective* TP does not coincide with the *apparent* TP. If, as it seems to be the case, the

[17]A review of the principal methods used to correct for truncation in height samples is presented in Komlos (2004). See also A'Hearn (2004)

height of 59.5 inches tall recruits was rounded up and reported as 60 inches, the former and not the latter represents the effective truncation point. A simple modification rule consists in applying a TP equal to the apparent one (60 inches in this sample) minus one-half the rounding interval (a quarter-inch here). Subject to this rule, the TML estimator has been shown to be unbiased with rounded data.[18] In the following analysis, therefore, a TP of 59.75 inches has been applied.

Another regression is also performed using a TP of 60 inches (so that all the observation below or equal to this threshold are discarded from the analysis) and constraining the standard deviation σ to be equal to 6.86 cm, a value suggested as a plausible figure for male, based on data for modern populations. Alongside the attenuation of the heaping problem mentioned before, this approach offers greater sampling precision when compared with unconstrained estimations, regardless of any bias introduced by incorrect restrictions σ.[19]

1.3 Regression results

1.3.1 Cross-sectional effects

Table 1.5 presents the estimated results. As already mentioned, height was recorded in feet, inches and lines. In Europe in the 19th century, several different "feet" were used, each one with a different relation with the linear meter. The Austrian foot, for example, was equal to 31.6 cm, while the French foot (also known as Parisian foot) used to be equal to 32.5 cm until

[18] See Komlos (2004) and A'Hearn (2004)
[19] A'Hearn (2004)

1812, when it was set to 33.3 cm. The foot was a common unit of measurement also in the Italian states. Its length varied enormously not only form state to state, but very often also from town to town.[20]As the original sources do not specify which foot was used to measure the soldiers, the conversion in centimetres has to be inferred. A possible strategy consists in convert the MHR applying different standards to see if the derived measure is plausible or not.

The papal army could have adopted as unit of measurement the "Roman foot", equal to 29,8 centimetres.[21] The MHR would have then been in this case equal to 149 centimetres. Such a small lower bound is in line with the one adopted few decades later in the new kingdom of Italy.[22] However, the height of soldiers aged 18 years or more would range between 120 and 180 centimetres, with 2% of the recruits shorter than 138 cm a too lower bound to be credible. Transforming the regression results with this coefficient would lead to an estimated mean of less than 150cm, a value that does not compare well with the 165 cm of contemporaneous Northern Italians or with the 162 cm of Italians born only few decades later.[23] Furthermore, the Roman foot was divided in 16 *once* (ounces) and not in 12 feet and 12 lines as in these registers.

An alternative can be represented by the "Austrian foot". After Napoleon's defeat, in fact, the Congress of Vienna made Austria the new protector of the papal states. The Austrian army remained throughout the territories

[20]For example in Bologna 1 foot = 38 centimetres while in the other areas of Romagna 1 foot = 29,8 centimetres. See C. (1880)

[21]Martini (1883)

[22]The newly created Italian army in 1863, in fact, adopted a MHR of 150 cm (Arcaleni 1998, 2006)

[23]For Northern Italians see A'Hearn (2003); for the Italians born in 1854 see Arcaleni(2006)

and the Vienna settlement allowed Hapsburg troops to occupy key papal fortresses.[24] Traditionally, the papal army used to adopt the military organization, weapons and uniform of the army of the allied foreign power. It could be the case, than, that among the other features, the papal army adopted also the Austrian MHR, and in particular Austrian instrument to measure the height of the recruits. In this case, one foot equals 31.6 cm (and 1 inch = 2.63 cm); the MHR would then be equal to 158 centimetres. The same lower threshold was applied for the recruits in the Austrian army in the Italian regions of Lombardy and Veneto.[25] Until 1840, however, in the Austrian measurement system, one *line* represented a quarter inch and only after 1840 it represented one-twelfth inch. Despite the big percentage of observations with a recorded *line* equal to zero (41% of the sample), no concentration around specific numbers can be appreciated.[26] In other words, the *lines* appear to represent always one-twelfth inch. Given that the recruits collected in this sample entered the army before 1840, the Austrian foot does not seem a plausible candidate.

A last opportunity could be represented by the "French foot". The papal army, in fact, could have kept some of the military practices adopted by the French army, which ruled over those territories until 1814. This choice could have been driven by practical reasons: the military staff of the papal army could have served and thus have being trained in the Napoleonic army, or they could have used measurement instruments left by the French. The French foot, as it was used before the decimalized system of units of 1799, was equal to 32.5 cm (1 inch = 2.71); its use was abolished during the French revolution, but, given the difficulties of using the newly introduced metric system, in

[24] Laven (2000).

[25] A'Hearn (2003)

[26] The distribution does not change considering different enrolment years

1812 a system of measurement (*mesures usuelles*) was introduced that acted as a compromise between traditional and new measures. According to the *mesures usuelles*, a foot was equal to a third of a meter (33.3 cm, and therefore 1 inch = 2.77 cm). If the papal army in 1814 adopted the new French foot, then, the latter coefficient is the one that it has to be applied, leading to a MHR equal to 166.6 centimeters; it is also likely, however, that the papal army could have used the old French foot if this was the standard adopted during the French rule and even before.[27] In this case the MHR would be equal to 162.5cm. MHRs pretty high in comparison to the average height of the population were not infrequent in Europe at that time.[28] In the case of Italy, 166 centimetres appear to be higher than the average height of Italian men born in 1854, and higher than the estimated height for Northern Italians born in the 1830s, while 162.5 cm are quite close to the average height of Italians born in 1854 and slightly below that of Northern Italians.[29] If the French foot was then the standard applied, the TP should be on the right of the height distribution or, at best, it could coincide with the mean of the population. The graphical analysis of the height distribution (figure 1.2) would support this hypothesis. Furthermore, the relative high number of observations below the TP is coherent with a MHR fixed at a very high level, making the French foot a very plausible choice. Finally, the estimated mean would be close to 163 cm, a value that is comparable to Arcaleni' and A'Hearn's estimates.

[27]Actually, this could be the case. The analysis of a small sample of papal soldiers in 1802, reveal an identical height distribution and an identical MHR. One may suspect, then, that the papal army continued to adopt its own foot (based maybe on the French foot), irrespectively of what happened in France.

[28]The Saxonian army, for example, applied during the 18th century a MHR of 72 Saxonian inches (circa 170 cm) (Cinnirella (2006)); the British army in the first decades of the 19th century a MHR of 65 British inches (circa 165 cm) Cinnirella (2007); the Austrian army applied before 1795 a MHR of 63 Austrian inches (165.9 cm) (A'Hearn (2003))

[29]See Arcaleni (2006) and A'Hearn (2003)

The "French foot" as it was before the *mesures usuelles*, is then applied to convert the estimated coefficients in centimeters. The first model applies a TP of 59.75 inches (161.8 cm) and considers younger and older soldiers together. The second model applies the same TP, but restrict the analysis only to soldiers aged 20 years or more. The reason for this restriction is that the higher percentage of teen-agers (whose growing process was not completed) in the later birth cohorts may lead to a spurious downward trend in height. The third model, finally, accounts for the heaping problem fixing a higher TP (60 inches, 162.5 cm) and constraining the standard deviation to be equal to 6.86 cm (2.53 inches if using the French foot).

Table 1.5: Truncated Maximum Likelihood Estimate

Variable	**Model 1**	**Model 2**	**Model 3**
Birth cohort			
- 1785	1.243*	1.619**	0.953†
1786 - 1790	0.141	0.525	-0.119
1791 - 1795	0.287	0.761†	0.230
1796 - 1800	*Reference*	*Reference*	*Reference*
1801 - 1805	-1.048**	-0.498	-0.135
1806 - 1810	-3.068**	-1.947**	-0.690
1811 - 1815	-3.055**	-1.725**	0.003
1816 -	-5.210**	-5.105*	-5.430*
Region of birth			
Bologna	*Reference*	*Reference*	*Reference*
Ferrara	-0.138	-0.252	-0.414
Forli	0.393	0.290	0.363

Continued on next page...

... table 1.5 continued

Variable	**Model 1**	**Model 2**	**Model 3**
Ravenna	0.130	0.046	0.160
Lazio	0.073	-0.041	0.818
Roma	0.295	0.566	1.105
Marche	-0.179	-0.236	-0.219
Umbria	-0.701	-0.341	0.122
Benevento	-1.942†	-2.944*	0.295
Urban birth			
If born in a mountain area	0.141	0.298	0.011
if born in a city with more than 50,000 inh.	-1.408**	-1.533**	-1.099†
if born in a city with a port	-0.823	-0.209	0.631
if born in an administrative center	-0.802*	-0.737†	-0.330
if born in a town (more than 15,000 inh. in 1861)	-0.236	-0.016	0.306
if born in a rural place and emigrated to a town	-1.159**	-1.062*	-0.636
Age dummies			
age 15	-3.631†	-	-
age 16	-3.231**	-	-
age 17	-3.859**	-	-
age 18	-2.792**	-	-
age 19	-1.124†	-	-
age 20	0.041	0.531	-0.008

Continued on next page...

... table 1.5 continued

Variable	**Model 1**	**Model 2**	**Model 3**
age 21	*Reference*	0.485	-0.214
age 22	-0.864	-0.439	-0.991†
age 23	-0.282	0.246	-0.414
age 24 - 49	-0.720	*Reference*	*Reference*
age 50	0.401	1.064	0.937
Military Grade			
simple soldier	*Reference*	*Reference*	*Reference*
officer	1.541**	1.511**	1.397**
musician	-1.665	-0.317	0.379
head quarter	4.636**	3.653**	3.821**
grenadier	8.029**	7.750**	6.299**
Provenance			
volunteer	*Reference*	*Reference*	*Reference*
deserter	0.311	0.539	0.959
prisoner	-0.043	-0.217	-0.165
Professional categories			
Agricultural laborer	*Reference*	*Reference*	*Reference*
Barber	2.077*	1.389	0.972
Elite	3.564**	3.461**	2.898
Food	0.482	0.154	-0.097
Mason	0.290	0.287	0.292
Metal Workers	1.698**	1.094†	0.444
Miscellaneous crafts	1.281*	0.934†	0.463
Retail	1.259	0.785	0.598

Continued on next page...

... table 1.5 continued

Variable	**Model 1**	**Model 2**	**Model 3**
Shoemaker	1.148*	0.829†	0.376
Skilled Woodworkers	1.070	0.921	0.263
Soldier	2.860**	2.635**	2.166**
Tailor	0.737	0.458	0.450
Textiles	1.332*	1.416*	1.257†
Unemployed, not listed	1.099	0.528	0.826
Unskilled	0.658	0.734	0.720
Intercept	163.441**	162.802**	164.010**
Standard Deviation	6.775**	6.597**	6.859
N	7,821	6,035	5,109

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Data in original measures (inches)

A number of cross-sectional patterns may be highlighted. No significant differences between birth regions are evident in any of the three model specifed, with the only exception of Benevento. Soldiers born in the enclave of Benevento were 0.71 inch (1.9 cm) shorter than soldiers born in the area of Bologna. When the analysis is restricted to adults, the difference increases to 1.075 inches (2.9 cm). Both genetics and economics may help in explaining this result. Southern Italians, in fact, are also nowadays shorter than northern Italians and that could be due to a different pool of genes. From an economical point of view, the status of small enclave in southern Italy enjoyed by Benevento, may have been detrimental for the biological standard of living. In particular, the small extension of the territory and therefore of the land available for agriculture, may have force Benevento's inhabitant to import foodstuff from the surrounding Kingdom of the two Sicilies. Given the custom tariffs in place between the two states, food may have been more expensive in Benevento than in other parts of the Papal states, reducing the biological welfare of the population. The small number of observations (only 193 recruits from Benevento), however, calls for caution in the interpretation of this result.

Although not significant at usual levels, the signs on the coefficients on the other birth regions are as expected, with the only exception of Lazio and Rome that enjoy a positive premium. Soldiers from area that includes the mouth of the Po river (the Legation of Ferrara) were 0.038(0.10) inches(cm) shorter, difference that increases to 0.073(0.19) inches(cm) when only the adults are considered. This result may be the consequence of the poor disease environment of those regions, characterized by a geographical conformation (low-lying areas with stagnant water) particularly favourable for the breeding of the malaria mosquito.[30] The negative sign on the height coefficients for the conscripts born in Umbria and Marche is also consistent with the economic backwardness of these regions, with an agricultural system based mainly on sharecropping. An height penalty for those regions in comparison with the Emilia-Romagna, is highlighted also in Arcaleni (2006) for the cohort of Italians born in 1927.[31]

The lack of significant differences in height (that persists even using alternative territorial definitions) between areas with very few interaction and with marked differences in both the economic and the natural environment,

[30]See Braglia (1962), Zamagni (1993), pp. 48-49.
[31]See Arcaleni (2006), fig.3 p.30 and tab.1 p.31

is somehow surprising. Most probably, the similarities among these areas were much bigger than it is usually described. In particular, they could have shared a common structure of the society with welfare nets (such as guilds or parishes) that may have helped to working class to achieve the same degree of access to the resources (particularly food), irrespectively of the different agrarian systems.

Being born in a metropolis (namely in the city of Rome or Bologna) implies a significant height penalty of half inch (circa 1.57 cm). The difference for those born in other urban areas (such as, portal cities, administrative centres or in medium size towns[32]), is still negative but generally not significant. Height penalties for a urban-birth is not a new result for historical populations.[33] Different factors can explain this result. Cities, for example may have enjoyed a worse disease environment. Despite public health measures (such as sewers) and the availability of hospitals, the high population density in urban environments eases the transmission of diseases.[34] A second reason why the urban environment could lead to shorter heights is related with the higher cost of food. Being specialized in manufacturing and service sector activities, urban inhabitants had to "import" food from the countryside. If this connection was not working properly, foodstuff in cities may have been more expensive or, for the same price paid in the countryside, its quality may have been lower. Given that a height penalty is observable only for big cities and administrative centers, we could argue that is the density of population (and therefore the worse disease environment) the main factor

[32]In this study a medium size town is defined as a municipality that in 1861 had 15,000 or more inhabitants. The urban share in this municipalities at the time of unification was 19%.(Santis (2002)) This implies that those towns had at least 3,000 inhabitants. All the administrative centres are also medium size towns.

[33]Such penalty is found in Northern Italy (A'Hearn (2003)), Bavaria (Baten and Murray (2000)), Cinnirella (2006).

[34]See for example Anderson and May (1991), Arita et al. (1986).

affecting negatively height in cities and not the higher food price. If that was the case, in fact, we would have expected a significant height penalty also in the other urban environments (portal cities and medium size towns) that had to import food as well from the countryside.This result and its interpretation would be also coherent with the fact that in Italy the degree of urbanization was much higher than the European average since the 16th century.[35] This long tradition of urbanization may have strengthen the ties between towns and countrysides and improved the commercial channels between the two, so that no significant differences in food availability may have been noted.

Emigration from the countryside to cities appears to be detrimental for the biological living standards, leading to a height penalty of circa 0.4 inches (1.08 cm). The ignorance of the timing of the movement (if done during the childhood, following the family, or later searching fortune), however, is a confounding factor. In particular, it does not possible to know if this result is genuine or if it is the outcome of a self-selection of the short countrymen into the migration stream to the cities.

Recruits born in mountainous areas appear to be taller that the others, although the coefficient is not significant. As expected, the lower density of population in these areas, the colder climate, less favourable for the breeding of viruses and bacteria, and the relative isolation they enjoyed, preventing their food prices to fluctuate due to external market changes, affected positively the biological standard of living of those recruits.

In line with similar samples, the estimated age effects show an annual increase in height from age 15 through the mid 20's, with a global increase of

[35]In Italy the share of individuals living in cities never went below 12% since the 16th century, whereas in the rest of Europe this percentage was equal to 5% 1500 and 10% at the beginning of the 19th century. See Santis (2002)

about 4 centimetres.[36] The magnitude of the coefficients is credible, although the height gains are pretty small making the central Italians more similar to the Bavarians or the Saxonian rather than to Northern Italians.[37] Furthermore, while growth for the latter group appear to be prolonged well beyond the age of 20, in this sample, the height of recruits older than 20 years is not statistically different from the height of 24 years old soldiers. The pubertal growth of these individuals, then, does not appear to be delayed in time, a results that may suggest an adequate nutritional status during childhood.

The estimated occupational effects on height reveal a certain degree of inequality in the distribution of wealth in the papal states. Recruits' occupation, in fact, can be considered a proxy for the social status of the parents and thus of the nutritional status in the earliest years (the most crucial in determining final height). If access to food and to health care is very different between social classes and if the degree of social mobility is low (so that is unlikely that the offspring of a poor family ends up in a better status and vice versa), significant height differences between various professional groups are expected. The obtained results are coherent with this picture. Agricultural labourers are at the bottom of the scale, with all the other professional groups enjoying an height premium. At the other extreme of the scale there are the middle and upper class (the group "Elite" that includes property owners, merchants and professions requiring some degree of education) and the soldiers, with an height advantage of 1.3 inches (4.2 cm) and 1.4 inches (3.6 cm) respectively. Skilled workers - such as shoemakers, metal workers

[36] See for example A'Hearn (2003), A'Hearn (2006), Baten and Murray (2000), Cinnirella (2006)

[37] For Lombardy and Veneto, A'Hearn (2003) estimates an increase from age 16 to age 24 of more than 8 centimetres. Using a different sample, A'Hearn (2006) obtains similar increase of about 7 cm. For Bavaria, Baten and Murray (2000) estimate a difference between 18 years old and 24 years old of 3.5 cm while for Saxony, Cinnirella (2006) finds an increase form age 16 to age 22 of 3 centimetres.

or craftsmen, enjoy as well a statistically significant height premium. In contrast with what expected, but in line with the results for northern Italians,[38] recruits with a preferential access to food (such as butchers, cooks, bakers) are not significantly taller than agricultural labourers.

The unequal distribution of wealth is somehow confirmed by the significant height premium enjoyed by officiers and members of the head quarter. Education, in fact, was a rewarded merit in order to make advancements in the military ranks. As a results, officers came mainly from the middle and upper classes that had access to education.[39]

1.3.2 Time trends

The estimated time trend, show a clear downturn in height in the first fifteen years of the 19th century, with a decline of 1.9 inches (5.1 cm) from 1796 to 1815. The downward trend is confirmed also when the analysis is restricted only to soldiers aged 20 years or more (model 2).[40] It seems, then, that the trend is genuine and not spuriously imparted by the higher percentage of teenagers in the last two birth-cohorts. A declining height trend in the last quarter of the 18th century is a feature common to many other European countries such as Bavaria, France, Britain, the Habsburg empire, Saxony,[41] which experienced a strong demographic growth the put under pressure agri-

[38] A'Hearn (2003).

[39] Not surprisingly, more than 17% of the officers and almost 22% of the members of the head quarter belong the "Elite" group, whereas this professional category represents only a bit more than 7% of the whole sample.

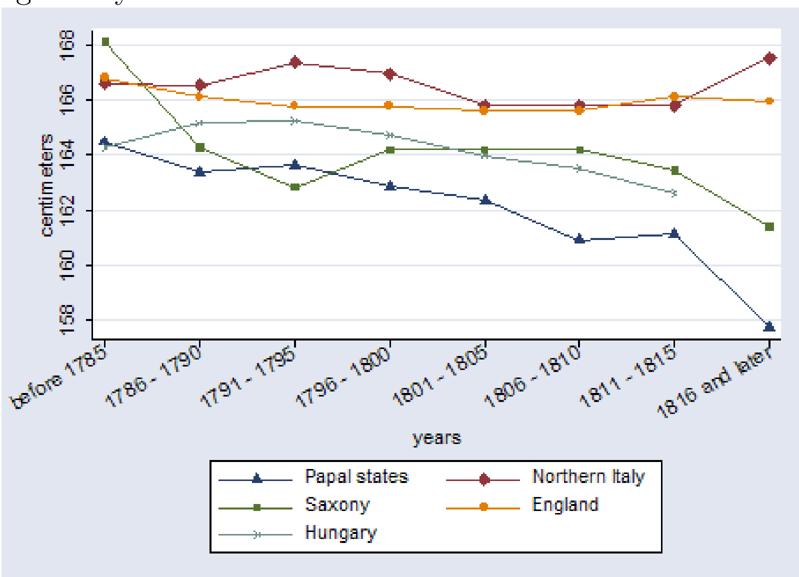
[40] Similar results are obtained also when other age restrictions are used (excluding the soldiers up to 21 years, up to 22 years, up to 23 years).

[41] For Bavaria see Baten (1999); for France see Weir (1997), Komlos (1994); for Britain see Komlos (1993); for the Habsburg empire see Komlos (1985), Komlos (1989); for Saxony see Cinnirella (2006). For an overview of height trend in Europe in 18th century see also Komlos and Cinnirella (2005).

cultural resources, boosting up the prices for food.

However, while in the rest of Europe much of the decline was accomplished by the early 1800s, in the papal states average height continued to fall well into the 1820s, as depicted in figure 1.5. As in Saxony, also in the papal states the years of the Napoleonic rule coincide with a sharp decline in height. The turmoil following the French victories in Italy, the increased tax burden and the administrative reforms that characterized these years may have had a negative effect on the biological standard of living of the local population.

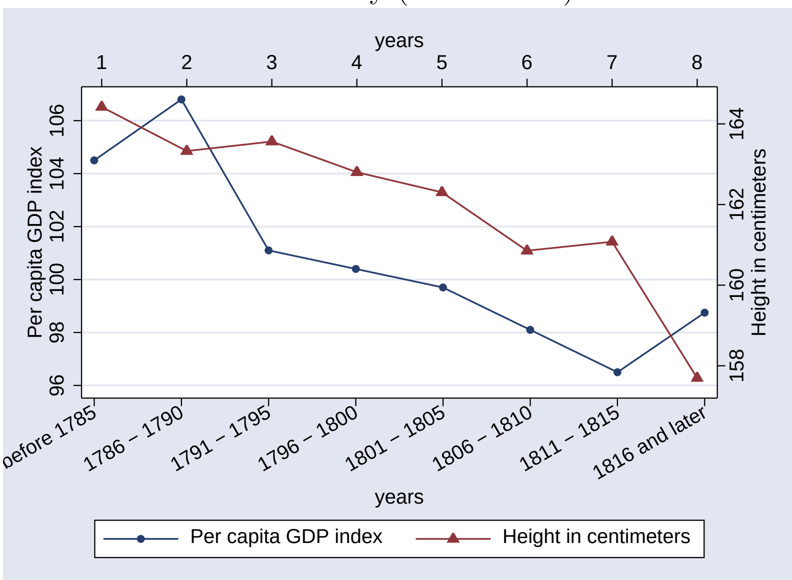
Figure 1.5: Height trend in the papal states and in other European countries. Soldiers aged 20 years or more



Sources: Papal states: weighted average of the regional and professional coefficients from Tab. 1.5, model 2; England: Komlos (1993), Tab. 6, height of soldiers in the British army, average index for all age groups multiplied by base (167.6 cm); Northern Italy: A'Hearn (2003), tab.2; Saxony: Cinnirella (2006), Tab. 2, model 1 (Adults); Hungary: personal communication from Komlos

Other quantitative evidence points out a worsening of the living standards in these decades. Malanima's recent estimates, in fact, highlight a growth in aggregate terms of the GDP in Central and Northern Italy, financed primarily by a decline in the standard of living of the population.[42] Per capita GDP reached the minimum over the last six centuries in the first two decades of the 19th century. In the same period, both agricultural and urban wages decreased while prices increased, reducing drastically the real wages of the working class. The estimated height trend in the papal states is coherent with the story that emerges from Malanima's estimates (Figure 1.6 and 1.7: height trend on the right axis).

Figure 1.6: Height trend for soldiers aged 20 years or more and per capita GDP index in Central-Northern Italy (1860 = 100)

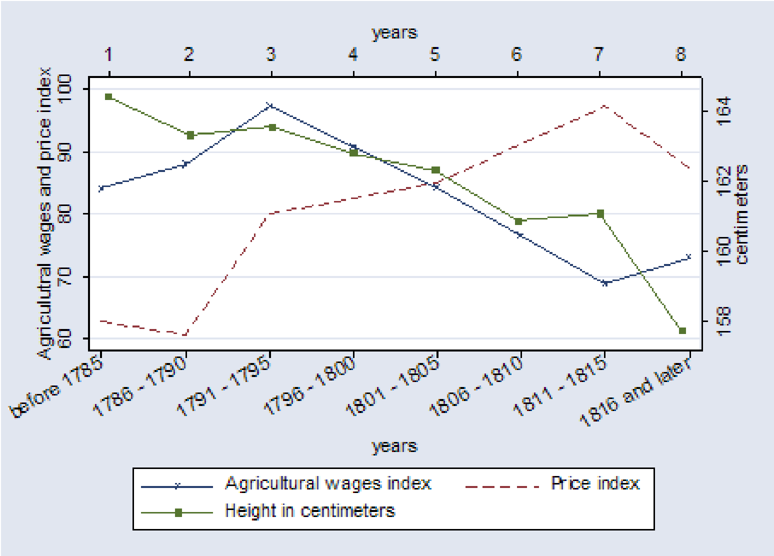


Source: Height trend: present estimates; per capita GDP index: Malanima (2003),Appendix 1

Given the differences not only in the kind of political rule the Frenchmen exerted in the papal states but also in the economic system that characterised the different areas, a separate height trend for each region is then estimated and plotted in figure 1.8; for comparison, the height trend for the Northern regions (Lombardy and Veneto) is also plotted. The height trend of the last

[42]See Malanima (2003)

Figure 1.7: Height trend for soldiers aged 20 years or more, agricultural wage index and price index in Central-Northern Italy (1860 = 100)



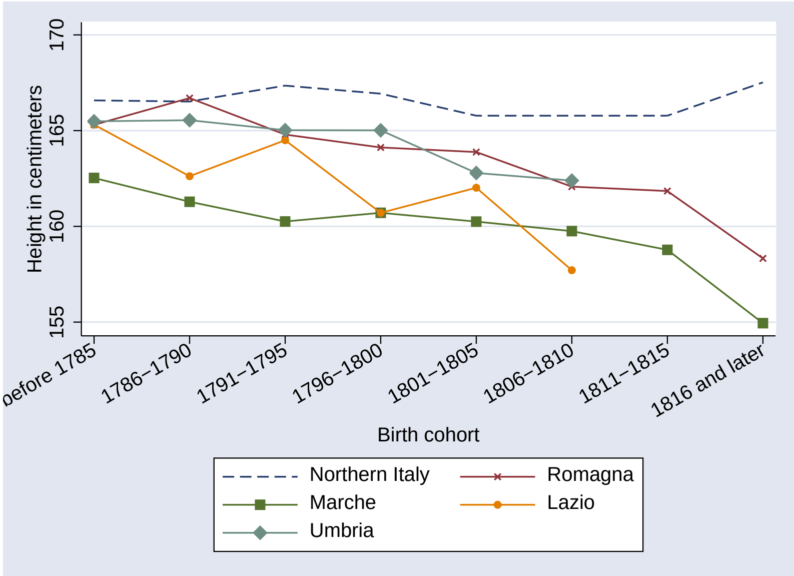
Source: Height trend: present estimates; agricultural wages and price index: Malanima (2003),Appendix 1

two birth cohort for Lazio and Marches is not plotted given the small number of observations in these cells.[43]

All the four areas show a similar pattern. It is interesting to note that at the beginning of the time span here considered, the height of soldiers born in Romagna (the red line with **x** markers in figure 1.8) is very close to that of soldiers born in Lombardy and Veneto(represented by the blue, dashed line in figure 1.8): however, the two trends start to diverge at the end of the 18th century. The political history of the four areas under the French dominion is somehow different. While Romagna entered the Republic of Italy in 1802, later transformed in the Kingdom of Italy, the other areas of the papal states were annexed directly to the French empire between 1808 and 1809.

[43]Regional trends were calculated using truncated maximum likelihood regression, controlling for the same variables used in the main regression. Data for Northern Italians from A'Hearn (2003), table 2.

Figure 1.8: Regional height trends



Source: Romagna, Marche, Lazio and Umbria: present estimates; Northern Italy: A'Hearn (2003), Tab.2

Napoleon's transformation of the Republic and Kingdom of Italy surpassed that of any other part of Italy, inasmuch as French domination here lasted longer than in any other part of the peninsula.[44]Old ecclesiastic privileges were dismantled and most of the Church lands were sold. A central authority, fairly efficient and reliable, was created. Eliminating all the internal tariffs and making use of a uniform commercial code, a single currency and common measures, the French administration succeeded in the creation of a unified market between areas formerly belonging to several different states. Furthermore, the extensive construction of roads and waterways improved the communications in the area. Landowners mainly benefited from these reforms, as they purchased most of the confiscated Church land, they enjoyed a bigger market and a rise in the prices for grain, rice and wine. The paralysis of commerce and the decline of the textile industry due to the Continental

[44]Grab (2000)

blockade, shifted resources into an already rich and capitalistic agriculture, encouraging further its growth.

The other three areas that were annexed directly to imperial France. The French legal code (the *Code Napoleon*) and taxation were introduced; convents were dispersed, many Church lands sold and some public works were initiated. However, the reforms were less incisive than in Romagna, partially because of the shorter time these regions were under the French administration, partially because, being directly ruled by French prefects, there was no opportunity (as on the contrary happened in Romagna) to create a new class of local administrators introduced to the modern administrative practices and institutions.

The situation for the lower classes, however, appears to have been heavy in all the four areas, irrespectively of the different political rule and of the deepness of the reform process. The estimated regional height trend reveal that higher taxes on consumption goods and the consequences of the agricultural commercialization affected negatively the biological standard of living in similar ways.

1.3.3 Sensitivity analysis

In section 1.2 we already discuss about the problem of heaping. The abnormally high frequency of observations at 60 inches may exert a counfounding influence on the attempt to estimate sample moments. To account for that, another model has been estimated using only the observations above the apparent TP of 60 inches. One disadvantage of this strategy consists in the reduction of the sample size. However, even after discarding all the observation below or equal to 60 inches, sample size does not appear to be a major problem. A second problem introduced by applying a higher TP is the increased variability of the TML. In particular, as the truncation point approaches the mean and only the right tail of the distribution is observable, it could be difficult to distinguish between distributions with different means and standard deviations.[45] For this reason we constrained the standard deviation of the distribution to be equal to 6.86 cm, a value suggested as a plausible figure for male, based on data for modern populations.[46]

Model 3 in table 1.5 reports the estimated results. With only few exceptions, the height coefficients loose their significance. The only results that remain significant at standard levels are the height penalty for the recruits born in big cities, and the height premium for officers and members of the head quarter and, among the professional groups, for soldiers. The sign of the coefficients is unchanged in the vast majority of the cases; the magnitude, however, is sensibly reduced.

1.4 Mortality analysis

As already mentioned in section 1.2, the registers here collected reported also the date of death of the recruit, in case he died while being in the army. The availability of this information allows us to perform a mortality analysis.

For all the recruits but one (who sunk), the registers report the sentence "died in the hospital". In other words, it seems that none of the recruits died on the battlefield, but rather because of diseases although the information on the exact cause of death is missing. An estimation of the survival probability,

[45] A'Hearn (2004)

[46] A'Hearn and Komlos (2003)

then, can offers further information on the diseases environment in central Italy in the first half of the 19th century, and on how it changed according to different socio-economic characteristics.

1.4.1 Theoretical framework

Some aspects of survival analysis data, such as censoring and non-normality, generate great difficulties when trying to analyse the data using traditional linear regression. For this reason, special methods, able to deal with such problems, have been developed and will be used in this section. An essential tool in this kind of analysis is the *hazard rate*. This quantity summarizes the concentration of exit times at each instant, conditional on survival up to each point,[47] allowing to model explicitly the instantaneous probability of experiencing a certain event (death, in our case) as depending on the time already spent in the initial state (being alive in our case). Other indicators of interest, such as the *density function* f_i or the *survivor function* S_i , can be derived from the hazard rate.

What is of major interest, here, is to investigate how some socio-economic conditions modify the mortality experience of the individuals. For this reason we want the hazard rate to depend not only on the survival time, but also on a set of individual characteristics X_i . In a discrete time setting (that is, considering intervals of time rather than a continuum of instants) as the one in this paper, the hazard rate $h_{i,t} = Pr(t-1 \leq t \mid T \geq t-1, X_i)$ is the probability of dying in the time interval $[t-1, t)$ (where t measures age in years), conditional on survival up to time $t-1$ and on a set of individual covariates X_i . The best way to estimate the effect of on mortality is to use

[47]For this definition, see Jenkins (2004)

maximum likelihood (ML) methods.

The likelihood function used, has to be appropriate for the type of process that generated the data, that is the type of sampling from the underlying population of soldiers. To understand that, the nature of the registers and of the selection of soldiers from registers has to be clarified. As already mentioned in section 1.2, each register pertain to a specific regiment of the papal army; it "born" with the regiment, was kept updated until the regiment was in place, and it was closed when the regiment was disbanded. Each soldiers that joined the regiment, as a volunteer or as a soldier transferred to the current regiment from another one, was recorded, irrespectively on the time he effectively served up in the army. Given that the registers were randomly chosen, we have then a random sample of individuals from the stock of those who survived up to the age at which they entered the regiments sampled.[48] This kind of sampling (called in the literature *stock sampling*) causes a clear *sample selection* problem: by construction, in fact, all the individuals that were born in the same years as the sampled ones, but that died before the regiment was created are excluded form the sample. These observations are not missing at random, as only individuals with higher survival times have a greater chance of selection. The implemented likelihood function, therefore, has to correct for this bias.

Another aspect that is relevant for the analysis is the censoring time c_i, that is the time after which we stop following the observation. A fundamental assumption in this kind of analysis, in fact, is that, conditional on the set of covariates X, the duration (that is the total number of years spent alive) is

[48] It is worth to remark here that this is not a random sample of the whole population that survived up to a certain age, but is a random sample of the population of soldiers, that is of all those individuals that entered or were interested in entering the army.

independent of c_i. To check if this assumption holds, we have to consider the structure of the data we have. While for those who died we know exactly the entire length of their spell (that is, how many years they lived), for all the others the exact age of their death is unknown and therefore they are right-censored. There are several reasons why these observations may be censored: *i)* the soldier deserted at a certain point of time; *ii)* the soldier served for five years (the time stated in the contract they signed) and then left the army; *iii)* after five year the soldier decided to remain in the army and he survived the disbandment of the regiment.[49]If we consider the observations for which we do not know the year of death as censored at the interview date (that is the last time they were observed alive) and we use all the other observation with the completed spell, it is likely that the conditional independence assumption is violated. It could be the case, in fact, that the decision of remaining in the army was driven by some unobservable factors that affected also longevity. For example, if those with better (worse) health conditions were also more likely to stay longer in the army (so that their death is more likely to be observed because the time they were under observation was longer), then survival time is not anymore independent on the censoring point and we would overestimate (underestimate) the survival probability. The conditional independence assumption clearly holds when c_i is constant for all the individuals. If the percentage of soldiers that successfully deserted (that is, that managed to desert and that was not captured after that) is negligible, then all the soldiers in the sample were in the army for at least five years. We can therefore consider all the observations for which we do not know the date of death as well as the spells that ended after more than five

[49]Another possibility would be that the soldier was transferred to another regiment before the disbandment of the observed one. No such cases were reported in the collected registers.

years from the entrance into the regiment as right-censored at the age they had when they entered the regiment plus five years. All that given, we can now specify the likelihood contribution of a censored spell at time j. This is is given by the discrete time survivor function :

$$_{c}\pounds_i = S_i(j) = \prod_{k=1}^{j}(1 - h_{i,k}) \tag{1.1}$$

while the contribution of an uncensored spell is given by the discrete time density function:

$$_{u}\pounds_i = f_i(j) = h_{i,j} \cdot S_i(j-1) = \frac{h_{i,j}}{1 - h_{i,j}} \prod_{k=1}^{j}(1 - h_{i,k}) \tag{1.2}$$

If $d_i$is a censoring indicator equal to 1 if duration i is uncensored and 0 otherwise, the likelihood for the whole sample is:

$$\pounds = \prod_{i=1}^{N}(_{c}\pounds_i)^{d_i}(_{u}\pounds_i)^{1-d_i} = \prod_{i=1}^{N}\left[\frac{h_{i,j}}{1 - h_{i,j}}\prod_{k=1}^{j}(1 - h_{i,k})\right]\left[\prod_{k=1}^{j}(1 - h_{i,k})\right] \tag{1.3}$$

Simplifying the above expression and taking the logarithm, we obtain the log-likelihood function:

$$L = \sum_{i=1}^{N} d_i \log\left(\frac{h_{i,j}}{1 - h_{i,j}}\right) + \sum_{i=1}^{N}\sum_{k=1}^{j}\log(1 - h_{i,k}) \tag{1.4}$$

Introducing a binary indicator variable $y_{i,k}$ such that :

if $d_i = 1 \Rightarrow y_{i,k} = 1$ in the last year of individual i's life, and $y_{i,k} = 0$ otherwise;

if $d_i = 0 \Rightarrow y_{i,k} = 0$ in all the observed years,

the log-likelihood function can then be rewritten as:

$$L = \sum_{i=1}^{N} \sum_{k=1}^{j} [y_{i,m} \log h_{i,j} + (1 - y_{i,m}) \log(1 - h_{i,k})] \tag{1.5}$$

This log-likelihood function coincides with that of a binary choice model and the estimation can be carried out using standard techniques for such models. The only difference is that the data has been reorganized so that instead of having one record per person, each individual appears several time as a survivor and once in the year of death.

This framework allows also to easily take into account the fact that the mortality experience in the sample refers only to those who already reached the age at which they entered the army (left-truncation or "delayed entry"). In this case, the likelihood contribution of each individual is given by

$$\pounds_i = \frac{\left(\frac{h_{i,j}}{1-h_{i,j}}\right)^{d_i} \prod_{k=1}^{j}(1 - h_{i,k})}{\prod_{k=1}^{t_i}(1 - h_{i,k})} = \left(\frac{h_{i,j}}{1 - h_{i,j}}\right)^{d_i} \prod_{k=t_i+1}^{j} (1 - h_{i,k}) \tag{1.6}$$

and therefore the log-likelihood of the sample is:[50]

$$L = \sum_{i=1}^{N} \sum_{k=t_i+1}^{j} [y_{i,m} \log h_{i,j} + (1 - y_{i,m}) \log(1 - h_{i,k})] \tag{1.7}$$

To practically implement a maximum likelihood estimator (MLE), the hazard function $h_{i,t}$ has to be specified. Among the several possible, two specifications have become popular in empirical work to model the hazard

[50] Jenkins (1995)

function when the time setting is discrete. The first one is the *complementary log-log specification (cloglog)*, the second is the *logistic model*. While the cloglog specification is more appropriate to model in a discrete time setting continuous time phenomena, the logistic model was developed to be applied when survival times are intrinsically discrete. In practice, as cloglog and logistic hazard models yield similar estimates - at least for small hazards, in order to study the determinants of mortality a logistic model is here adopted.

This model is based on the assumption that the relative odds of dying at any given time is the product of two components: *i)* a relative odds common to all the individuals and *ii)* an individual-specific scaling factor. This can be summarized by:

$$\frac{h(j,X)}{1-h(j,X)} = \underbrace{\left[\frac{h_0(j)}{1-h_0(j)}\right]}_{commonpart} \underbrace{\exp(\beta^T X)}_{individualscalingfactor} . \tag{1.8}$$

The logistic model is then given by:

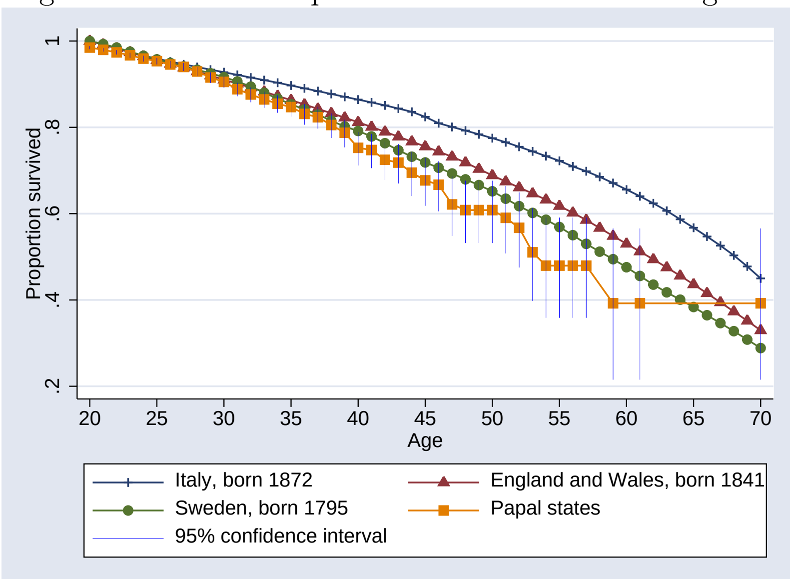
$$logit[h(j,X)] = \log\left[\frac{h(j,X)}{1-h(j,X)}\right] = \alpha_j + \beta^T X, \tag{1.9}$$

where $\alpha_j = \left[\frac{h_0(j)}{1-h_0(j)}\right]$. To characterize the α_j, that is the common relative odds in each time interval that describes the duration dependence within each interval, a quadratic function of time is used.

1.4.2 Estimation results

The Kaplan-Meier estimator is commonly used to estimate non-parametrically the survivor function. Given the discrete time setting of the data in the present study, an adjusted version of the Kaplan-Meier estimator, the lifetable estimator, is here used. Figure 1.9 plots the survivor function (and the 95% confidence interval, the vertical blue lines around each point estimate) for the Papal states' sample. The comparison with the life tables for the Swedish cohort born in 1795, the English cohort born in 1841 and the Italian cohort born in 1872[51] does not highlight major differences in the survival probabilities at younger ages. These estimates suggest that the mortality experience in Central-Northern Italy at the beginning of the 19th century was not dissimilar from that of other European nations until about age 40; thereafter it diverged substantially, and the life table curve for the Papal states lies constantly below that of the other countries.

Figure 1.9: Life table plot for male survival after age 20



Source: Papal states: present estimates; Italy, Sweden, England and Wales: Human mortality database (data downloaded on January 20, 2007), available at www.mortality.org

Results of the logit regression model with the indicator variable $y_{i,k}$as

[51]Life table for Sweden, England and Italy from the Database (2007) (data downloaded on January, 20, 2007), available at www.mortality.org.

a dependent variable are shown in table 1.6. In addition to controlling for individual age (and its square), the model include also the calendar year in order to account for long-run trends, although, due to collinearity, it is not possible to disentangle effects that accrue for either the birth year or the year when at risk of dying. A dummy variable for particularly *warm* and *cold* years is also used to account for unusual weather conditions that may have implied environmental stress.[52] Model 2 additionally uses a index of urban real wages in the year at risk of death to control for changing in the purchasing power of the working class.[53] The individual characteristics here considered as relevant in determining the mortality rate are the area of birth (grouped in four macro-regions), the birth in an urban area (that is in a city that, in 1861, had at least 15,000 thousand inhabitants[54]) and the profession (grouped in six big categories);[55] Model 3 adds to this set of variables also height measured in inches[56] to capture the long-lasting effects on mortality of nutritional insults at younger ages and a dummy variable equal to 1 if the individual moved to a rural area.

[52]Temperature values refers to annual average temperature in Rome (source:www.wetterzentrale.de/klima/troma.html) A year is define as warm (cold) if the temperature was 1 standard deviation higher (lower) that the average annual temperature in the time span 1811 1906.

[53]The urban real wages index is constructed linearly interpolating the series in Malanima (2003). As the linear interpolation smooths the yearly variations in the real wages and as the series do not take into account regional differences, this index has to be considered a very rough proxy for the trend in the real purchasing power of the working class.

[54]The category "urban", then, include here all together the same categories used in the height regression (metropolis (Rome and Bologna), the portal towns (Ancona and Civitavecchia) the administrative centers and the municipalities with at least 15,000 inhabitants in 1861).

[55]The categories are so defined: agricultural laborers, upper class (practitioners, writers, students, land owners, soldiers); skilled craftsmen (blacksmiths, armourers, grinders, carpenters, cabinet makers, turners, carvers); unskilled workers (unemployed, domestic servants, coachmen, launderers); textile workers (tailors, weavers, combers, spinners); other (barbers, bakers, butchers, millers, hut makers, rope makers, tanners, painters, innkeeper, shopkeeper, shoemakers).

[56]Several different measures of height have been used (such as predicted height, dummy variable for being tall), but the results are virtually unchanged.

Table 1.6: Survival analysis estimates (odds ratios)

Variable	**Model 1**	**Model 2**	**Model 3**
Region of birth			
Romagna	*Reference*	*Reference*	*Reference*
Marche	1.118	0.867	0.863
Lazio	1.033	1.040	1.045
Umbria	1.124	1.090	1.099
Urban birth			
Birth in an urban environment	1.105	1.116	1.160
Emigration form city to country	-	-	0.448
Professional groups			
Agricultural laborers	0.941	0.974	0.992
Skilled craftsmen	0.637*	0.643*	0.647*
Upper class	0.913	0.892	0.891
Unskilled	1.290	1.200	1.225
Textiles	0.743	0.742	0.745
Other	*Reference*	*Reference*	*Reference*
Environmental variables			
Warm year	0.412**	0.260**	0.259**
Cold year	1.111	0.812	0.808
Urban real wages index	-	0.323**	0.321**
Height in inches	-	-	1.002
Pseudo R-squared	0.018	0.041	0.043

All models include also age, age squared and year at risk as additional regressors.

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

No significant differences in the estimated mortality rates emerge, with the only exception of the skilled craftsmen (such as carpenters, blacksmiths, armourers, grinders), whose odds of dying was almost 35% lower than that of the other workers. This results holds also trying different professional groupings or different specifications of the model.

In particular, the expected negative effect of the urban environment on the mortality experience is not significant: being born in an urban environment increases the odds of dying by almost 10%, but the coefficient is not significant at the usual levels. Individuals born in cities, that moved in a rural environment, reduced by almost 50% their probability to die (model 3), confirming, indirectly, the negative effect of cities on survival.

As in other studies (Lee (1997), Costa (1993), Costa (2003), Murray (1997)), height does not appear to affects the probability of dying: one inch more not only does not significantly reduces the odd ratios, but it seems to even increase the risk of dying. Some caution has to be used in interpreting this results, because, as noted in Costa (2004), the relationship between height and mortality is very sensitive to sample size.

The mortality experience does not differ in a relevant fashion across geographical areas, and the result does not change using different definitions of "region" or controlling for being born in special environments such as lowlands or mountains.

Environmental variables appear to be significant and their coefficient is in line with what expected. A year warmer than average reduces by more than half the probability of dying, while an increase by one point of the urban real wages index decreases this probability by circa 70%.

One could argue that the lack of significance is due to the non-randomness of the sample here analysed. The selection of soldiers, in fact, is a random sample of the population of soldiers, but it is not a random sample of the whole population, as only the ones who decided to enrol and that were accepted into the army are observed. If the enrollment decision was driven by some unobservable factors that affected also the odds of dying, then we observe a relatively homogeneous population in terms of survival probability, so that no differences arise due to place of birth or profession.

Imagine that individuals born in a rural and in an urban environment enjoy a very different survival probability, with the latter having significantly shorter survival rates. Furthermore, only individuals with (unobserved) better health (and therefore with survival probabilities above a certain threshold) applied and were accepted into the army. The estimated survival probabilities overestimate of course the "true" survival probability in both the populations. However, given that a bigger portion of individuals with "bad" survival curves is not observed in the urban group, the upward bias is bigger for this group pushing the estimated survival curve closer to that of the rural group, making the differences not significant. The sign of the coefficients, however, could still highlight the right direction of the change. In other words, if we observe an increased probability of dying for individuals born in cities, and this result is stable across specifications, we can then believe that a negative effect on survival really existed in cities, even if the coefficients are not significant at the usual levels.

1.5 Summary and conclusions

Using a sample of soldiers enrolled in the papal army between the 1814 and the 1836, the evolution of the standard of living of the population in Central and Northern Italy at the beginning of the 19th century is investigated in this work. The analysis has been conducted looking at two dimension of the broader concept of “living standards”: the evolution of height and the mortality experience.

Several patterns can be highlighted: despite the great economic variety within the papal States, no significant birth-province effects in height are found. The same lack of differences emerges also when the mortality experience is analysed. Occupational differences however emerge from the height analysis and to a lesser extent also from the survival analysis, highlighting a certain degree of inequality in the wealth distribution in the society, with the agricultural laborers being the most disadvantaged in terms of height and the educated class being at the top of the height distribution. The urban-rural differential in height reveals a disadvantage for individuals born in big metropolis and administrative centers; difficulties in sanitation in these centers, as well as the high density of population, may have led to a worse disease environment. This explanation finds a confirmation in the higher (although not significant) probability of dying for individuals born in cities, and in the increased probability of surviving for individuals who emigrated from towns to rural areas.

The estimated time trend highlights a decline in height for the cohorts born under the French rule. The dismantling of the corporative organizations with the consequent exposure to the market forces and competition coupled with the lost of the charitable functions provided by the guilds and with the reorganization of the charitable system that excluded from their services all but the extremely poor ones.[57] These abrupt changes together with economic conditions that were negative in all Europe (high food prices, years with bad harvests and the disruption of the international trade)[58] led to a downward trend more accentuated than in other countries. This result holds even after correcting for the spurious downward trend imparted by the presence of many young (and not completely grown) soldiers in the last birth cohorts.

The results appear to be sensitive to the truncation point applied in the truncated maximum likelihood regression: estimating the model using a higher truncation point and constraining the standard deviation to be equal to 6.86 centimeters, in fact, lead to not significant results.

Regional height trends reveal a similar pattern in all the four areas: high taxes on consumption and an increasingly commercialized agriculture reduced the biological welfare of the lower classes, irrespectively of the political regime. Also the most advance and dynamic area within the papal states (Romagna), failed to keep a level of living standard comparable to that of its neighbor northern regions.

[57] Davis (2000)

[58] On bad climatic conditions see for example: Post (1974). O'Rourke (2006) shows how the continental blockade and the disruption of trade led to a sensitive welfare reduction (although with several differences) in the countries involved in the wars.

Chapter 2

The biological standard of living in Germany before unification 1815 - 1840

2.1 Introduction

At the beginning of the twentieth century, the unified German Empire had one of the world's leading economies, with the largest and most modern factories in many strategic sectors.[1] However, the situation was rather different within the German confederation a century earlier. Despite progress in some regions (such as Saxony or the district of Nürnberg), the major economic indicators were not far advanced. The conventional wisdom dates the beginning of the process of Modern Economic Growth[2] after 1870 and most

[1] Cameron (1997)

[2] The term Modern Economic Growth was used by Simon Kuznets to identify a particular period characterized by high rates of growth of per capita product and population, increase in productivity, structural transformation of the economy and of the society and

research on German economic history has focused on this period.

Nonetheless, the first half of the nineteenth is especially interesting because of the important economic and social reforms that set the basis for the subsequent impressive catch-up growth. Despite the relevance of this period, few quantitative studies have been devoted to it and the important issue of living standards have been all but neglected. This is in stark contrast for British scholarship, where the standard of living debate has been a long-standing topic of intense controversy. Estimates of per capita gross domestic product (GDP) in Germany do not exist for the period before 1850,[3] and data on real wages have a limited scope.[4] Furthermore, the destruction of many archival sources during World War II complicates all aspects of historical investigation, including that of height.

In such a context, anthropometric research can be of use in the analysis of the effects of changes in the economic structure on welfare. The relation between human height and the socio-economic environment is well known. Although genes play a relevant role in determining adult anthropometric characteristics, environmental factors are the main determinants in trends in height as well as of the differences in mean height among genetically similar populations.[5] Individuals who are poorly fed and have recurrent infections rarely grow well in either childhood or adolescence and are unable to achieve a final adult height that is commensurate with their genetic potential. For children and adolescents, height depends essentially on past food consumption

increasing market integration. See Kuznets (1973).

[3]See, for example, Fremdling (1995). Angus Maddison has estimated German per capita GDP for 3 benchmark years: 1820, 1830 and 1850. The data are available at his web sitehttp://www.ggdc.net/maddison/

[4]Mitchells series from 1820, for example, covers only industrial workers starting from 1820.

[5]See for example the study of Cavelaars et al. (2000). A guide to other recent studies can be found in Rona (2000)

and the incidence of diseases. Changes in socio-economic factors that influence the availability of nutrients or of the claims on them (such as changes in the price of food or in public health policies) are then reflected in adult stature. Given the multiple external influences on net nutritional intake, inferences about the biological standard of living are not straightforward and require careful consideration of all the possible factors. Nonetheless, the analysis of stature has proved to be a useful tool and during the past 20 years, anthropometric research has made important contributions toward understanding the effect of economic processes and institutional changes on the biological standard of living.[6]

Time trends of height during the early nineteenth century have been estimated for many countries such as the United States, England and France as well as for the Habsburg Empire.[7] In Germany, height trends are known for three states (Bavaria, Württemberg and Saxony),[8] but data for the entire country have not yet been analyzed and data for Württemberg pertain only to the second half of the century. In this article, a unique dataset is used to reconstruct the height trend for Germany during the first half of the nineteenth century.[9] Time trends are also derived for the main regions, allowing comparison of the effects of different economic policies on the biological standard of living.

[6]See Steckel (1995), Fogel (1994), Komlos (1985).

[7]This is a short anthology of articles on height trends. For the US, see Komlos (1998); for England, see Nicholas and Steckel (1991) and Komlos (1993); for France, see Komlos (1994) and Weir (1997); for the Habsburg Empire, see Komlos (1989)

[8]For Bavaria see Baten (1999), Baten (2001) and for Wrttemberg, see Twarog (1997); for Saxony, see Cinnirella (2006)

[9]The appropriateness of the term "Germany" is questionable, given that it did not exist as such before 1871. The Vienna settlement in 1815 created a conglomeration of 39 separate states.(Tipton (2003b)) Here, "Germany" is defined as the set of states (with the exception of Alsace-Lorraine) that became part of the German empire in 1871.

2.2 Living standards in Germany in the first half of the 19th century: a quick overview

At the beginning of the nineteenth century, the German economy was primarily agrarian. A review of the most recent estimates from Angus Maddison shows that German per capita GDP in 1820 was one of the lowest in Western Europe. Nearly a century later, on the eve of World War I, per capita GDP had more than doubled, and Germany was among the wealthier European nations. In 1860, the German GDP was still behind that of France and Austria and was less than 60% of the British GDP. By 1913 it was ahead of Austria, France, Sweden and it was 75% of the British GDP (Table 2.1).

Table 2.1: German per capita GDP in international comparison 1820 - 1913 (1990 International Geary - Khamis dollars)

	1820	**1830**	**1840**	**1850**	**1860**	**1870**	**1913**
Austria	1,218	1,399	1,515	1,650	1,778	1,863	3,465
Belgium	1,319	1,354		1,847	2,293	2,692	4,220
Denmark	1,274	1,330	1,428	1,767	1,741	2,003	3,912
France	1,135	1,191	1,428	1,597	1,892	1,876	3,485
Germany	**1,077**	**1,328**		**1,428**	**1,639**	**1,860**	**3,648**
Italy	1,117			1,350	1,447*	1,486	2,564
Netherlands	1,838	2,013	2,283	2,371	2,377	2,672	4,049
Sweden	1,198	1,175	1,231	1,289	1,488	2,557	3,096
United Kingdom	1,706	1,749	1,990	2,330	2,830	3,031	4,921

Source: Maddison's web site http://www.eco.rug.nl/ Maddison/

∗ Data for 1861

This super performance had deep roots that extended back to the beginning of the nineteenth century. The French Revolution and the Napoleonic Wars, with the defeat of the Prussian Army at Jena and Auerstadt, stimulated an important series of reforms. A new group of younger government officials dedicated to reform came into power and introduced many socioeconomics edicts. Already in the 18th century Prussia was in the forefront by creating a universal primary education system. In 1807 and 1808, it emancipated the peasantry from bondage to the aristocratic landlords (*Bauernbefreiung*), and created occupational freedom in the cities in order to reduce the power of the artisan guilds to determine eligibility for employment with manufacturers (*Gewerbefreiheit*). The Prussian example was followed in many other states, with the divesting of state-owned manufacturing enterprises across Germany.[10]

Napoleon's defeat and the Vienna settlement that returned the traditional elites to power did not stop the modernization process. During the first half of the nineteenth century, Germany continued to invest heavily in human capital. German administrators became increasingly conscious of the economic changes in other countries, which showed that industrialization is necessary for the creation of a strong economy. The adjustments that were necessary to transform Germany into an industrialized country were, however, difficult for private entrepreneurs to accomplish by themselves. The new technologies were complex and expensive, and the limited markets in the small German states generated concern about whether sufficient revenue would be generated to recover the initial investments. The implications of these argument were actively debated at the time, and much was accomplished by local governments.[11] One of the major achievements was the establishment in 1834 of the Zollverein, which, through the abolition of internal custom duties, unified most of the German states (with the significant exclusion of Austria) into a single market.

[10]Tipton (2003a)

[11] Beck (1992). For a review of the successes of the government in fostering industrialization see Henderson (1958)

The socio-economic transformations connected with this process were substantial. The balance of power shifted toward middle-class groups, as old forms of dependence were abolished and new forms were created. What were the effects of these rapid and fundamental changes on living standards?

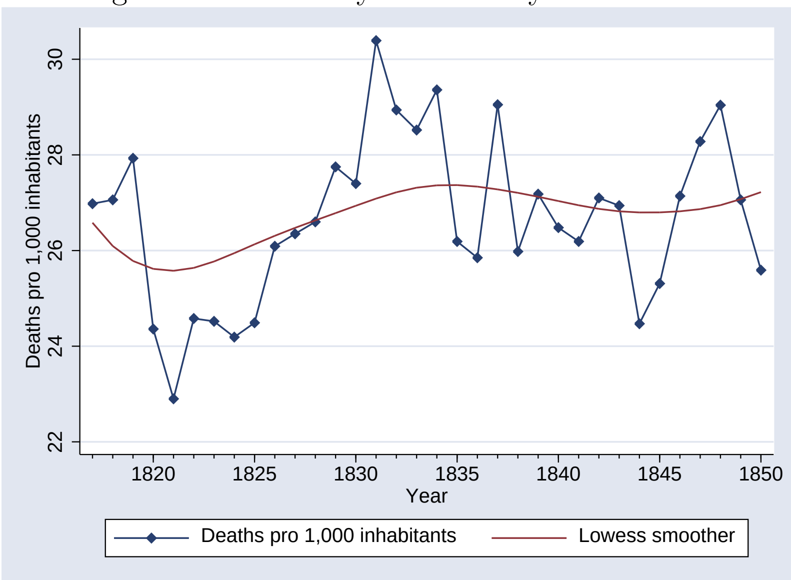
Data pertaining to living standards in Germany at the beginning of the nineteenth century are limited. Figure 2.1 shows an index of real industrial wages during 1820-1855. After a small increase during the 1820s, the index changed little during the 1830s and began to decrease in the mid-1840s. Apart from questions concerning their reliability, these data are limited to industrial workers and thereby exclude data for peasants and prevent inferences about the living standards of people who were not in the labour force, such as women or children.

Figure 2.1: Industrial real wages index in Germany 1820 - 1855

Source: Mitchell (1992)

In recent decades, several investigators have argued for moving beyond measuring living standards in terms of monetary units to measurements involving broader concepts.[12] The pattern obtained for Germany using such concepts does not indicate a major improvement in the standard of living during the first half of the nineteenth century. Mortality rates were high and even increased during much of the period (figure 2.2). Life expectancy at birth was relatively low at the beginning of the century and did not begin to increase until after 1850. For example, during the 1820s, a 20-year-old person could expect to live until about age 60, with a slight increase beginning only in the 1860s.[13]

Figure 2.2: Mortality in Germany 1817 - 1850



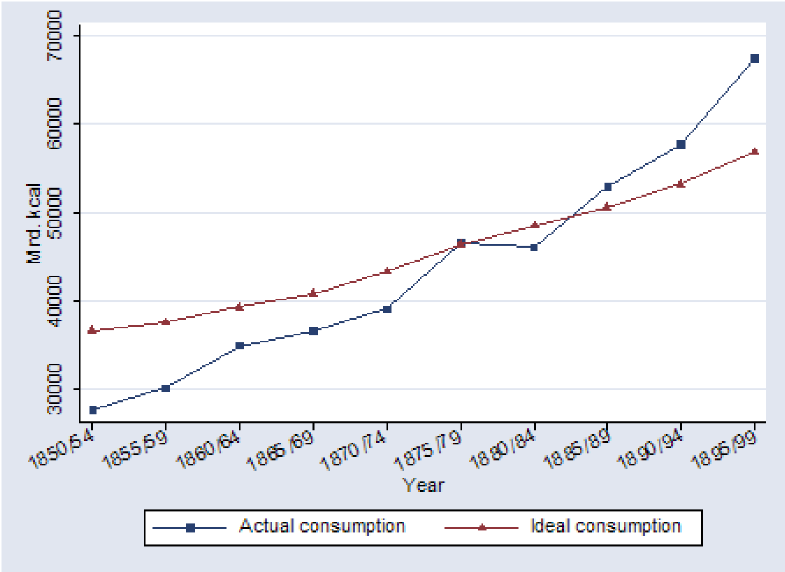
Source: Hoffmann (1965), Table 1 pag. 172

Data on caloric availability, a measure of another dimension of the living standards, reveals that Germans consumed enough calories to fully satisfy their nutritional needs only beginning with 1885-9 (figure 2.3).

The economic reforms implemented in Germany seem not to have pro-

[12]On the living standard debate, see, for example, Sen (1984).
[13] For an overview of the main studies on mortality in Germany in the nineteenth century see Guinnane (2003); data on remaining life expectancy at age 20 from Imhof (1990)).

Figure 2.3: Actual vs. Ideal caloric consumption in Germany 1850 - 1900



Source: Hoffmann (1965), Table 170 pag. 659

duced major changes in living standards during the period under consideration. Important improvements in the standard of living are not evident, but neither are the substantial increase in the prevalence of poverty and the deterioration of living standards hypothesized by historians and contemporary observers.[14]

2.3 Materials and methods

Data on the height of Germans born during 1815-1840,[15] who served as soldiers under the British flag at the time of the Crimean War (1854-1856) are analysed. In accordance with firmly established military tradition, in 1854, the British government allowed the military to recruit foreign soldiers to sup-

[14]Knapp (1887), Harnisch (1974).

[15]As shown in table 2.2, more than 80% of the observations belong to the cohorts born during 1820- 1835, so our analysis is particularly significant for that period.

plement the regular army, given the substantial loss of soldiers at the end of that year and the difficulty in attracting new domestic recruits.[16]

The original data set includes records for approximately 13,500 soldiers. In addition to height, the recruitment lists specify age, state and city of provenance, former profession, date of physical examination and regiment. The database was compiled using British German legion: Nominal Rolls (6-16) and the Inspection certificates of the recruits (32 - 35) (Public Record Office London, England, WO15). Because two sources were used, records for some recruits appeared more than once. Thus, almost 5,000 duplicates were excluded from the analysis.[17]

The duplicate records facilitated testing of the accuracy of the measurements. For one-half of the soldiers whose records appeared more than once, the measured height was exactly the same. When there were discrepancies, the reported heights differed by less than 0.5 inches (i.e., slightly more than 1 centimetre). This imparts some confidence in the accuracy of the data. Additionally, we have records for nearly 2,000 soldiers who were not born in German states. Data were grouped into seven regions: Prussia, Baden-Württenberg, Bayern, Sachsen -Thuringia, Hessen, Mecklemburg and Hannover. Figure 2.4 shows their location and table 2.2 shows the composition according to birth cohort and region.

The representative nature of the data must be considered. Because of enlistment into the British army was voluntary, self-selection could be a confounding factor.[18] Thus, the conditions under which recruitment occurred,

[16]For a detailed history of the foreign legion during the Crimean War see Bayley (1977).

[17] Several tests were performed on the data to exclude from records that were not initially recognized as duplicates because of slight variations in the spelling of recruit's name (e.g., Mathias vs. Matthias).

[18]This problem appears in all studies that use data from volunteer army. See, for

Table 2.2: Composition of the sample by region of origin and birth cohort

	Cohort of birth					
	1816-1820	**1821-1825**	**1826-1830**	**1831-1835**	**1836-1840**	**Total**
Non German States	65	476	595	732	129	1,997
Prussia	39	363	767	963	242	2,374
Baden-Württenberg	14	129	271	290	106	810
Bayern	8	166	313	416	105	1,008
Sachsen - Thuringia	8	54	94	166	25	347
Hessen	10	99	132	225	64	530
Mecklemburg	20	107	183	224	36	570
Hannover	15	150	238	300	79	782
Total	179	1,544	2,539	3,316	786	8,418

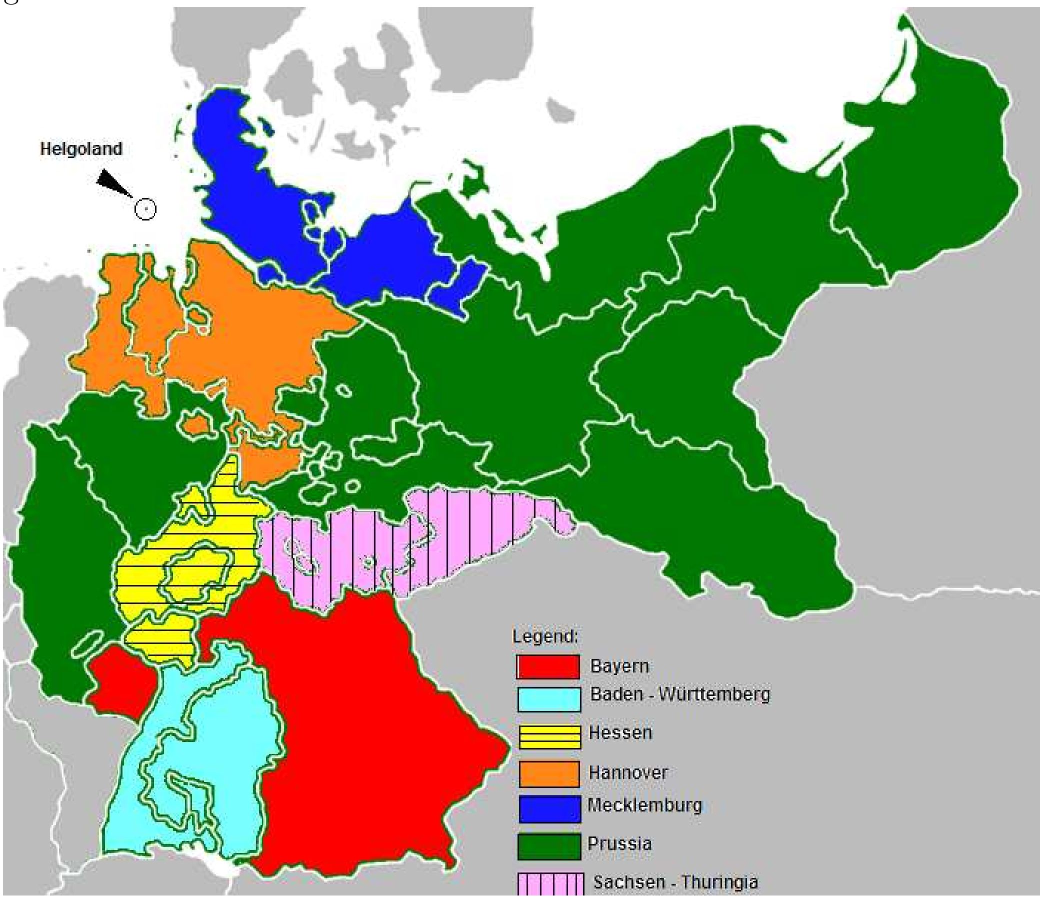
and the possible reasons why an individual chose to enlist should be considered. British recruitment operations in the Germans states were delegated to Baron von Stutterheim, a charismatic figure who served in the British army in the late 1830s and also participated in the Schleswig-Holstein uprising against Denmark in 1848. The involvement of this influential personage is crucial: his emphatic liberal views reflected the political convictions of many of the soldiers who served with him during the 1848 rebellion. At the end of the revolutionary storm, being too destitute perhaps to afford the cost of the trip back home, many soldiers gravitated to the coastal cities (Kiel, Altona, Hamburg and Lübeck) where they led a poverty-stricken existence. The arrival of Stutterheim in Hamburg on April 1855 was welcomed by the Schleswig-Holstein veterans, who were apparently destined, in absence of other alternatives, to be absorbed into the ranks of the urban proletariat and casual labourers of the counting houses and docks of the great German northern ports. Within a few weeks, Stutterheim raised a force of several thousands men, despite the fact that recruitment for the foreign legion had been declared illegal in January of 1855 by the Senate of Hamburg and by the city of Lübeck and despite the efforts of the local police to stop the recruitment activities.

The collection point was set in Helgoland, a small island 70 km from the German coastline that, after the Napoleonic Wars, belonged to Britain.[19] No aid was given to the potential soldiers to help them reach Helgoland. Travel to Helgoland was not an easy task, given the lack of a regular service by steamship (which was closed during the winter season), and the substantial police surveillance of the embarkation procedures in the main ports. In many

example, Mokyr and Gráda (1996)

[19] See figure 2.4 for the approximate location of Helgoland.

Figure 2.4: German states after 1815, regional groups and location of Helgoland island



cases, the men had then to travel to the small and distant cities of Stade or Glückstadt and find a local sailor willing to adjust his normal route to take them to Helgoland.[20]

To better understand the possible factors involved in self selection, one might consider the decision to enlist in the army as tantamount to the decision to participate in the labour force. The rational individual would choose to enlist if the wage he would obtain from the army, w, was higher than his

[20] An idea of the difficulties faced by the recruits in their travel to the recruitment point appears in the letters to home written by the recruits. [Steinhart (1859)]

reservation wage, w_r, defined as the wage at which he was indifferent with respect to enrolling in the army or being unemployed or working at home.

$$y^* = w - w_R \begin{cases} \leq 0 & \text{not in the sample} \\ > 0 & \text{in the sample} \end{cases}$$

The reservation wage for an individual was a function of his human capital (*i.e.*, educational attainment and physical capability) and the conditions of the labour market (*e.g.*, the unemployment rate) where he lived. Distance from the recruitment point also played a role, with an effect that, at first glance, is unclear. A first line of reasoning leads to expect a positive association between distance and the reservation wage. If the soldier came directly from home, the farther away the country of origin, the greater was the cost to reach Helgoland, and, therefore, the greater is the wage that had to be offered by the army to compensate for the cost of travel. Given that the army offered a fixed wage (w), we may expect a lower number of recruits coming from regions very faraway from the recruitment point. However, if the financial situation of the majority of the recruits is taken into account, we suppose that, as the distance from the recruitment point increases, the reservation wage decreases. This is the case insofar as people coming from distant regions (such as Bavaria or Baden) were part of the crowd of veterans of the Schleswig-Holstein uprising who could not afford the cost of the trip back home and, therefore, who searched the harbour looking for any jobs, including low-paying ones. In contrast, veterans from northern regions were more likely to be able to afford returning to their home towns after the conflict. Thus, the cost of searching for a job was lower for the latter group, because they could rely on the support of their family and on a better knowledge of the local economic conditions.

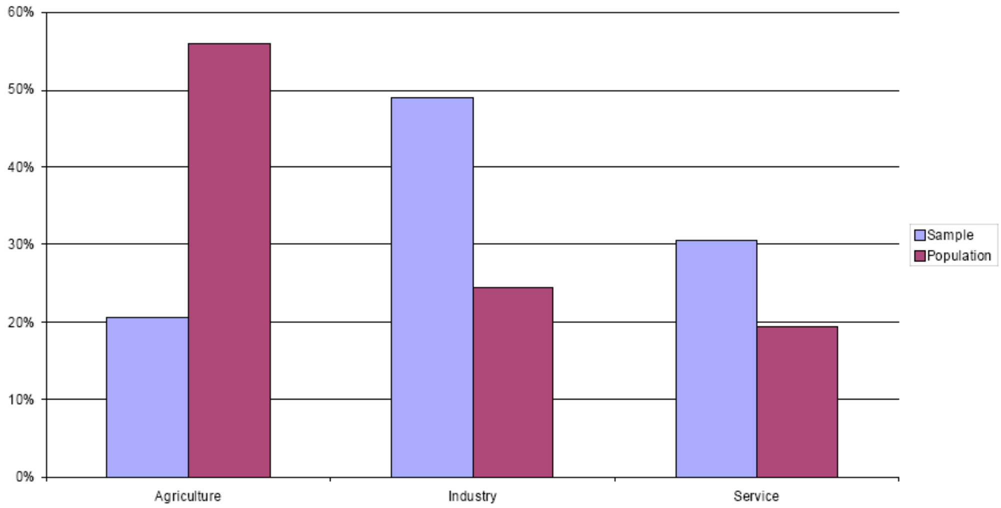
In light of these considerations, the sample cohort likely comprises primarily poor and unskilled workers who were mainly from southern German states. The characteristics of the sample substantiate these considerations. Almost 100 different professions were listed in the original documents, and they were grouped into 11 categories. Although the majority of the recruits were unskilled workers, recruits from other professions were also represented: skilled industrial workers (e.g., molders and carpenters) and white collar workers (e.g., secretaries, physicians, merchants and renters) represent 16% of the sample (Table 2.3). The variety of professions reported suggests that the sample is composed of a broad spectrum of workers.

Table 2.3: Composition of the sample by profession

Profession	**Frequency**	**Percentage**
Elite	552	6.69
Services	501	6.07
Food	712	8.63
Skilled industrial workers	742	8.99
Tailors	412	4.99
Shoemakers	598	7.25
Textiles	366	4.44
Miscellaneous crafts	878	10.64
Soldiers	500	6.06
Unskilled workers	1,156	14.01
No profession listed, unreadable, unemployed	1,833	22.22

The occupation can be organised into 3 major sectors (Agriculture, Industry and Services) to compare the composition of the sample with that of the population of the German states at large. As shown in figure 2.5, the recruits were employed predominantly in non-agricultural occupations, and the agricultural sector is highly underrepresented (despite the inclusion of the workers with no profession listed). The analysis, therefore, mainly pertain to what we might call the “industrial proletariat”. The heights of the recruits should, in turn, be compared with those of persons from other lower classes.

Figure 2.5: Composition of the sample by sector of activity

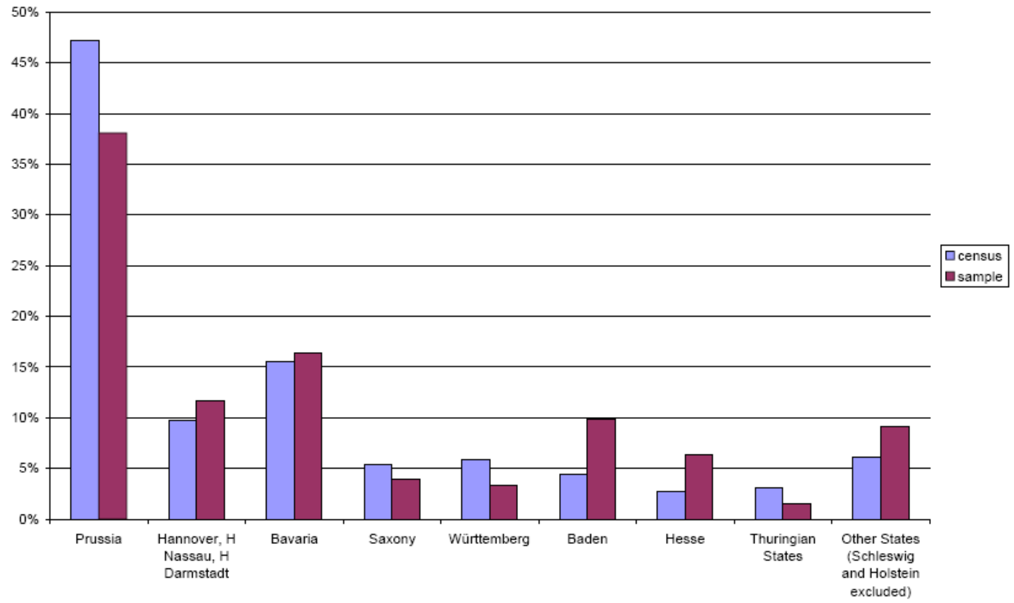


*Note:*Population data for year 1852
Source: Hoffmann (1965), Table 20 pag. 204

Although recruitment was in a remote location that was difficult to reach, the sample provides good regional coverage for all the birth cohorts (figure 2.6).[21] The percentage of recruits from Prussia is slightly less than that for the general population, whereas the percentages of recruits from Bavaria, Baden and Hessen is moderately greater than those for the general population. The discrepancies, however, all appear to be less than 10%. Our sample, therefore, is not biased toward specific regions. On the contrary, the regional composition of the sample is very similar to that of the general population.

[21]The census data are from Mitchell (1992) and are available for 1816, 1828 and 1834. The sample data were aggregated into regions that cohere with the definition used in the census.

Figure 2.6: Sample and population composition by regions

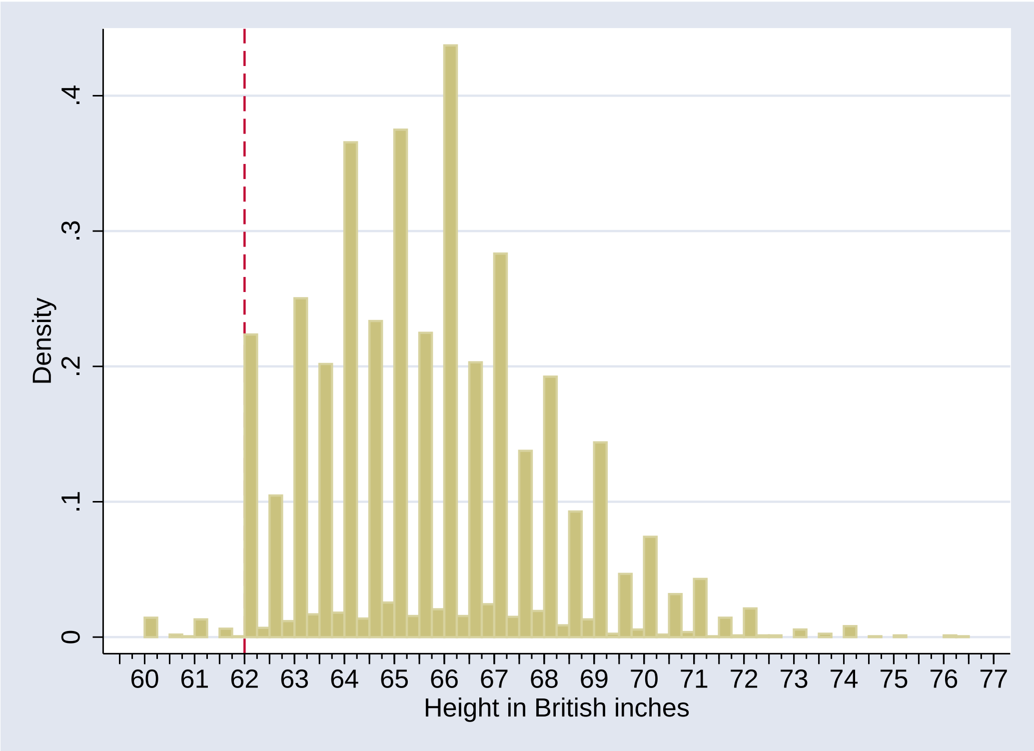


Source: Population data: Mitchell (1992); Sample: own calculations

Note: Population composition by region is calculated as average from the censuses for the years 1816, 1828 and 1834

As with the vast majority of military cohorts, this sample is affected by the problem of truncation, because of the minimum height requirement imposed on the recruits. Figure 2.7 clearly shows a truncation point at 62 inches (157.48 cm).[22] If truncation is not adequately taken into account, estimates will be biased. Truncated maximum likelihood regression has proven to be an efficient way to explicitly model this phenomenon, giving unbiased and consistent estimates.[23]

Figure 2.7: Height distribution of German born soldiers



[22] Changes in the truncation point across regiments, time and regions were analysed. In all cases, the military height requirement was fixed at 62 inches.

[23] A review of the principal methods used to correct for truncation in height samples is presented in Komlos (2004). See also A'Hearn (2004)

2.4 Results

2.4.1 Cross sectional results and height trends

Truncated regression analysis reveals that the height of recruits form the southern states (Baden, Württenberg and Bavaria) was approximately 1 cm less than that of recruits from Prussia (Table 2.4, Model 1). The interesting feature is that a similar regional pattern is evident for contemporary Germany: the difference in mean height between persons from the southern and northern states is about 1.5 cm, with the difference decreasing sharply for cohorts born in the 1970s (figure 2.8). If the disparity in height among nineteenth century German recruits can be explained on the basis of the poorer economic conditions in the less developed southern states, the fact that people from the southern states are currently more affluent than people from the northern states and still shorter deserves further analysis.

Table 2.4: Truncated maximum likelihood regression estimates

Variable	**Model 1**[a]	**Model 2**[b]	**Model 3**[c]
Region			
Prussia	*Reference*	*Reference*	*Reference*
Baden-Württenberg	-1.391**	-1.225**	-1.260**
Bayern	-1.203**	-1.136**	-1.165**
Sachsen-Thuringia	0.450	0.548	0.590
Hessen	-0.040	0.004	-0.016
Mecklemburg	1.575**	1.669**	1.686**

Continued on next page...

... table 2.4 continued

Variable	**Model 1**[a]	**Model 2** [b]	**Model 3**[c]
Hannover	1.627**	1.774**	1.788**
Profession			
Elite	4.067**	4.153**	4.213**
Services	2.338**	2.349**	2.381**
Food	1.079*	1.089*	1.122*
Agricultural labor, hunters and fishers	3.363**	3.233**	3.309**
Skilled metal workers	1.225**	1.175**	1.221**
Textiles workers and tailors	0.316	0.504	0.520
Miscellaneous crafts	1.406**	1.452**	1.481**
Soldiers	5.067**	5.074**	5.145**
Unskilled workers	*Reference*	*Reference*	*Reference*
No profession listed, unreadable, unemployed	2.276**	2.352**	2.410**
Birth cohort			
1816-1820	1.729*	1.717*	1.715*
1821-1825	0.688*	0.680*	0.682*
1826-1830	*Reference*	*Reference*	*Reference*
1831-1835	0.145	-0.399	-0.643*
1836-1840	-	-1.213**	-1.925**
Age dummies			
age 20	-2.379**	-	-
age 21	-1.631**	-1.085**	-0.846*
age 22	-0.732	-0.190	0.054

Continued on next page...

... table 2.4 continued

Variable	**Model 1**[a]	**Model 2** [b]	**Model 3**[c]
age 23	-0.147	0.403	0.649
age 24 or more	*Reference*	*Reference*	*Reference*
Intercept	164.489**	164.387**	164.329**
Standard deviation	6.495**	6.470**	6.509**
N	5,575	6,200	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

a : latest birth cohort excluded

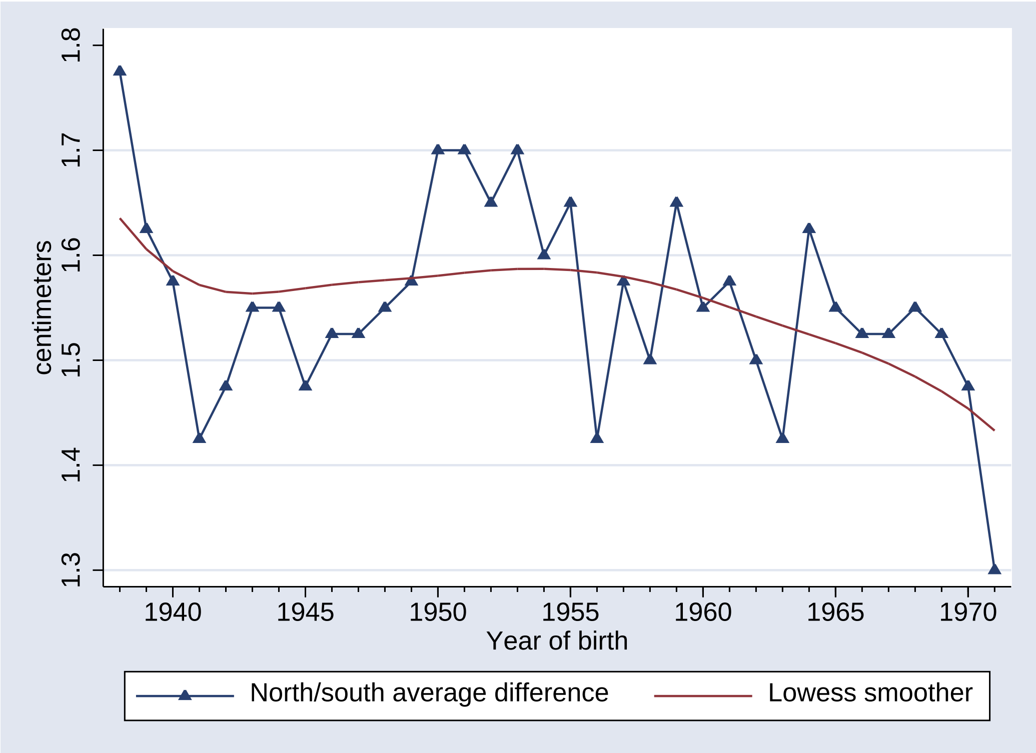
b : latest birth cohort (1836-1840)included. Height at age 21 for recruits aged 18 to 20 calculated using the annual height increments of Hungarian soldiers born in 1780/1790 from Komlos (1989), bottom of tab. 2.10 page 80.

c : latest birth cohort (1836-1840)included. Height at age 21 for recruits aged 18 to 20 calculated using the annual height increments of Hungarian soldiers born in 1750/1760 from Komlos (1989), bottom of tab. 2.10 pag. 80.

The available evidence on income distribution in German states in the 19th century highlights some degrees of inequality: in Prussia in 1875 the share of the top quintile was about 48%, while in Saxony the top quintile owned the 56% of the resources.[24] Since height is sensitive to income distribution and since previous occupation is a proxy for the social status, differences across different occupational groups are expected. The results are coherent with the expectation (Figure 2.9). Soldiers were the tallest group, more than 5 cm taller than unskilled workers. Recruits belonging to the elite group (e.g. merchants, students, physicians) enjoyed a height premium of 4

[24]See Kuznets (1955) and Procopovitch (1926).

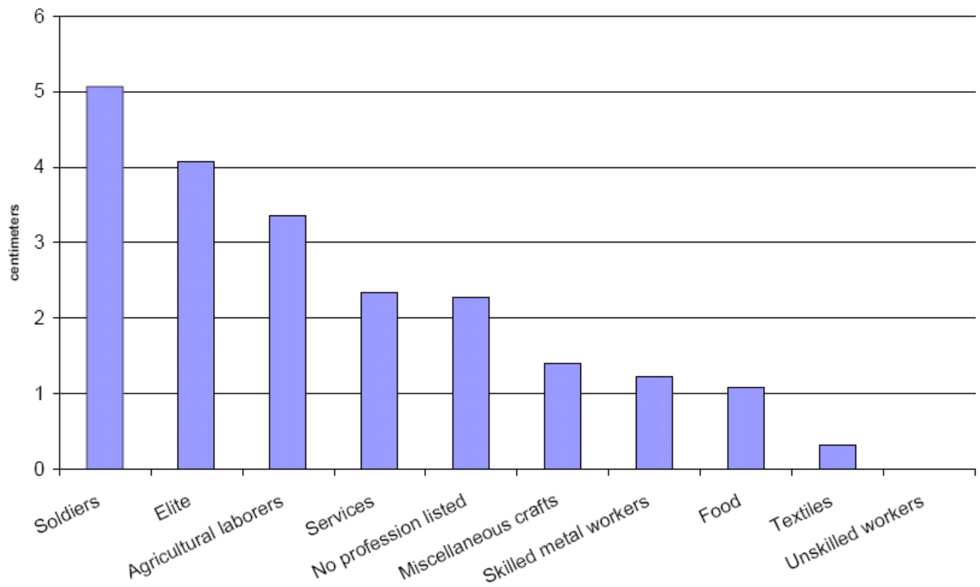
Figure 2.8: Average difference in height between Northern and Southern states in contemporary Germany



Source: Bundesministerium (1997)

cm, while those with privileged access to food (as butchers or cooks) were slightly more than 1 cm taller than recruits from other professions. Finally, low skilled workers from the manufacturing sector (e.g. tailors, weavers, spinners) were not significantly taller than unskilled workers.

Figure 2.9: Height premiums by professional categories



Source: coefficients from tab.2.4, model 1

A decreasing trend in height is evident for the first 15 years after the Vienna settlement. Heights reached a trough for the cohorts born at the end of the 1820s and remained stable thereafter: recruits born during 1826 - 1830 are 1.7 cm shorter than recruits born during 1816-1820, whereas the height of recruits born during 1830 - 1835 is not significantly different from the height of the cohort born during 1826-1830 (model 1, table 2.4). This trend generally accords with the data for most European countries which showed a decrease in height among birth cohorts from the 1830s.[25] While in comparison with the rest of Europe the estimated decline starts a bit earlier, the timing and the magnitude are coherent with the results obtained for both Saxony and Bavaria.[26]

In estimating the height trend the presence of soldiers less than 20 years of age in the last birth cohorts is a possible confounding factor. In well fed populations, normal pubertal growth ends at the age of 20. In case of poor net nutrition during childhood, however, the growth process past the usual age of cessation and extends into the early 20s. As the dummy variables that control for the age show, in fact, that recruits younger than 21 years of age were significantly shorter than 24 or more years old. These young men likely had not reached their final adult height. Given that the last birth cohort includes only individuals younger than 20 years, the contemporaneous presence of dummy variables for birth cohort and for age would cause a problem of multicollinearity, so in model 1 the last cohort was excluded from the regression. Model 2 and 3 offer a correction for the problem of young recruits, giving an indication of the possible direction of the height trend in the late 1830s. Using the annual height increments estimated for the Hungarian soldiers born at the end of 18th century, a forecast of the height the youngest recruits would have had at the age of 21 was constructed. Two different scenarios are considered. Model 2 represent a lower bound scenario: the coefficients used for the forecast are those estimated for soldiers born in 1780s and 1790s, a period of decline in the nutritional status of the population in

[25]For further discussion and bibliography on the height decrease in Europe and the united States in the 1830s, see Komlos (1998). Recent evidence outlined a downturn in US heights between 1820 and 1840 for the working class but not for the upper-middle class. See Sunder.

[26]Saxon recruits born in 1815 1819 are 1.71 cm taller than recruits born in 1825 1829 (Cinnirella (2006), tab. 5); Bavarian convicts born in 1810 1819 are 1.52 cm taller than convicts born in 1825 1829 (Baten and Murray (2000)- tab. 5 pag 360).

Hungary in comparison with the 1750s and 1760s. The estimated growth increments between ages 18 and 21 for the Hungarian recruits born in the latter period are used to forecasts the heights used in model 3, representing, then, a more favourable scenario.[27] In both cases, the declining trend extends beyond the 1820s well into the 1830s. Different robustness checks were applied. In particular, the height of the youngest recruits was forecasted using the cumulative height increments of modern, well fed adolescents: even using the most favourable assumptions, the coefficient for the birth at the end of the 1830s stays negative.[28]

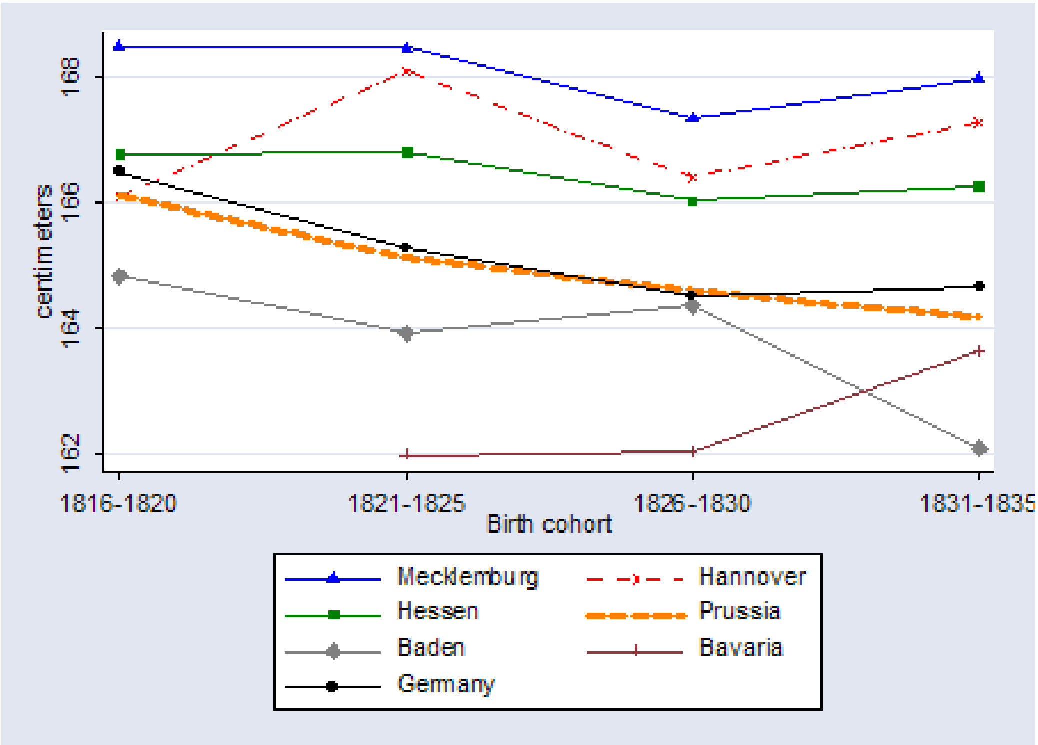
The sample numerosity allows also to estimate the time trend in heights at a regional level (figure 2.10) .[29] Some regional differences appear. While Baden Württemberg shows a sharply declining height trend, heights in the neighboring Kingdom of Bavaria appear to be increasing at the beginning of the 1830s. The northern areas of Hannover, Mecklenburg and Hessen show a similar path, although Hanover has, among the three, wider fluctuations. The estimated trends and levels of height reveal that the negative differential for the southern states, highlighted already in the cross sectional analysis, persisted during the first half of the century. It is also interesting to note that, despite their contiguity, the southern states (Baden Württemberg and Bavaria) show a divergent trend.

[27]For further details on the estimated annual growth coefficients and for a discussion of the nutritional status in Hungary at the end of the 18th century see Komlos (1989).

[28]Even when the counterfactual height was constructed using the height increases of contemporary American boys aged 13.5 years (coefficient taken from Tanner and Davies (1985)), the latest birth cohort would still be 0.4 cm shorter than the cohort born at the end of the 1820's.

[29] We exclude from the analysis Saxony and the Thuringian states, given the small number of observations. Results are obtained using truncated maximum likelihood regressor, using the same controls as in the tab.2.4.

Figure 2.10: Height trends by region



Source: Germany: weighted average of the regional and professional coefficients from table 2.4, model 1; German regions: weighted average of the professional coefficients from separate regressions (results not reported).

Put in international comparison, the height of the German soldiers both at adult age and at age 21 falls in the lower tail of the distribution, above Galicia, Lower Austria and Hungary, but below Bohemia, Holland, France and England (table 2.5 and figure 2.11). The fact that the estimated height for Germany falls between the values for Saxony (Cinnirella (2006)) and Southeast Bavaria(Baten (1999)), estimated using two different and independent samples, gives some degrees of confidence in the validity of the results here obtained. Looking at the position of the single regions in this comparative perspective, a wide range of variation among the German States emerges: while Bavaria is at the bottom, Mecklemburg and Saxony are near to the top of the rank. Bearing in mind the problems of selection of the sample and the multiplicity of factors that influence height, the precise ordering has not to be taken in a very strict sense. The only conclusion about relative standard of living that is striking is the wide regional variation within Germany, which calls for a further analysis.

Table 2.5: German height in international comparison

Country	**Age 21**	**Adult age**	**Source**
Bavaria	158.96	161.54	*This study*[a]
Galicia	161.40	163.30	Komlos (1989) table B9 and table 2.1[b]
Saxony	161.39	160.49	Cinnirella (2006), Table 2[c]
Baden Württemberg	163.46	163.86	*This study*[a]
Lower Austria	161.70		Komlos (1989) table B9[b]
Hungary	162.50	165.80	Komlos (1989) table B9 and table 2.1[b]

Continued on next page...

... table 2.5 continued

Country	**Age 21**	**Adult age**	**Source**
Germany (whole)	162.68	164.44	*This study*[a]
Prussia	163.10	164.13	*This study*[a]
Southeast Bavaria	163.41		Baten(1999) tab.6.4 col.1[d]
Bohemia	163.80	166.30	Komlos (1989) table B9 and table 2.1[b]
Hessen	163.99	166.12	*This study*[a]
Netherland	164.40		Drukker and Tassenaar (1997), Table 9A.1[e]
France	164.50		Weir (1997), Table 5B.1[f]
Hannover	164.59	166.91	*This study*[a]
Northern Italy	165.38	166.63	A'Hearn (2003), Table 2 [g]
England	166.10		Komlos (1998), Fig.2[h]
Saxony and Thuringia	167.26	167.83	*This study*[a]
Mecklemburg	166.85	167.79	*This study*[a]
Switzerland	166.76	167.56	Kues (2006), Table 2[i]

a : Truncated Maximum Likelihood estimates. Unskilled worker, born during 1815 1840. Adult = older than 23. Separate estimates for each region.

b : Height at age 21: Quantile-bend estimates for ages 19-20 plus 1 cm. Soldiers born in the late 1830's. Adult height: truncated sample means converted to estimates of population mean assuming a standard deviation of 6.86 cm, a normal distribution, and an effective truncation point 0.5" below the official MHR of 63".

c : Truncated Maximum Likelihood estimates. Craftsman born in an industrial region between 1829-1829.

d : 21 years old conscript from the working class, born between 1825-1829 in a rural area

Continued on next page...

... table 2.5 continued

Country	Age 21	Adult age	Source

e : Median height at age 20 plus 6.4mm

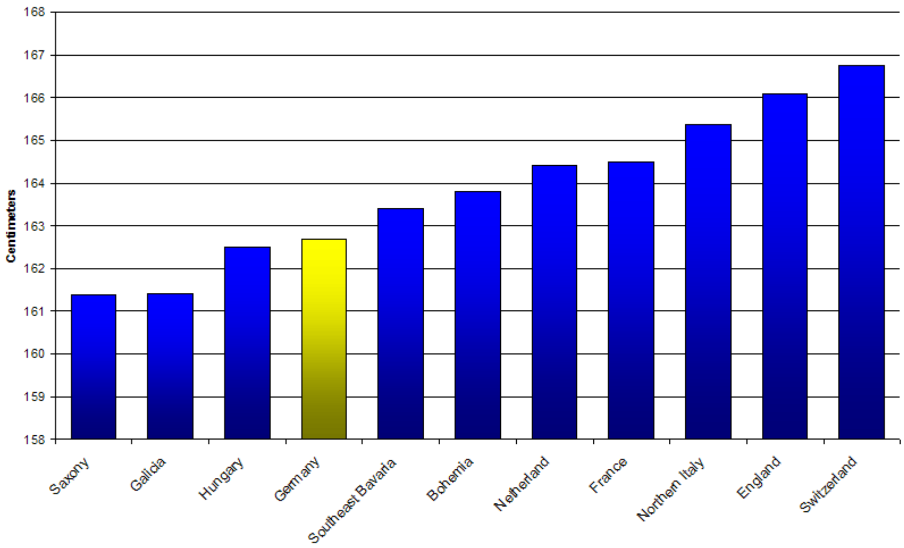
f : Median height, ages 20-21, soldiers born in the late 1830's

g : Truncated Maximum Likelihood estimates. Soldiers born 1825 - 1830, rural residence, no occupation given.

h : Index for age 20 - 23, times 167.7 cm base.

i : Truncated Maximum likelihood estimates. Soldiers born between 1825-1829

Figure 2.11: German height in international comparison



Source: table 2.5

2.4.2 Agrarian reforms and living standards in Prussia

One of the more debated questions in the economic history of Germany pertains to the effect of the agrarian reforms (*Bauernbefreiung*) on the living standard of the population. German states differed in the timing of the reforms and in their strength. Prussia at the beginning of the nineteenth century implemented several reforms in a fundamental fashion to renew the agricultural sector; Saxony and Hanover followed its example and implemented similar reforms during the 1830s but in a weaker fashion, providing financial support to peasants who wanted to buy their land. Other states (such as Bavaria) waited until the second half of the nineteenth century to start any reform. The effect of these processes on the living standard of peasants has been controversial. Scholars have argued whether the reforms led to the pauperization of the peasantry.[30] Although appealing, the comparison between the different German states has to be interpreted cautiously, because many external factors changed between the early reforms of some states and the late reforms of other states. In this respect, Prussia, having implemented the agrarian reforms at the same time but with different nuances within its large boundaries, offers a good set to test the effect of these changes.

Given the considerable extension and the economic differences of Prussian territories, the height trend is estimated separately for its east and west provinces. The indication of the city of provenance was available for approximately half of the Prussian recruits and for 88% of them it was possible to locate the city in the east or in the west part of the Prussian kingdom. 62% of the recruits came from the West, while the remaining 38% were from the

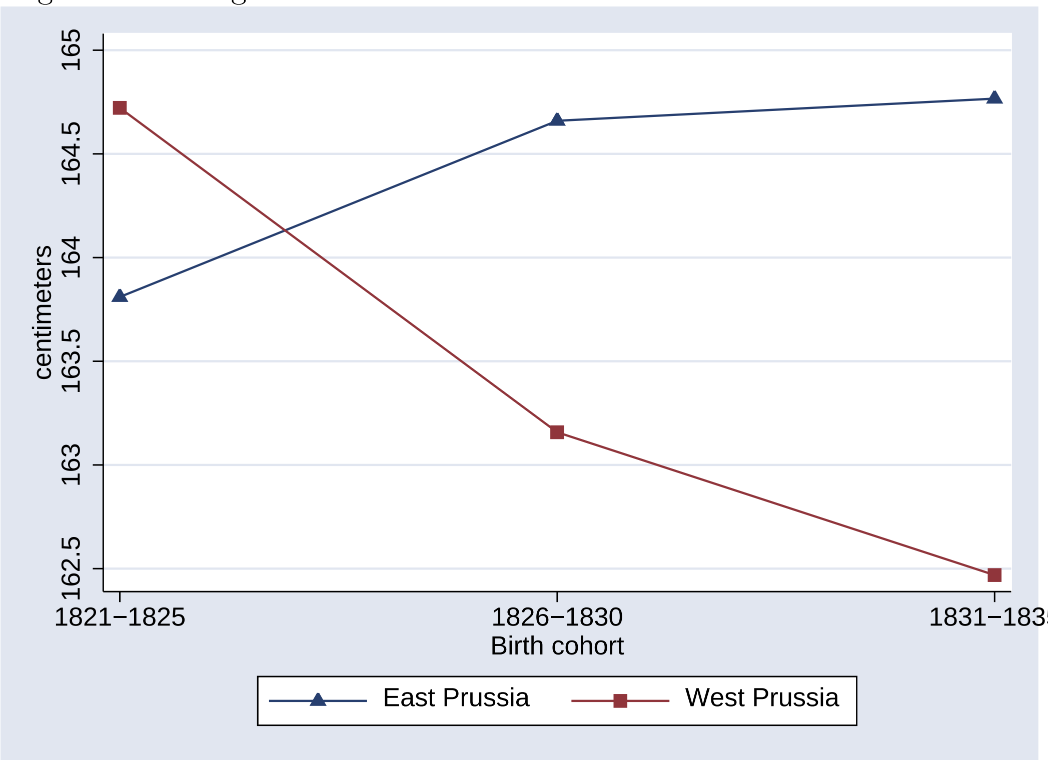
[30] Harnisch (1974) agree with the pessimistic view expressed by Knapp (1887). Henning (1996) criticizes this view. For further discussion on the effect of the agrarian reforms see Baten (2003).

East. Recalling the discussion on the selection of the recruits in section 2.3, given that the majority of the Prussian participants in the 1848 revolution were coming from Rhineland and Westphalia (two districts of West Prussia[31]), these percentages are not surprising. The first birth cohort was left out from the analysis given the small number of observations while the last birth cohort was left out to prevent a spurious downward trend due to the presence in this cohort of soldiers who had not reach yet their adult height. Although the cohort coefficients are not significant, the signs characterize a divergent height trend for the two areas, decreasing for the West and slightly increasing for the East (figure 2.12).

The traditional reconstruction of the effects of the Prussian reforms points to the concentration of the land in the hands of the Junkers estate owners and of the large scale peasant cultivators in the East: small farmers either became daily labourers for the big landowners or emigrated to the cities. The comparative advantage enjoyed by these big estates in the grain production, strengthened the tendency toward grain monoculture. As a function of the land redistribution and of the emphasis on grain, a marked decline in livestock holding among the peasantry was observable. The increased grain exports induced the substitution in the peasant diet of wheat and rye with the nutritionally inferior potatoes. On the contrary, in the West, where the peasants traditionally enjoyed stronger tenurial rights, the reforms produced a more balanced land distribution. Furthermore the process of enclosure of common lands as implemented in the West, encouraged the retention of livestock by small sized peasants, a trend encouraged also by the adoption of

[31] What is here defined as *West Prussia* are the territories that were situated on the left of the Kingdom of Hanover and it has not to be confused with the region "West Prussia", one of the region of the Eastern part of the Prussian kingdom, corresponding to the modern area of Danzig (Poland)

Figure 2.12: Height trends in the Eastern and Western Prussian territories



new fodder crops that improved the milk yields.[32] If that was the case, given that Eastern recruits in the sample were coming mainly from areas where the agrarian reforms were implemented in a harsh fashion,[33] a decline in their height and an increase in Western soldier's height would have been expected.

Given the small sample size, great caution has to be used in interpreting the results. Furthermore, it is worth to remind us that there are data only for a few soldiers who previously worked in the agricultural sector. If, as highlighted in section 2.3, this sample is representative of the industrial lower classes, the positive height trend in the East may reveal that the agrarian reforms and the stronger commercialization of the agricultural products that followed, improved the food supplies of that part of the population that was not working in the primary sector. On the contrary, in the West the increase in the number of medium size holdings, if beneficial for the peasants, may have not been able to support, at least at the beginning, the food demand of the industrial sector. As a consequence, the poorest in this group may have suffered a decline in their biological living standards. The Western recruits, however, were enjoying an higher level of living standards, as suggested by the cross sectional analysis of the Prussian recruits (Table 2.6). Although the differences between recruits coming from different areas are not statistically significant, the sign of the coefficient for the recruits coming from the Western is positive, signalling a height premium for those recruits. Baten (2003), using a different set of indicators, draws similar conclusions.[34]Further analysis is, of course, necessary. However, if confirmed, the results support the idea that

[32] See Lee (1984, 1981)

[33]For a classification of the Prussian districts according to the type of agrarian reforms see Baten (2003), table 12.1, p. 392. 60% of the east Prussian recruits were classified into districts. The districts that are classified as "harsh" type (Posen, Pomerania, Berlin, Silesia) represent 54% of the sample, while the eastern districts classified as "mild" type (East Prussia, Brandenburg, Danzig, Saxony) represent the 46% of the sample.

[34]See Baten (2003), pag.391 394.

the agrarian reforms were at least not detrimental to the living standards of the industrial lower classes in the East.

Table 2.6: Height determinants in Prussia

Variable	Coefficient	(Std. Err.)
Region		
Unknown	*Reference*	
Harsh	-0.563	(1.004)
Mild	0.091	(1.024)
West	0.149	(0.837)
Profession		
Elite	3.683**	(1.306)
Services	2.850*	(1.212)
Food	-0.183	(1.520)
Agricultural laborers, hunters and fishers	2.832	(1.850)
Skilled metal workers	0.261	(1.093)
Textiles workers and tailors	0.687	(1.089)
Miscellaneous crafts	1.632	(1.029)
Soldiers	6.004**	(1.210)
Unskilled	*Reference*	
No profession listed, unreadable, unemployed	3.165**	(0.912)
Age		
Age 20	-2.464*	(1.099)
Age 21	-1.114	(0.845)

Continued on next page...

... table 2.6 continued

Variable	Coefficient	(Std. Err.)
Age 22	-0.336	(0.991)
Age 23	0.818	(0.879)
Age 24 and more	*Reference*	
Intercept	163.477**	(1.141)
Standard deviation	6.815**	(0.272)
N	1110	
Log-likelihood	-3427.236	
$\chi^2_{(16)}$	58.053	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

2.5 Summary and conclusions

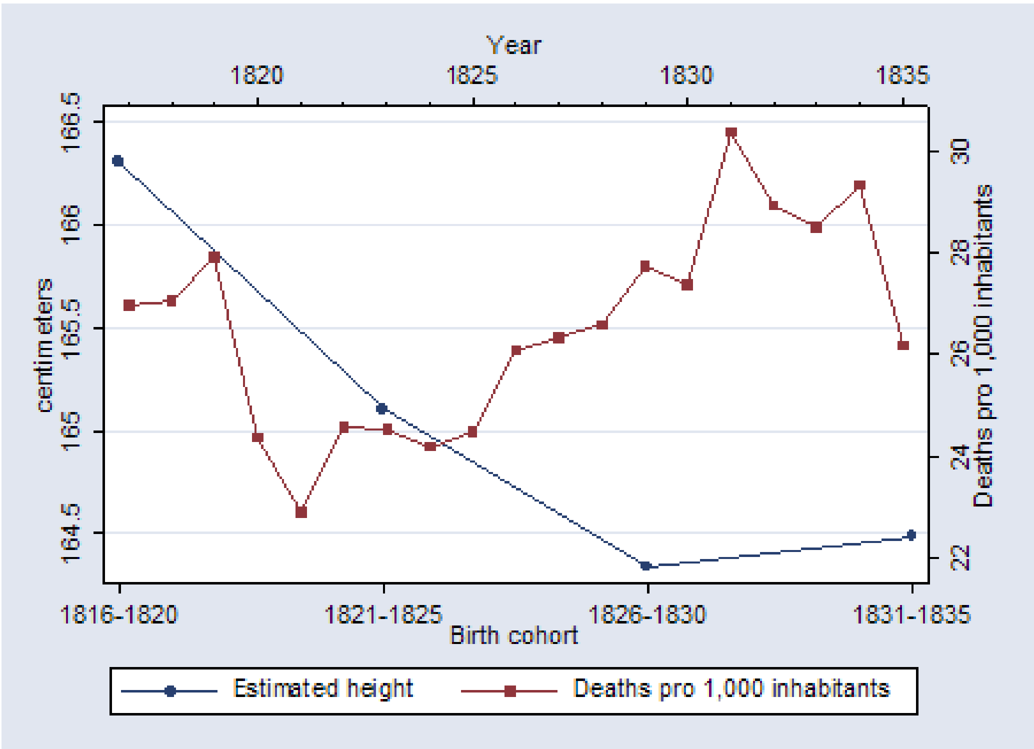
Using a sample of German soldiers enrolled as mercenaries in the British army during the Crimean War, the trend and the regional variation in height of recruits born during the first half of the 19th century has been investigated. This analysis contributed to shed some light on the evolution of the living standard in Germany during a period of economic transformation. Three main results can be highlighted.

The estimated height trend for the whole country shows a decline particularly substantial for those born at the end of the 1830s. Despite the limitations of the data, the negative trend appear to be robust to several corrections for confounding factors. Given the multiplicity of components that influence final height, is hard to say, without further data, what is driving this trend. A possible explanation is the increase in food prices, a pattern common to many other European states at that time, that led to a generalized height decline in Europe and America. According to the industrial wage index, however, the working class was generally able to keep its purchasing power, as the index appears to be stable from 1820 to 1840 (figure 2.1). Another factor that may have had contributed to the deterioration of the living standards, is the worsening of the disease environment: the increased urbanization related with the outset of the industrial society, the scarce provision of public sanitation and the difficult access to medical cares for the poor ones, may have favored the transmission of diseases. In this respect, it is interesting to note that the declining trend goes along with an increase in the mortality rates in Germany (figure 2.13).

Sample size allowed for the analysis at a finer geographical level. Height trend at regional level reveals a major North-South differential not only in level (the height advantage for the northern states is comparable to that observable in contemporary Germany), but also in trends. While, in fact, Prussia and Baden - Württemberg experienced a remarkable decline, height in Central and Northern states (Hessen, Hanover and Mecklemburg) was much less affected, and in Bavaria the estimated trend is even increasing. Despite the economic unification of the German states achieved with the *Zollverein* in 1834, common shocks had different effect on the biological standard of living, probably due to different institutions at a local level. The limits of the present data, however, do not allow for further investigation.

Finally, this paper contributed to the debate on the effect of the agrarian reforms in Prussia on the living standards . The increasing height trend in

Figure 2.13: Height trends and mortality rate in Germany



Sources and notes: Height on the left axis; weighted average of the birth cohort coefficients from table 2.4. Mortality on the right axis; Hoffmann (1965) table 1 pag. 172

the eastern districts of the Kingdom in comparison with a declining trend in the Western part, together with the absence of significative height differences between districts where reforms were implemented in a stronger fashion and districts where the reforms were milder, suggests that the agrarian reforms were not so detrimental to the standard of living of the industrial working class. The increase in small and middle size plots in the West, in fact, could have led to a lost of economies of scale so that the agricultural sector may have been not able to satisfy an increasing demand for its product coming from the industrial sector. On the contrary, the stronger commercialization of agricultural products fostered by the harsher reforms implemented in the East, improved the food supplies of that part of the population not employed in the agricultural sector.

Chapter 3

Obesity and the labour market in Italy, $2001 - 2003$

3.1 Introduction

The percentage of severely overweight and obese individuals rose dramatically in the last decades in western nations. In most European countries, obesity prevalence increased by 10 40% in the last ten years.[1] Apart for being recognised as a disease by the World Health Organization,[2] obesity may be considered as an economic phenomenon because of the important costs that it entails.[3] Obesity, in fact, is a substantial risk factor for a range of diseases (such as hypertension, cardiovascular diseases, osteoarthritis, diabetes and certain types of cancer) which lead to higher direct health care costs and increases the indirect costs related to morbidity and mortality of

[1] WHO (2003)
[2] WHO (2000)
[3] Finkelstein et al. (2005)

obese individuals.[4] Additionally, there are other social effects, inasmuch as obese individuals may suffer from stigmatization and discrimination.

Since the seminal paper of Hamermesh and Biddle (1994), the relationship between physical appearance and labour market outcomes has been widely documented, and many of these studies pointed out the negative effect of body weight on wages or earnings among both men and women.[5] Part of the relationship may be determined by culture. For example, in a society with stronger cultural norms for thin body types, employers may be more likely to discriminate against obese employees. It is then likely that labour market outcomes of obese workers differ across countries.

While this relation has been intensively studied in the US,[6] the empirical evidence available for Europe is more limited. Some studies focus on Europe as a whole, using the European Community Household Panel. Brunello and D'Hombres (2007), pooling all the countries together and using an instrumental variable approach, find a negative association between wages and body size measured with the Body Mass Index (BMI)[7] - for both men and women. When they divide the countries in two groups (the "beer-belt" - Austria, Belgium, Denmark, Finland and Ireland and the "olive-belt" -Greece, Italy, Portugal and Spain) they find that the negative effect is much stronger

[4]For a review of the medical literature on the relation between obesity and diseases: Sturm (2002) For a review of the literature on the medical costs of obesity see Bhattacharya and Bundorf (2005).

[5]See among the others Averett and Korenmann (1996), pagan and Davila (1997) and Cawley (2004).

[6]There are several articles that focused on the effect of obesity on earnings in the US. Among them Register and Williams (1990) Gortmaker et al. (1993) Averett and Korenmann (1996) Behrman and Rosenzweig (2001) Cawley (2004). On the secular trend in obesity and height in the U.S. see also Komlos and Baur (2004)

[7]The Body Mass Index is measured as weight in Kilos divided by height in squared meters. Although BMI does not directly measure the percentage of fat, it is found to be highly correlated with other commonly used measures of obesity. Kannel (1983)

in Southern Europe. Similarly, Sousa (2005), using a propensity score approach, finds that overweight and obesity decrease labour force participation for women and increase that for men. The results are similar also when she estimates the effect separately in Northern and Southern countries. The main flaw of pooling all the countries together, is that the coefficient structure (including that on the body size measure) is restricted to be the same for Europe as a whole, or, at best, for the same sub-sample of countries. Moreover, the fact that Brunello and D'Hombres (2007) find a different BMI wage relationship for each of these groups strongly support the idea of a relationship that differs across countries. For these reasons, Garcia and Quintana-Domeque (2007) estimate the association between body size and labour market outcomes without restricting all associations to be equal across countries. They find weak evidence that obese worker are more likely to be unemployed or tend to be more segregated in self-employment jobs. They also find the association regarding unemployment and wages to be different for men and women and to be heterogeneous across different European countries. The statistical significance of the association between labour market outcomes and obesity, though, appear to be low. Using the same dataset but focusing on deviations from the median BMI, Fahr (2006)) finds that the negative relation between body mass and wages is neither confined to severe obese employees nor to women only. The findings differ substantially across countries, but it is interesting to note that the negative association is rather confined to men: deviating from the reference BMI reduces wages for men in 4 out of 9 countries, while in only 2 countries for women.

Other studies focus on specific countries. There are works on United Kingdom (Sargent and Blanchflower (1994), Harper (2000), Morris (2006)), Finland (Sarlio-Latheenkorva and Lahelma (1999)), Germany (Cawley et al.

(2005); Heineck (2005) studies the relation using height as a measure of body size), Denmark (Greve (2006)) and France (Paraponaris et al. (2005)). The evidence is mixed. In UK Sargent and Blanchflower (1994) and Harper (2000) find that, conditioned on being obese (at the age of 16 and at the age of 23 respectively), hourly earnings (respectively at the age of 23 and at the age of 33) for women were lower, while no such relation was found for men. Morris (2006) finds in an OLS regression a significant and negative effect of BMI on occupational attainments for women and positive one for men, although the latter is not robust across different specifications. However, after using instrumental variables for BMI, no significant effect either for men or women is found. Similar trends are highlighted also in Finland, where obese women have lower income levels, but not obese men, and in Denmark, where for men overweight and obesity seem to have even a positive effect on employment. On the contrary, empirical evidence for Germany shows that obesity is negatively associated with wages both for women and for men, although after using instrumental variables to address the endogeneity of weight, there is no evidence that body size causally affects earnings. Finally, Paraponaris et al. (2005) analyse the relation between obesity and employability, finding that in France upward deviations from the mean BMI significantly increase the percentage of time spent unemployed during working years, and decrease the probability of regaining employment after a period of unemployment.

This study aims at giving a further evidence to complete the picture of which are the effects of obesity on labour market outcomes, measured in terms of probability of being employed nad probability of reaching top professional positions. Italy differs under two relevant aspects from the ones that have been analysed up to now in the literature. First, in contrast with the Anglo-Saxon countries, the centralized bargaining system to determine wages and the high trade union coverage make more difficult for employers to calibrate wages according to worker's productivity. Standard results obtained for the US or the UK, then, cannot be applied in this different institutional setting. Second, Italy is a country with one of the lowest obesity rates in Europe, but that experienced since the end of the 1990s a substantial growth in the incidence of obesity.de Galdeano (2005) These features affect the perception of body size among people and, in turn, the degree of stigmatization and discrimination against heavier individuals. The relative rarity of obesity in Italy (especially if compared with the incidence of this condition in the US), may affect labour market outcomes in a different fashion. Despite these peculiar features, Italy has been not analysed thoroughly. The present study will then bridge this gap.

3.2 Statistical issues

Identify a causal effect of body size on labour market outcomes without experimental data is a challenging task because of the endogeneity problem. As pointed out by Cawley (2004), in fact, the observed correlation may reflect three possible relations: the effect of obesity on labour market outcomes, the effect of labour outcomes on obesity and the effect of a third, unobserved factor on both obesity and outcomes.

The effect of obesity on labour market is what we would like to observe and it may arise in several ways. First, obesity may directly affect worker productivity *tout - court*. Obese workers, in fact, may be slower than other workers or they may be sick more often. If that is the case, after controlling for a set of productivity related variables, obesity should not significantly affect labour market success any more. Second, obesity may affect productivity in a specific occupation or sector. This may arise because customers may prefer to deal with attractive people (customer discrimination), so, all other thing equal, good looking workers are more productive because they are able to attract more customers.[8] In this respect, then, obese workers are less productive than other workers, but only in those sectors or occupations where there is customer discrimination. In this case, no difference in labour market outcomes between obese and non-obese workers should be observed in those sectors or occupations where there is no specific return to physical appearance. Finally, obesity may affect labour achievements because of pure employer discrimination. In other words, employers may prefer individual with certain physical characteristics which are unrelated with productivity, leaving the less preferred group with fewer job opportunities and lower pay. Pure discrimination may arise not only because employers may simply dislike obese workers, but also because they may erroneously ascribe productivity related qualities to physical appearance.[9] If that is the case, after controlling for productivity, obese worker should have lower wages irrespective of the sector of the labour market.

As mentioned before, however, the observed relation may also reflect the effect of labour market on body size, inasmuch as poor labour attainments may cause obesity (reverse causality). This would be true if poorer people consume cheaper, more fattening food. Studies for the U.S. show that cost is the most significant predictor of dietary choices and that for people with a low socio-economic status, food costs more because it is purchased in smaller

[8]For the theory of customer discrimination see Becker (1957)

[9]Psychological studies, for example, suggest that greater height among men is positively related to perceived social status which may result in tall men being treated preferentially (see Martel and Biller (1987)). Economical studies find discrimination against short men, Herpin (2005), or the existence of a pay premium for tall men, Harper (2000).

quantities and there is more reliance on processed food.[10] Furthermore, poor neighbourhoods in the U.S. have a limited access to supermarkets which offer a wider variety of food at lower prices, so that poor communities may not have an equal access to the variety of healthy food choices, making dietary changes difficult to achieve.[11] If that may be the case for the U.S., it is less realistic for Italy, where fresh and healthy food is easily available at a low price.[12] However, poor neighbourhoods often lack green areas where people can exercise for free. In this respect, then, poor individuals may get fatter because they do not have the opportunity to do enough physical activity.[13]

Finally, the relationship between labour market outcomes and obesity may be the effect of a third factor that affects both, as for example individual time preferences (unobserved heterogeneity). Individuals who have higher marginal rates of time preferences may be less concerned about the possible long term health effects of obesity and, consequently, be more likely to be obese.[14] Furthermore, such myopic individuals may also be less likely to invest in education or to engage in training programs, resulting in a flatter career profile.[15]

Several empirical strategies have been suggested to disentangle causality

[10]Foley and Pollard (1998); Mackerras (1997). Although processed food costs more than non-processed food (that is, a frozen pizza costs more than flour, water, tomato sauce and cheese separately bought), it is cheaper in terms of time needed to prepare it. As for low-income households time is a very scarce resource (both parents need probably to work full time), processed food is more may be in this respect cheaper and therefore preferred.

[11]Morland et al. (2002)

[12]For Italy in the year 1999, for example, the comparative price level index for fruit and vegetables was 92.5 and 92.1 respectively (EU15 = 100), in comparison with the 107.3 of United Kingdom, 107.9 of Germany, 109.8 of France or 121 of Finland. (Source: Eurostat website)

[13]Physical activity is here meant in a broader sense, including also a simple activity like walking.

[14]Komlos et al. (2004)

[15]Baum and Ford (2004)

from correlation in the relationship between labour market outcomes and obesity. As pointed out by Garca and Quintana Domeque, all the approaches come along with severe shortcomings. A first strategy consists in replacing current values with lagged measures of body size,[16] and is based on the assumption that lagged weight is uncorrelated with the current residual in the regression of labour market outcome on body size. While this strategy perfectly remove any contemporaneous effect of labour success on weight, it does not deal satisfactorily with the problem of omitted factors (such as genetic factors or self esteem) that may affect both past measures of body size and present labour market outcomes.

A second strategy to deal with the endogeneity problem is to use differences either with another individual with highly correlated genes (such as a same-sex sibling or a twin)[17] or with previous measures of the same individual (fixed effect model).[18] The main assumption behind this strategy is that all the unobserved heterogeneity is constant within pairs. If that is the case, differencing eliminates the variance in body size that is attributable to shared genes and shared environment. Recent research however, calls this assumption into question as it is shown that epigenetic differences might be present between adult twins. In other words, as the individuals go through life, environmental differences affect differently which genes are turned on or switched off, so that individuals with similar (or identical as with monozygotic twins) genes, might have different outcomes in their adulthood.[19] That would imply a non constancy of unobserved heterogeneity. The assumption

[16] Gortmaker et al. (1993), Sargent and Blanchflower (1994),Averett and Korenmann (1996), Harper (2000), Conley and Glauber (2005)

[17] Averett and Korenmann (1996), Behrman and Rosenzweig (2001), Baum and Ford (2004), Cawley (2004), Cawley et al. (2005), Conley and Glauber (2005)

[18] Baum and Ford (2004), Cawley (2004) and Brunello and D'Hombres (2007).

[19] Fraga et al. (2005)

would still be valid when using individual fixed effect model in a relatively short time span. As highlighted by Garca and Quintana Domeque, the problem here is that the shorter the time period, the higher the imprecision of the estimates (in the limit, if there is no change at all, the estimation is not possible). On the contrary, the longer the time period considered, the higher the precision of the estimates, but the lower is the likelihood that the unobserved heterogeneity stays constant over time, leading to inconsistent estimates. In any case a differencing strategy is not able to deal with the problem of reverse causality.

Recently, Sousa (2005) applied a propensity score approach. This method consists in creating, on the base of observable characteristics, similar groups of individuals and in comparing within each group the mean outcomes for the obese and the non obese. The average difference in the outcomes across all the groups is a consistent estimate of the average effect of obesity on labour achievements under the assumption that individuals, that are similar in their observable characteristics, are similar also in their unobservable ones. A central role, then, is given to the variables chosen to determine the similarity: the better and more informative the data are, the easier is to credibly justify the assumption and the matching procedure. As shown by Heckman et al. (1997), omitting important variables can seriously increase bias in resulting estimates. Furthermore, the selected variables have to be such that they affect the probability of being obese but they are not influenced by obesity. Therefore a very long panel dataset is required, that ideally gives information on individual characteristics before the onset of obesity, a phenomenon that develops in most cases at very young ages. Given the small set of variable used in Sousa (2005) and the relatively short length of her panel dataset, it is difficult to avoid the suspicion of serious bias in her results.

A strategy widely used in the literature is the instrumental variables approach (IV), that is the use of a set of variables (instruments) that are highly correlated with the endogenous regressor conditional on the other variables that affect the dependent variable (relevance condition), but that are uncorrelated with the error term of the regression (exogeneity condition). Several instruments have been proposed: the weight of the child as instrument for the weight of the mother Cawley (2000), the weight (adjusted for sex and age) of a sibling (Cawley (2004),Cawley et al. (2005)), mean BMI and prevalence of obesity across individuals living in the health authority where the respondent lives (Morris (2006)), assumption of obesity related medicaments and mortality status of the individual's parents (Greve (2006)). In all the cases, the exogeneity condition is likely to be violated.[20]

In this study an instrumental variable approach is used to estimate the effect of body size on labour market outcomes. Using the richness of information on food and spare time habits included in the survey, a new set of instruments is proposed. Although significantly correlated with the endogenous variable, the proposed set is less likely than other instruments used in the literature to violate the exogeneity condition.

3.3 Data, variables and estimation strategy

Individual level data used in this paper come from three round (years 2001 to 2003) of a survey on several aspects of the Italian households' habits (AVQ Aspetti della vita quotidiana) conducted by the Italian Institute of Statistics

[20]For a discussion of the shortcomings of the instruments see Garcia and Quintana-Domeque (2007).

(ISTAT).[21] The aim of the AVQ is to analyse how the households are living and their degree of satisfaction with public services and is articulated in several thematic areas such as health conditions, life styles, drugs consumption and usage of health services, spare time and so on.

The survey is run on a yearly basis. For every round a new sample is drawn and using a mixture of face-to-face interviews and self-administered questionnaires, data are collected both at the individual and the household level. Each year around 20,000 households (circa 53,000 individuals) were interviewed .

The survey includes self-reported data on height and weight, with whom the BMI index (kg/m^2) was constructed to measure obesity. Self-reported anthropometric variables contain usually measurement errors. It has been shown, in fact, that height and weight are misreported by individuals, whose deviations from the true data usually tend toward a "preferred" body size.[22] The extent of the error change according to several characteristics such as age, sex or actual weight: men tend to over report their height and women under report their weight, old people misreport both height and weight while heavier subjects under report their real weight.[23] Those errors are compounded in the derived BMI variable and this is important when individuals are classified into standard categories of BMI (underweight, normal weight, overweight and obese, all based on some fixed BMI thresholds). Misclassification of overweight and obese subjects as belonging to a lower BMI category would bias the relative probabilities of labour market success associated with increasing

[21] ISTAT, "Indagine multiscopo sulle famiglie. Aspetti della vita quotidiana." Anno 2001, 2002, 2003. The survey can be purchased at www.istat.it/servizi/infodati/

[22] Ziebland et al. (1996)

[23] Roberts (1995), Paeratakul et al. (2002), Kuczmarski et al. (2001), Ezzati et al. (2006). Danubio et al. (2006) conducted a study on Italian youths, finding as well misreporting of height and weight.

BMI. Unlike other datasets (such as the Third National Health and Nutrition Examination Survey), this survey does not allow to properly correct for the measurement error, given that there is not a sub sample of individuals that were measured and with whom correct the other measures. The introduced bias, however, is not expected to contaminate too much the estimations for several reasons. First, the presence of the interviewer reduced the scope for big misreporting.[24] Second, studies that correct for bias, find little variation in the misreporting with age from 25 to 54 (individual in those ages represent 65% of sample used in this study).[25] Furthermore Lakdawalla and Philippson (2002), after correcting for the misreporting in weight, find that the extent of the error in their sample is not sufficiently large so as to appreciably affect the estimates of their models. Third, given that men and women models are always estimated separately, the sex bias variation is not a concern here. Finally, the IV approach deals with the endogeneity problem and corrects also for systematic measurement errors in the reported height and weight. Appendix 3.A offers a possible correction for the problem of misreporting and presents the results obtained with and without correction. No major differences emerge after the systematic errors in the anthropometric measures is corrected.

Although most of the questions are referred to all the individual present in the household (from age 0 on) given the interest of the present study in the effect of body size on labour market outcomes, only individuals in their working age (18 to 65 years) are considered. Furthermore, individuals that are out of the labour force, either because of their own decision (such as housewives, students and retired people) or because of external reasons

[24]Ezzati et al. (2006) find that the presence of the interviewer significantly reduce the errors.

[25]See Thomas and Frankenberg (2000).

(such as disability and individuals on military duty), are excluded from the analysis. The results are then based on a final sample of 68,231 individuals.[26]

There is no generally accepted definition of the measure for the labour market outcomes.[27] Wages or actual earnings are among the most often used measures in the literature.[28] Unfortunately, the AVQ does not provide this kind of information. Individuals are rather asked their labour market status, if they were occupied in the past, the economic sector of activity and the professional position within the occupation. This paper focuses then on two measures: the labour market status (employee, self-employed and unemployed) and, for the sub sample of the employees, the professional position (blue collar workers and apprentices, intermediate employees, executive employees and managers). These two measures may be particularly appropriate to analyse the effect of body size in the Italian labour market. According to the OECD (1994) Employment Outlook, in fact, Italy has both one of the highest collective bargaining coverage rate and trade union density.[29] Existing evidence shows that in those countries where bargaining is centralized and union membership is high, the reduction in wage inequality due to the unions is strong. As already suggested by Garca and Quintana Domeque then, if employers are limited in their possibility to calibrate wages to different type

[26]The sample is made of circa 40,000 men and 27,000 women. Almost 8,000 individuals are classified as unemployed; almost 16,000 individuals are self−employed and 48,000 are employees; 4,000 employees are in the top professional positions (executive employees or managers).

[27]Harper and Haq (1997); Morris (2006)

[28]See, among the others, Cawley (2004), Cawley et al. (2005), Conley and Glauber (2005).

[29]The collective bargaining coverage rate is defined as the number of employees covered by a collective agreement over the total number of employees. In the year 2000 in Italy more than 80% of the employees were covered by collective agreements, whereas the OECD weighted average is 35%. The trade union density is measured as the percentage of wage and salary earners covered by unions: in the year 2000, that was equal to 35%, a percentage above the OECD weighted average of 21%. See OECD (1994), table 3.3, p. 145.

of workers, the only way they have to discriminate across individuals is during the hiring process. In other words, if there is any discrimination against obese workers, given that the employer cannot pay them a lower wage, he will prefer not to hire them at all.[30] The same should be true for the obese employees: if there is any discrimination, they will be less likely to advance in the profession.

We first estimate the relationship between body size and the probability of being employed using a probit regression without correcting for endogeneity (section 3.4). The same model is also used to estimate in the sub-sample of the employees, the effect of body size on the probability of being a manager or a executive employee. We deal subsequently with the endogeneity problems highlighted in section 3.2, estimating the models using a set of suitable instruments described in section 3.5.1. Finally, as a robustness check, we estimate the relationship using a multinomial logit with three outcomes (section 3.6): employee, self-employed and unemployed. This approach is justified by the fact that if there is discrimination in the hiring process, obese individuals not only will be more likely to be unemployed, but they will also be more likely to be in self-employment jobs. Also the association between body size and professional position in the sub sample of the employees, is re-estimated considering more than one outcome: manager and executive employee, intermediate employee and blue-collar worker. An ordered probit is more appropriate in this case, given that the different outcomes are naturally ordered (being a manager is a better outcome than being an intermediate employee, although it is not possible to say that is twice better than being a blue-collar worker). Again, if obese employees are hampered in their careers,

[30]As a partial confirmation, studies that analyse the relationship between wages and body size using the ECHP, found no significant relation for Italy (Fahr (2006), Garcia and Quintana-Domeque (2007))

they will be less likely to be in higher professional positions.

To characterize body size, four alternative measures are used: 1) weight in kilos controlling for height in centimetres; 2) logarithm of the BMI; 3) three indicator variables for clinical weight classification;[31] 4) an indicator of the relative position in the sex and age distribution of the BMI.[32] The first measure is meant to capture the differences in outcomes for individuals with different heights. Several studies, in fact, point out the positive effects of height on labour achievements for both men and women,[33] so it could be that heavy but tall individuals have different outcomes. The logarithm of BMI is used to capture eventual non linearities in the relation between body size and labour market status. The same aim is pursed using the dummy variables; this approach, however, has the advantage of not imposing any functional form on the relationship. The latter indicator, finally, is meant to capture the effect of social norms.[34] As pointed out by Harper (2000), in fact, relative rather than absolute measures of obesity provide a better explanation of different labour market achievements. Furthermore, relative measures are less sensitive to misreported anthropometric data, and that reduce the bias due to measurement errors.

Besides the body size variable, both the labour market status and the professional position equations include other regressors: age and age squared, number of years of completed education, a dummy variable if the individual is living in the south of the country, an indicator of the economic sector of

[31]ccording to the WHO, the indicators are so defined: BMI below 18.5 is underweight, between 18.5 and 24.99 is normal weight, between 25 and 29.99 is overweight and over 30 is obese.

[32]Three indicators are used: being in the top quintile, in the second top quintile and in the bottom quintile. Five age groups are considered: 18 29; 30 39; 40 49; 50 59; 60 and older.

[33]See Heineck (2005), Judge and Cable (2004),Persico et al. (2004)), Schultz (2002)

[34]On the effect of social norms on wages, see Fahr (2006).

activity (in 9 categories), a dummy variable if the individual is in a good health status, the number of chronic diseases that affects the interviewee, number of nights spent in the hospital in the three months preceding the interview, dummy variables that account for the year in which the interview took place, number of members of the household, a dummy variable for being married or living together with the partner, the number of children aged 0 to 5 years and the number of children aged 6 to 13 years. The last two variables are particularly important for females, as the presence and the number of children affects both their weight gain and their labour supply. Although the relevance of those regressors in the male equation is much lower, they have been kept for comparability. Finally, to control for potential big misreporting, an indicator whether the answer was given directly to the interviewer is included. Table 3.1 presents basic descriptive statistics for the samples of men and women.

Table 3.1: Descriptive statistics of the main covariates by sex

Variable	**Average**	**Min**	**Max**
Women Subsample			
BMI	22.71	15.05	42.97
Age	38.09	18	65
Education	11.43	0	21
Living in the south[a]	0.33	0	1
Health status[b]	0.36	0	1
Number of chronic diseases	0.40	0	15

Continued on next page...

... table 3.1 continued

Variable	Average	Min	Max
Number of nights spent in the hospital in the last 3 months	0.17	0	82
Households members	3.28	1	11
Married[c]	0.55	0	1
Children 0 - 15	0.18	0	3
Children 6 - 13	0.26	0	5
Presence of the interviewer[d]	0.40	0	1
Economic sector of activity			
Agriculture	0.06		
Industry, extraction	0.14		
Construction	0.01		
Trade, hotels, restaurants	0.19		
Transports, communications	0.02		
Intermediation, rentals	0.04		
Public administration	0.10		
Education, health care, social services	0.19		
Other services	0.14		
Men Subsample			
BMI	25.30	14.51	42.24
Age	39.89	18	65
Education	10.45	0	21
Living in the south[a]	0.40	0	1
Health status[b]	0.87	0	1
Number of chronic diseases	0.39	0	15

Continued on next page...

... table 3.1 continued

Variable	Average	Min	Max
Number of nights spent in the hospital in the last 3 months	0.15	0	90
Households members	3.40	1	12
Married[c]	0.60	0	1
Children 0 - 15	0.19	0	4
Children 6 - 13	0.28	0	5
Presence of the interviewer[d]	0.37	0	1
Economic sector of activity			
Agriculture	0.06		
Industry, extraction	0.24		
Construction	0.11		
Trade, hotels, restaurants	0.15		
Transports, communications	0.06		
Intermediation, rentals	0.04		
Public administration	0.10		
Education, health care, social services	0.07		
Other services	0.12		

a : Dummy variable = 1 if the respondent lives in the south

b : Dummy variable = 1 if the respondent states that his health condition is "good" or "very good"

c : Dummy variable = 1 if the respondent is married or is living together with the partner

d : Dummy variable = 1 if the questionnaire was compiled while the interviewer was present

3.4 Probit results

Table 3.2 reports the results for women and men (in the upper and lower panel respectively) of a probit estimation of the probability of being employed. The table reports marginal effects. They indicate how a marginal change (or a discrete change in the case of dichotomous variables) in the body size measure affects the probability of being employed. All the regressions are unweighed. The probability of an individual being sampled in the survey (and thus the AVQ sampling weights), in fact, is not a function of the dependent variable of our model. In this case then, an unweighed regression is more efficient than a weighed one, yielding smaller standard errors.[35]

The estimated association reveals a negative correlation between the log BMI and the probability of being employed for women: a 10% increase in BMI (that means an increase of 6 kilos for women with an average height) decreases by 0.34% the probability of being employed (Upper panel, column 1, first row).[36] The penalization seems to affect heavier women more than the others: women in the second top quintile do not significantly differ form women in the median range, while the probability of being employed decreases by 1% for women in the top quintile of the BMI distribution. The relationship has an opposite sign for men, where a bigger body size increases the probability of employment. In particular, a 10% increase in the individ-

[35]see Winship and Radbill (1994).

[36]It is worth to remind that when the independent variable X enters the regression in log-form, the interpretation of the results goes like this: a 1% change in X, changes the dependent variable Y by β%. In our case, if $\beta = 0.034$, a 1% increase in BMI changes the probability of being employed by 0.034% and therefore a 10% increase in BMI changes the probability of being employed by $(10 * 0.034)$%

ual BMI (that means an increase of 8 kilos for men with an average height) increases the probability of being occupied by 0.25%. Big deviations from the median range of BMI, however, seem not to pay off. Only men in the second top quintile have a significantly bigger probability of being occupied, while for men in the top quintile the coefficient is not significant. Given that muscles weigh more than fat, it is be possible that men classified as overweight have a high total mass of muscles. Their advantage in the labour market may be then stem from the positive health signal that the big size lead to the potential employer. Finally, being in the bottom quintile of the BMI distribution represents a penalty for men, whose probability of being employed is reduced.

Height is a positive determinant of the probability of being occupied: *coeteris paribus*, each centimetre above the average size increase this probability by 0.1%. To put it differently: having a height that is a standard deviation above the mean height, increase the probability of being occupied by 0.6% and 0.7% for women and men respectively.

Body size and obesity may have a different effect on the labour market status of young and old individuals. Therefore, separate regressions have been performed for individuals aged 18 to 39 years and for individuals aged 40 to 65 (Table 3.2, second and third row of each panel). None of the body size measures in the regression for women over 40 years has a significant coefficient, while the negative effect of body size on the probability of being employed is particularly strong in the youngest group. In particular, for clinically obese women under 40 the probability of being occupied is reduced by 4.4%, and for women in the top quintile of the distribution, this probability is reduced by 2.2%. Note that being in the top quintile of the BMI distribution does not necessarily mean an unhealthy BMI: in the youngest age group for

Table 3.2: Labour Market Status Equations. Marginal effects, probit estimation

Probability of being employed: women	**log BMI**	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**	**Obese**	**Over weight**	**Under weight**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Full sample	-0.034*	0.001*	-0.001*	-0.010*	-0.003	0.001	-0.013	-0.011*	0.004
18 - 39 years	-0.072*	0.002*	-0.001*	-0.022*	-0.009	-0.000	-0.044*	-0.034*	0.003
40 - 65 years	-0.003	0.000	- 0.000	0.000	0.003	0.003	0.001	0.001	0.007

Probability of being employed: men	**log BMI**	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**	**Obese**	**Over weight**	**Under weight**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Full sample	0.025*	0.001*	0.000	0.001	0.005*	-0.007*	0.004	0.006*	-0.006
18 - 39 years	0.032*	0.001*	0.000	0.002	0.010*	$-0.008^{\dagger}$	0.006	0.006	0.002
40 - 65 years	0.015	0.000	-0.000	- 0.001	0.001	-0.007*	0.003	0.004*	-0.047*

Significance levels : † : 10% ∗ : 5%

example (18 to 30 years) women with a BMI of 23.5 (that is, a BMI within the range of values considered healthy) belong already to the top quintile of the distribution.

Also young and old men are affected differently by body size in their labour status. In particular, the positive effect of a bigger body size is much smaller in the over 40s group: a 10% increase in the BMI increases the probability of being employed by 0.15% while for the youngest the increase is 0.32%. Also being in the top quintiles of the BMI distribution represents an advantage only for men in the 18-39 group. On the contrary, being thin is more penalized in the older group: for clinically underweight men over 40 years, the probability of being occupied is almost 5% lower. This result, however, may just be the outcome of the small number of observations in the cell: only 1.29% (329 observations) of men older than 40 years, in fact, are classified as clinically underweight.

When the analysis is restricted at the subgroup of the employees (Table 3.3), body size appears to be correlated with the professional position achieved in the profession only for men who are clinically overweight. The effect appears to be stronger for men in the older age group: the coefficient on log(BMI), in fact, is 0.038 while it is only 0.012 for men in the 18-39 age group. A bigger body size does not seem to affect women's probability to become an executive employee or a manager in a significant fashion. The sign of the coefficient is however negative, pointing out at a penalization in the career suffered by broader women.

The results obtained in this section reveal a positive correlation of body size and labour market outcomes for men and a negative one for women. For men the advantages deriving from body size are only limited to small, upper

Table 3.3: Professional position: probit estimates, marginal effects

Probability of being a manager or an executive employee: women									
	log BMI (1)	**Height** (2)	**Weight** (3)	**Top quintile** (4)	**Second top quintile** (5)	**Bottom quintile** (6)	**Obese** (7)	**Over weight** (8)	**Under weight** (9)
Full sample	-0.006	0.001*	-0.000	0.001	0.003	0.006	-0.004	-0.002	-0.005
18 - 39 years	0.006	0.000	0.000	0.003	0.002	0.001	0.009	-0.007	-0.003
40 - 65 years	-0.019	0.001†	- 0.000	-0.002	0.006	0.011†	-0.007	0.002	-0.004
Probability of being being a manager or an executive employee: men									
	log BMI (1)	**Height** (2)	**Weight** (3)	**Top quintile** (4)	**Second top quintile** (5)	**Bottom quintile** (6)	**Obese** (7)	**Over weight** (8)	**Under weight** (9)
Full sample	0.022*	0.000	0.000	0.002	0.004	-0.003	0.007	0.004*	0.011
18 - 39 years	0.012	0.000	0.000	0.002	0.001	-0.001	0.004	0.003	0.004
40 - 65 years	0.038*	0.001†	0.003	0.008	-0.007	-0.007	0.012	0.007	-0.043

Significance levels : † : 10% ∗ : 5%

deviations from the average. While being heavier represents a penalty for women who are searching for a job, being particularly thin is not an advantage either. For both sexes, the effects of the body size on the probability of being occupied are stronger in the youngest group rather than in the older. Once employed, however, body size does not appear to be a matter of concern any more, playing no role in the probability of reaching managerial positions.

As already pointed above, however, the results are likely to be biased because of endogeneity and cannot be interpreted causally. The next section offers a possible correction for the mentioned problem based on the instrumental variable technique.

3.5 Instrumental variable approach

3.5.1 The instruments

There are several reasons to believe that body size is an endogenous regressor: labour market outcomes can itself affect body size, or unobserved factors such as individual time preferences may affect both body size and labour market outcomes. Furthermore, measurement errors in the BMI variable due to systematic misreporting of height or weight represent an additional source of bias.

To cope with this problem, an instrumental variable regression approach is applied. The set of instruments used in this paper includes variables that capture attitudes towards food, smoke and physical activity of the peers of the respondent, that is of people with whom the respondent may relate and compare himself. More specifically, the instruments are the percentages by sex, age class and region of residence of the respondent, of non-smokers, of alcohol drinkers (individuals that drink more than half liter of beer or wine per day and individuals who are used to drink alcohol outside of meals), of people that consume no fruit or vegetables, of people that use to do some physical activity and the average number of hours daily spent watching TV.

The first requirement that an instrument has to fulfil to be valid, is that it is correlated with the endogenous measure of body size, conditional on the other variables that may affect occupational attainments. It is well known that the main risk factors for obesity are an incorrect nutrition (with an excessive intake of high- fat, high-calorie foods and a limited consumption of high-fiber, low-calorie foods) and physical inactivity (NHLBI (1998)). Smoking is another factor that affects individual's weight. Although the direction of the relationship is still a matter of debate,[37] the fact that smoke and eating habits are correlated (with smokers generally consuming less fruit and vegetables or less high fiber grains) it is widely accepted.[38] While individual preferences are ultimately driving these behaviours, environmental influences affect also individual attitudes to smoke, food intake and exercise becoming, in the end, another determinant of obesity (James (1995)). The selected instruments, therefore, are expected to be non-weak predictor of individual body size conditional on the other covariates, inasmuch as they provide a measure of obesity-affecting environmental influences. A simple way to test the strength of the instrument is to regress the endogenous variable on all the other covariates plus the instruments and to run than a F-test for the significance of the instruments coefficients. Staiger and Stock (1997) sug-

[37]While an extensive medical literature supports the idea that smoking facilitates weight control (see U.S. Department for Health (1990) for a review of the medical studies), recent studies question the negative relationship between BMI and smoking (see Gruber and Frakes (2006)).

[38]See for example Subar et al. (1990))

gested the rule of thumb that, in the case of a single endogenous regressor, instruments be deemed weak if the F-statistic is less than 10. With the only exception of the indicator for being clinically obese as a measure of body size, the F-statistic exceeds this minimum value both for men and women, suggesting that the selected instruments are significant predictors of the body size (Table 3.4).

Table 3.4: Validity of the instruments

	Log(BMI)		**Weight**		**Top quintile**		**Clinically obese**	
	Women	Men	Women	Men	Women	Men	Women	Men
F-test	13.99	11.38	13.09	10.16	10.01	11.63	2.34	3.19

The second requirement of an instrument is that it is not correlated with the error term in the occupational attainment regression. If there are unobserved factors that affect both individual's occupational attainment and some of the instruments, the IV estimation is then inconsistent. More specifically, given that the selected instruments are measures based on the area where the respondent is living, the correlation with the occupational attainment may arise if the choice of the location of residence is itself guided by the same factors (such as ability or time preferences) that determine also labour market outcomes. If that is the case, we would expect that people with lower time discount rates that may also have better labour market outcomes, move to regions where maybe it is easier to get fresh and healthy food or where it is easier to exercise. Although that is still a possibility, data on mobility within Italy show that the great majority of moving is within the region of previous residence.[39] In other words, Italians do not move too much within the country. They rather prefer to settle in the same region (and very often also in the same province) where they were born and where most of their

[39]In the year 2001, for example, out of the 1,133,006 changes of residence, more than 70% was within the same region. See ISTAT (2006), Tab. 2.4 pg. 36.

relatives are still living. Moving to other regions is mostly driven by job opportunities rather than by the desire of living healthier, so it is really unlikely that the choice of the location of residence is endogenous in the labour outcomes equation.

3.5.2 Instrumental variables with binary dependent variables

In linear models, the standard solution to the endogeneity bias is an estimator such as two-stage least squares (2SLS). Two great advantages of linear 2SLS estimation are its numerical simplicity and the fact that it does not require explicit modelling of the endogenous regressor. All that is needed are valid (in the sense explained in the previous section) instruments, no matter if the endogenous regressor is discrete, limited or truncated. Unfortunately, unless we are willing to use a liner probability model (LPM), 2SLS is inconsistent for most limited dependent models.

The LPM cannot be a good description of the population response probability, because the predicted probability can be outside the unit interval. However, LPM offers very often a convenient approximation to the underlying response probability for common values of the covariates. For this reason, we start estimating a LPM using 2SLS; given that the selected instruments appear to be weak when the indicators for being clinically obese are used, the LPM has been estimated without these measures.

Generally speaking, the IV results reveal a stronger effect of BMI on occupation. In particular, three interesting outcomes emerge: *i)* the increase in the estimated effect in both groups, *ii)* the change in the direction of the effect of body size for men (from positive in the regression without taking into account endogeneity to negative), and *iii)* the fact that in the full sample BMI has a stronger negative effect for men than for women.

Table 3.5: Labour market status equation: linear probability model with instrumental variables

	Log (BMI) (1)	**Height** (2)	**Weight** (3)	**Top quintile** (4)	**Second top quintile** (5)	**Bottom quintile** (6)
Probability of being employed: women						
Full sample	-0.192	0.008†	-0.001	2.155†	-1.835*	0.739
18−39 years	-1.274*	0.021*	-0.020*	0.750†	-1.494*	-0.171
40−65 years	-0.403†	0.019*	-0.006	0.435*	-0.151	0.375†
Probability of being employed: men						
	Log (BMI) (1)	**Height** (2)	**Weight** (3)	**Top quintile** (4)	**Second top quintile** (5)	**Bottom quintile** (6)
Full sample	-2.383*	0.053*	-0.019*	2.834*	.1911	2.944*
18−39 years	-1.898*	0.068*	-0.019*	0.863	-1.193	0.427
40−65 years	-0.844*	0.021*	0.002	1.275	-0.203	0.681

Continued on next page...

... table 3.5 continued

Significance levels : † : 10% $*$: 5%

*Exogenous Regressors:*age, age squared, number of household members, years of completed studies, number of children aged 0 to 5 years, number of children aged 6 to 13 years, marital status, residence in Southern Italy, interview year, presence of the interviewer, health satisfaction, number of chronic illness, number of nights spent in the hospital in the last three months.

Instruments:(all the percentages have to be considered by age class, sex and region of residence): percentage of individuals who eat fruit only some time per week or less, percentage of individuals who eat vegetables only some time per week or less, percentage of individuals who eat leaf vegetables only some time per week or less, percentage of non-smokers, percentage of individuals who drink more than half litre of beer or wine per day, percentage of individuals that use to drink alcohol outside the main meals, percentage of individuals practising regularly some physical activity, average number of hours spent daily watching TV.

According to the IV estimates, a 10% increase in the BMI reduce by 2% the probability of being occupied for women (although the coefficient is not significant), while for men this probability is reduced by almost 24%. In accordance with other studies that find a positive correlation between height and labour success especially for men,[40] height appears to affect positively the probability to be occupied: one centimetre more, increase the probability of being employed by almost 1% for women and 5% for men. The effect is stronger in the youngest group: each centimetre more than the average height, leads to an increase in the probability of being employed by 2.1% for women and 7% for men. The results obtained using indicators for the relative

[40] Hübler (2006), Heineck (2005), Judge and Cable (2004).

position in the BMI distribution are controversial, pointing at a U-shaped relationship between occupational status and BMI: being at the extremes of the BMI distribution has a positive effect on the probability of being occupied (although for women the coefficients are not significant), while being in the second top quintile reduces this probability.

Table 3.6: Professional position:linear probability model with instrumental variables

	Log (BMI)	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**
	(1)	(2)	(3)	(4)	(5)	(6)
Probability of being in managerial positions: women						
Full sample	-0.461*	-0.006	-0.009*	0.161	0.475	0.739
18−39 years	-0.119	0.009	-0.002	-0.106	0.091	0.033
40−65 years	-0.372	-0.020†	-0.007	-0.776*	0.150	-0.457
Probability of being in managerial positions: men						
	Log (BMI)	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**
	(1)	(2)	(3)	(4)	(5)	(6)
Full sample	-0.184	0.004	-0.001	0.045	0.698†	0.334
18−39 years	-0.122	0.019†	-0.001	-0.088	0.682†	0.146

Continued on next page...

... table 3.6 continued

40−65 years	-0.465	0.003	-0.008	0.329	-0.121	0.159

Significance levels : † : 10% ∗ : 5%

*Exogenous Regressors:*age, age squared, number of household members, years of completed studies, number of children aged 0 to 5 years, number of children aged 6 to 13 years, marital status, residence in Southern Italy, interview year, presence of the interviewer, health satisfaction, number of chronic illness, number of nights spent in the hospital in the last three months.

Instruments:(all the percentages have to be considered by age class, sex and region of residence): percentage of individuals who eat fruit only some time per week or less, percentage of individuals who eat vegetables only some time per week or less, percentage of individuals who eat leaf vegetables only some time per week or less, percentage of non-smokers, percentage of individuals who drink more than half litre of beer or wine per day, percentage of individuals that use to drink alcohol outside the main meals, percentage of individuals practising regularly some physical activity, average number of hours spent daily watching TV.

The relation between body size and professional position appear to be only slightly significant also after correcting for endogeneity. For both men and women the magnitude of the estimated effects is bigger using a LPM with instrumental variables. However, only the coefficients on log(BMI) and weight for the whole sample of women, and the coefficient on being in the top quintile of the BMI distribution for women over 40's are significant at conventional levels. In comparison with the simple probit estimates, the sign of the coefficients on log(BMI) reverts for men, from positive to negative; none of the coefficients, however, is significant at the standard 5% level.

Aside from the issue of predicted probabilities being negative or greater than one, the LPM implies that a *coeteris paribus* unit increase in the covariate x_j always change the probability by the same amount, regardless of the initial value of x_j . For this reason a probit model is more accurate and, therefore, preferable.

In order to estimate a probit correcting for endogeneity,however, we need to make some fairly strong assumption.

We can write the model as:[41]

$$
\begin{aligned}
y_1^s &= \mathbf{z_1}\boldsymbol{\delta_1} + \alpha_1 y_2 + u_1 &\quad (3.1)\\
y_2 &= \mathbf{z_1}\boldsymbol{\delta_{21}} + \mathbf{z_2}\boldsymbol{\delta_{22}} + v_2 = \mathbf{z}\boldsymbol{\delta_2} + v_2 &\quad (3.2)\\
y_1 &= I[y_1^s > 0] &\quad (3.3)
\end{aligned}
$$

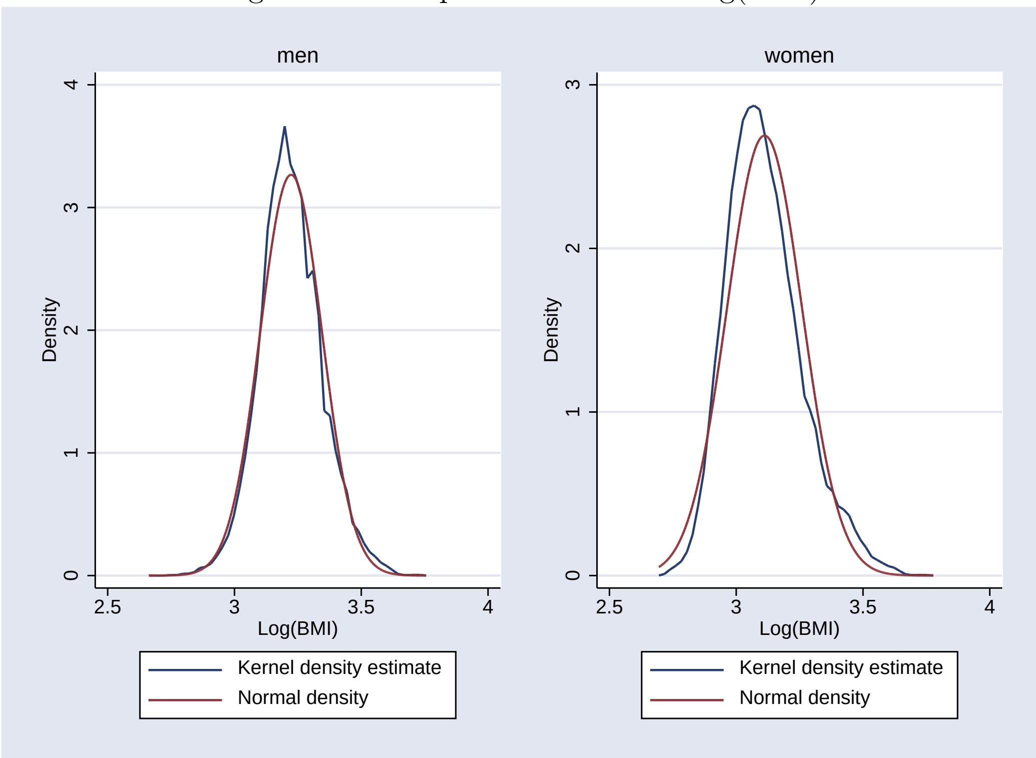
What is observable is variable y_1 that assumes value 1 when the underlying latent variable y_1^s, that depends on a set of regressors $\mathbf{z_1}$ and on the endogenous variable y_2, is greater than 0. Equation 3.3 represent a reduced form for y_2 regressor, which is supposed to be a linear function of the exogenous regressors in equation 3.2 and of some other regressors $\mathbf{z_2}$. The endogeneity problem arises if the error terms u_1 and v_2 are correlated.

Assuming that the vector of disturbances of equations 3.2 and 3.3 is independent of z, has zero mean and has a bivariate normal distribution, efficient estimators of the parameters of the structural equation 3.2 can be derived. The normality assumption limits the types of endogenous regressors that can be considered. In particular, because v_2 is supposed to be normally

[41]The notation used is the same as in Wooldridge (2003), pag. 472

distributed, we are assuming that y_2 given z is normal; thus y_2 should have features of a normal random variable and cannot be, for example, a discrete one. For this reason, we focus on log BMI as a measure of body-size. As shown in illustration 3.1, in fact, the estimated distribution of this variable is fairly normal.

Figure 3.1: Sample distribution of log(BMI)



Given these assumption, we apply Newey's two-step procedure (N2SP) to obtain the coefficient estimates. The procedure consists in: *i)* estimating the reduced form parameters using a least squares estimator and then *ii)* solving for the structural parameters by applying the Amemiya's generalized least squares estimator.[42]

[42]Amemiya (1978) presents the AGLS estimator. For a summary of how AGLS works see Maddala (1983). The two-step estimator used here is presented in Newey (1987). All

Table 3.7: Probability of being occupied: IV estimates. Marginal effects of log(BMI)

	Women	**Men**
Full sample	-0.553*(0.181)	-1.218*(0.225)
N	26,382	39,658
Pseudo R^2	0.33	0.26
18−39 years	-1.233*(0.386)	-1.124*(0.277)
N	15,608	20,980
Pseudo R^2	0.34	0.28
40−65 years	-0.284†(0.158)	-0.673*(0.279)
N	10,774	18,678
Pseudo R^2	0.17	0.16

Significance levels : † : 10% ∗ : 5%

*Exogenous Regressors:*age, age squared, number of household members, years of completed studies, number of children aged 0 to 5 years, number of children aged 6 to 13 years, marital status, residence in Southern Italy, interview year, presence of the interviewer, health satisfaction, number of chronic illness, number of nights spent in the hospital in the last three months.

Instruments:(all the percentages have to be considered by age class, sex and region of residence): percentage of individuals who eat fruit only some time per week or less, percentage of individuals who eat vegetables only some time per week or less, percentage of individuals who eat leaf vegetables only some time per week or less, percentage of non-smokers, percentage of individuals who drink more than half litre of beer or wine per day, percentage of individuals that use to drink alcohol outside the main meals, percentage of individuals practising regularly some physical activity, average number of hours spent daily watching TV.

---

the estimates are obtained using the command ivprob written by J. Harkness in Stata 8.0.

In comparison with the results obtained using a LPM, the estimated marginal effects are smaller for men and for the two subsample of young and old women. The bigger penalty deriving from body size suffered by men in comparison with women is confirmed also using the N2SP, although the difference is not so big as in the LPM estimate. The separate analysis of the effect in the two subsamples of young and old individuals reveals that while the negative effect of BMI on occupation is stronger for men than for women in the over 40's group, in the youngest subsample women are slightly more penalized than men. The estimated effect in the older group is much smaller: a 10% increase in individual BMI leads to a reduction in the probability of being occupied by 3% and 7% for women and men respectively. However, while in the simple probit regression (table 3.2) the coefficients on body-size for this group were not significant, in the IV regression the negative effect of BMI appears to be significant.

Table 3.8: Probability of being occupied: IV estimates. Marginal effects of log(BMI)

	Women	**Men**
Full sample	-0.318*(0.157)	-0.114 (0.178)
N	19,592	27,220
Pseudo R^2	0.24	0.34
18−39 years	-0.012 (0.194)	0.013 (0.142)
N	11,286	14,669
Pseudo R^2	0.20	0.27

Continued on next page...

... table 3.8 continued

40−65 years	-0.290 (0.243)	-0.549 (0.457)
N	8,216	12,551
Pseudo R^2	0.28	0.35

Significance levels : † : 10% ∗ : 5%

*Exogenous Regressors:*age, age squared, number of household members, years of completed studies, number of children aged 0 to 5 years, number of children aged 6 to 13 years, marital status, residence in Southern Italy, interview year, presence of the interviewer, health satisfaction, number of chronic illness, number of nights spent in the hospital in the last three months.

Instruments:(all the percentages have to be considered by age class, sex and region of residence): percentage of individuals who eat fruit only some time per week or less, percentage of individuals who eat vegetables only some time per week or less, percentage of individuals who eat leaf vegetables only some time per week or less, percentage of non-smokers, percentage of individuals who drink more than half litre of beer or wine per day, percentage of individuals that use to drink alcohol outside the main meals, percentage of individuals practising regularly some physical activity, average number of hours spent daily watching TV.

Concerning the relationship between BMI and professional position, N2SP leads generally to smaller effects than the LPM. Only the coefficient for women is however significant: when the relation is investigated in the two subgroups of young and old individual, none of the estimated effects is significantly different from zero. This result confirms the hypothesis that the significant reduction in the probability of being occupied suffered by heavier workers can be the outcome of pure employer discrimination. In the first stage of the selection of the candidate, employers may erroneously attach to body size productivity related characteristic, preferring a normal size individual. However, once the heavier worker is employed, the employer can observe worker's productivity and in decisions concerning career advancements, physical characteristics play a smaller role.

Table 3.9: Test for endogeneity: Rivers and Vuong procedure

Dependent variable: probability of being employed								
	Log(BMI)		**Weight**		**Top quintile**		**Clinically obese**	
	Women	Men	Women	Men	Women	Men	Women	Men
Residual	4.16*	12.67*	0.06*	0.16*	-1.51*	-0.75	-5.12*	2.99†
(st. er.)	(1.35)	(1.81)	(0.02)	(0.02)	(0.52)	(0.49)	(2.07)	(1.53)
R^2	0.33	0.26	0.33	0.26	0.33	0.26	0.33	0.26
Dependent variable: probability of being a manager								
	Log(BMI)		**Weight**		**Top quintile**		**Clinically obese**	
	Women	Men	Women	Men	Women	Men	Women	Men
Residual	2.08	3.09	0.04	0.04	1.22†	-0.67	7.07*	3.50†
(st. er.)	(1.58)	(2.16)	(0.03)	(0.03)	(0.66)	(0.66)	(2.51)	(1.80)
R^2	0.22	0.29	0.22	0.29	0.22	0.29	0.22	0.29

Significance levels : † : 10% ∗ : 5%

To test for the endogeneity of the body size measures, the two-step approach suggested by Rivers and Vuong (1998) is used. The procedure consists in first estimating equation 3.3 running an OLS regression of the endogenous regressor y_2 on all the covariates plus the instruments. The second step consists in adding the residuals $\hat{v}_2$ from the OLS regression in the probit regression of the dependent variable on all the covariates plus the endogenous regressor. A significant coefficient $\theta_{\hat{v}_2}$ on the residuals in the probit regression indicates that endogeneity exists.

Rivers and Vuong 2 step procedure

1. step:	OLS regression	$y_2 = \mathbf{z_1}\delta_{\mathbf{21}} + \mathbf{z_2}\delta_{\mathbf{22}} + v_2$	$\Rightarrow$	residuals $\hat{v}_2$
2. step:	Probit regression	$P(y_1 = 1 \vert \mathbf{z_1}, y_2, \hat{v}_2)$	$\Rightarrow$	t statistic on $\hat{v}_2$
	if	$\theta_{\hat{v}_2} \neq 0$	$\Rightarrow$	y_2 is endogenous

As results in table 3.9 indicate, log BMI appears to be an endogenous regressor in both the regressions for males and females, while the indicator for being in the top quintile of the BMI distribution is an endogenous regressor only in the women subgroup. These results implies that the estimates obtained using log BMI without taking into account endogeneity are inconsistent and biased, while using the indicator for being in the top quintile leads to biased estimates only in the women sub sample; in the male sub sample, on the contrary, estimates without correction for endogeneity should be preferred as they are more efficient.

When the dependent variable is the probability of being in managerial positions, the test Rivers and Vuong procedure does not identify any endogeneity problem with respect to body size measures, with the only exception of the indicator of clinical obesity. This finding suggest that, when investigating the relationship between obesity and professional position, simple probit estimates should be generally preferred.

The results are somehow surprising: in contrast with findings in most of the literature (Cawley (2004), Conley and Glauber (2005), Greve (2006), Morris (2006)) a negative relation between body size and labour outcomes is neither confined to severe obese individuals, nor to women alone. Also for men, in fact, even a relatively modest increase in body size leads to a substantial reduction in the probability of being occupied. Similar results were recently derived also in Fahr (2006).

The results in this study show furthermore that endogeneity leads to an attenuation bias in the estimates if the problem is not correctly handled. Not correcting for endogeneity or choosing the wrong tools to deal with it may lead to misleading results that underestimate the degree of discrimination that workers encounter in the labour market because of their body size.

3.6 Robustness check

This section extends the analysis of section 3.4 using, instead of a simple probit, a multinomial logit approach with three outcomes: employed, self-employed and unemployed. This model has the advantage of better capturing discrimination in the hiring process. If discrimination exists, in fact, heavier workers are not only more likely to be unemployed, but also more confined in self-employment jobs. A specification of the type occupied vs. unemployed does not allow to fully capture the effects of discrimination. Unfortunately, it is not easy to treat endogeneity in a multinomial setting, and we are not going to deal with this problem. The results presented here, therefore, are not conclusive but simply indicative.

Table 3.10 and table 3.11 report the results of the estimation of multinomial logit models for women and men respectively. Results are reported in terms of Relative Risk Ratios (RRRs) between the probability to work as a self-employed (upper panel of the tables) or being unemployed (lower panel of the tables) with respect to the probability of being an employee. The RRRs are the exponential of the coefficients of the multinomial logit regressions, and they have a straightforward interpretation: for a unit increase in the variable keeping all the other covariates constant, they show the change in the relative risk for the outcome of interest (being self-employed or being unemployed) in comparison with the base category (being an employee). So, for example, the weight coefficient 1.009 for women on table 3.10, lower panel, first row, third column, tells that for a unit increase in the weight, the probability of being unemployed rather than an employee increases by 0.9%. Roughly speaking, a coefficient greater than (smaller than) one indicates that the variable in question increases (decreases) the probability of being in the considered outcome rather then in the base value.

For women, body size seems to have no significant effect on the probability of being self-employed, while it strongly affects the probability of being unemployed: women in the top quintile of the BMI distribution have a 17% higher probability of being unemployed, while for clinically obese women this probability is 25% higher. The risk of unemployment estimated using the logarithm of BMI as body size measure is particularly high in comparison with all the previous estimates (probit without correcting for endogeneity, LPM with IV and N2SP): a 10% increase in the BMI for women aged less than 40 years, for example, more than doubles the risk of being unemployed rather than an employee.

Men's labour market outcomes are affected by body size in a different manner. In contrast with the results for women, body size is not particularly significant in determining the relative risk of being unemployed. The few coefficients that are significant at a standard level reveal that thinness is a characteristic not rewarded in the male labour market, while a little upward deviation in the body size slightly decrease the relative risk of being unemployed. Considering the attenuation bias of the estimates without correcting for endogeneity, the weak (and positive) correlation between obe-

Table 3.10: Labour Market Status equation. Relative Risk Ratios for females

Probability of being self-employed vs. probability of being employee									
	log BMI	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**	**Obese**	**Over weight**	**Under weight**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Full sample	1.137	1.014*	1.003†	1.055	1.034	0.990	1.133	1.003	1.058
18 - 39 years	1.230	1.004	1.007	1.023	1.017	0.984	1.340*	0.992	1.050
40 - 65 years	1.730	1.021*	1.003	1.086	1.046	1.039	1.084	0.994	1.099
Probability of being unemployed vs. probability of being employee									
	log BMI	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**	**Obese**	**Over weight**	**Under weight**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Full sample	1.730*	0.987*	1.009*	1.174*	1.058	0.987	1.254†	1.197*	0.963
18 - 39 years	2.071*	0.983*	1.012*	1.231*	1.095	1.002	1.501	1.369*	0.991
40 - 65 years	1.116	0.995	1.002	1.023	0.093	0.936	1.008	0.955	0.800

Significance levels : † : 10% ∗ : 5%

Table 3.11: Labour Market Status equation. Relative Risk Ratios for males

Probability of being self-employed vs. probability of being employee									
	log BMI	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**	**Obese**	**Over weight**	**Under weight**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Full sample	2.227*	1.002c	1.010†	1.221*	1.061†	0.920*	1.346*	1.138*	0.780
18 - 39 years	2.631*	0.998	1.013	1.123*	1.107*	0.908†	1.440*	1.189*	0.894
40 - 65 years	1.957*	1.006†	1.009*	1.205*	1.016	0.939	1.312*	1.094*	0.800
Probability of being unemployed vs. probability of being employee									
	log BMI	**Height**	**Weight**	**Top quintile**	**Second top quintile**	**Bottom quintile**	**Obese**	**Over weight**	**Under weight**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Full sample	0.719†	0.993*	0.996	1.029	0.908†	1.124*	0.997	0.917*	1.087
18 - 39 years	0.766	0.990*	0.997	1.022	0.896	1.101	0.991	0.958	1.002
40 - 65 years	0.718	0.996	0.997	1.094	0.0983	1.197†	0.979	0.884	2.468*

Significance levels : † : 10% ∗ : 5%

sity and unemployment for men is not surprising. Apart from econometric reasons however, the relation can be also explained with the role that men traditionally have in the household. Given that men are usually the bread-winners, their incentive to exit the unemployment status is higher than for women, who can usually rely upon their male partner's income to live. In this respect, the fact that for men being in the top quintile of the distribution increases the risk of being self-employed by 20%(while for women in the top quintile the relationship is not significant) can be seen as a sign of discrimination: employers prefer normal size men, so bigger individuals to support their families turns to self-employment jobs.

Coherently with the results obtained in the previous sections, also the multinomial logit approach reveal a different effect of body size on labour market status in the two subgroups of young and old individuals. The effect of BMI and obesity, in fact, is generally for both men and women much stronger in the former group rather than in the latter: all in all, physical appearance is more relevant in determining labour market status in earlier stages of one's own career, while for individuals at the end of their working lives, other factors contribute more in explaining labour outcomes.

Overall and keeping in mind that the results may be biased due to endogeneity of the body size measure, we could interpret the estimated associations as a sign of discrimination against obese workers of both sexes, although the effect differs according to age and gender. Men below the age of 40 and women aged 40 years and more are the groups whose labour outcomes are more affected by a deviation from the median BMI.

For the subgroup of the employees, the association between obesity and professional position has been estimated. The AVQ questionnaire classifies the employees in 6 groups: home employee, apprentice, blue-collar, intermediate employee, executive employee and manager. For the current analysis, however, 3 broader categories have been created: blue-collars (including apprentices and home employee), intermediate employees and managers (including the executive employees). Table 3.12 gives an overview of the professional composition of the sample: the majority of women are intermediate employees, while the majority of men are blue-collars.

Table 3.12: Composition of the sample of employees by professional position

Profession	**Men**	**Women**
Home employee	0.42%	1.01%
Apprentice	1.33%	1.45%
Blue−collar	52.88%	33.01%
Intermediate employee	35.86%	56.10%
Executive employee	6.50%	5.38%
Manager	3.01%	3.04%

Given the intrinsically ordered nature of the classification, the values assigned to each outcome conveys useful information (an individual with outcome 3 "executive employee or manager" has a better outcome than somebody with outcome 1 "blue-collar worker") that can be used estimating an ordered logit model.[43]

Table 3.13 shows the predicted probabilities of each outcome (blue-collar, intermediated employee and manger) for individuals in the top and bottom

[43]The implicit assumption of an ordered logit model is that the relationship between each pair of outcomes is the same. In other words, the β that describe the relation between the probability of getting the outcome i in comparison with all the other outcomes, and the β that describe the relationship between the probability of getting the outcome $j \neq i$ and all the other outcomes, are supposed to be the same. This assumption (also known as *parallel lines* assumption) is often violated. Indeed, also the model used in this work failed the Brant test for the parallel lines assumption. However, the coefficients on the body size measures do not differs greatly across different outcomes. Furthermore, a generalized ordered logit model was calculated, leading to similar estimates. For simplicity, then, only the ordered logit estimates were reported.

Table 3.13: Ordered logit predicted probabilities

	Men		**Women**	
	Top quintile	*Not top quintile*	*Top quintile*	*Not top quintile*
Apprentice, Blue−collar	0.56	0.55	0.32	0.26
Intermediate employee	0.42	0.42	0.66	0.71
Executive emp./manager	0.02	0.02	0.02	0.03
	Bottom quintile	*Not bottom quintile*	*Top quintile*	*Not bottom quintile*
Apprentice, Blue−collar	0.56	0.55	0.25	0.28
Intermediate employee	0.42	0.42	0.72	0.69
Executive emp./manager	0.02	0.02	0.03	0.02

Relative position on BMI distribution as measure of body size

quintile of the BMI distribution in comparison with all the others. Body size hampers women more than men in their career. On the one hand side, setting all the other variables at their sample mean, the probability of being in the blue-collar category in comparison with the other categories is for women in the top quintile of the BMI distribution 8 percent point higher than for all the other women, while their probability of being intermediate employees is 5 percent point lower.[44] On the other side, women in the bottom quintile of the distribution have a relatively higher probability of being managers or intermediate employees and a lower probability of being blue-collar workers.

[44]The probability of being a blue-collar worker is 26% for women not in the top quintile of the BMI distribution while is 32% for women in the top quintile (table 3.13 right-upper panel, first row): the probability of being blue-collar workers is therefore $26 - 32 = 8\%$ higher. At the same time, the probability of being an intermediate employee is 66% for women in the top quintile and 71% for all the other women: for bigger women, therefore, the probability of being intermediate employees is $71 - 66 = 5\%$ lower.

On the contrary, the predicted probabilities for men do not show any significant difference, neither when men in the top quintile are compared with the others, nor when the comparison is between men in the bottom quintile and all the others. The results are quite similar when the logarithm of BMI is used as measure of body size.

Illustration 3.2 plots the predicted probabilities for women (top panel) and men (lower panel) of being in each of the 3 outcomes for discrete increments of log(BMI).[45] While for women the probability of being in the better outcomes (intermediate employee and manager) decreases and the probability of being a blue collar increases as the logarithm of BMI increases, for men no change in the predicted probabilities can be appreciated.

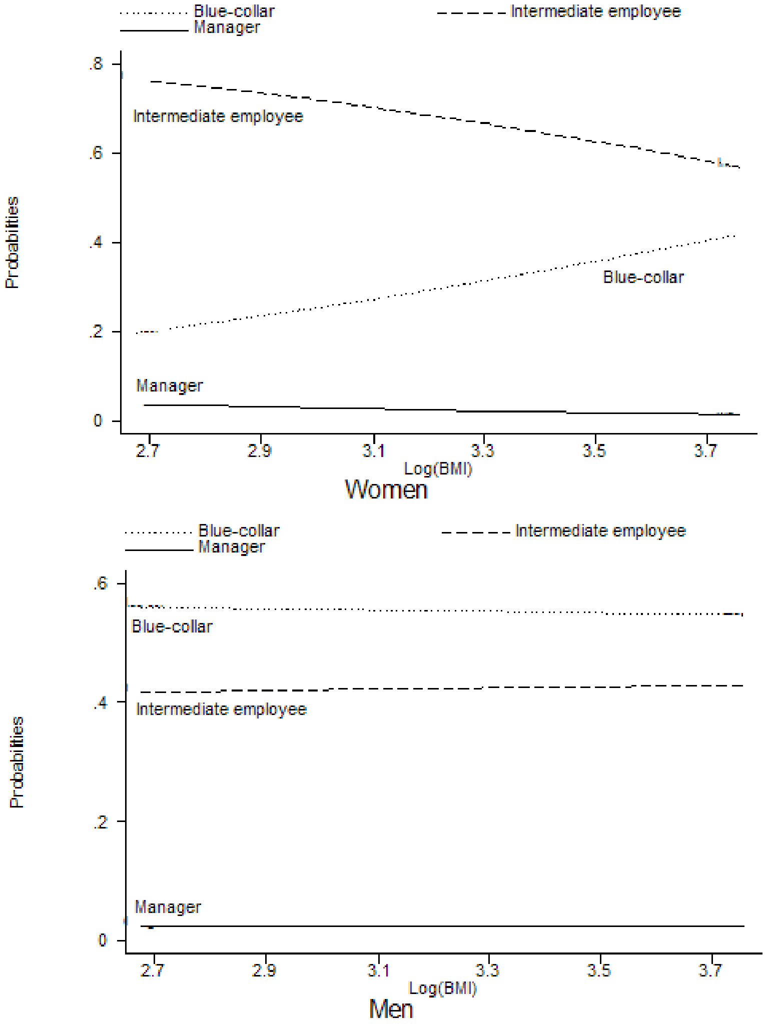
3.7 Concluding remarks

In this study, using a survey that investigates several aspects of households' habits, the relationship between body size and labour market status in Italy has been investigated.

The contribution to the growing body of literature on this issue is twofold: from a geographical point of view, this work investigates Italy, a country up to now almost neglected. The analysis of this country, characterized by labour market rigidities, a low average BMI and a fast increase in the incidence of obesity, helps in better understanding the effect of social norms

[45] The predicted probabilities have been estimated using a ordered logit model, controlling also for age, age squared, number of children aged 0 to 5 years, number of children aged 6 to 13 years, number of household members, marital status, number of years of studying, self-reported health status, number of nights spent in the hospital in the last 3 months, number of chronic diseases suffered, residence in the South of Italy, presence of the interviewer, year dummies, economic sector of activity. All the covariates are set at their sample means.

Figure 3.2: Ordered logit predicted probabilities(BMI)



and discrimination in an institutional setting very different from the Anglo-Saxon one, widely covered by the existing literature. From a methodological point of view, this paper proposes a new set of instruments to deal with the endogeneity problem. The set include variables that capture attitudes towards food, smoking and physical activity of the peers of the respondent, that is of people with whom the respondent may relate and compare himself. The instruments are found to be non-weak predictor of body size measures and are plausibly not themselves endogenous with labour market outcomes.

Controlling for a broad set of individual covariates, probit regressions, without controlling for endogeneity of the body size measure, highlight a negative relation between body size and probability of being employed for women and a positive one for men. After correcting for endogeneity, however, the relationship appears to be significantly negative for both men and women. In contrast with most of the existing literature, the results highlight the presence of discrimination against heavy workers irrespectively of their sex. We estimate also the model using a multinomial logit with three outcomes: employee, self-employed and unemployed. The multinomial logit results partially confirm the presence of discrimination also against men. The fact that heavier male workers tend to be more segregated in self-employment jobs, in fact, may be interpreted as the outcome of employers discrimination in the hiring process. Using a Rivers and Vuong two step procedure, we identify endogeneity with respect to body size measures when the occupational status is analyzed: considering body size as an exogenous regressor, then, leads to inconsistent estimates and IV estimates should be preferred. This study shows then that endogeneity leads to an attenuation bias in the estimates if the problem is not correctly handled. Not correcting for endogeneity or choosing the wrong tools to deal with it may conduct to misleading results that underestimate the degree of discrimination that workers encounter on the labour market because of their body size.

The relationship between body size and professional position in the subgroup of the employees appears to be not statistically significant for females, while for men it is significant only when the logarithm of the BMI is chosen as a measure of body size. Also IV coefficients are generally not significant. However, the Rivers and Vuong two steps procedure does not identify any endogeneity. In this case, the probit estimates should be preferred as they are more efficient.

A possible explanation for these results is that physical appearance works for employers as an imperfect signal of productivity. Obesity is usually related with lower health status and thus with lower productivity, although not all the obese individuals are unhealthy. The employer do not have full information concerning the productivity of the individual and, as a body size bigger than average convey the signal that the worker is less productive, she may choose to hire a normal-size individual rather than a bigger one. However, when decisions concerning career advancements of employees have to be taken, the employer has the opportunity to observe workers' productivity and she has not to rely any more upon imperfect signals (such as physical appearance). That is why body size plays no role in determining the probability of reaching top professional positions.

3.A Appendix

3.A.1 Correction for misreporting in height and weight

This section proposes a possible correction for the misreporting of the anthropometric variables (height and weight) used to measure body size.

A correction suggested in the literature consists in predicting the "true" values for height and weight using information on the relationship between true and reported values in a subsample of individuals that were actually measured. Separately by sex and gender, the true measures are regressed on the reported ones and the obtained coefficients are used to correct height and weight of the individuals for whom only the reported measured are known.[46]

As already highlighted in section 1.2, the survey used does not allow to correct for the measurement error, as there is not a sub sample of individuals that were measured and with whom correct the other measures. A different strategy, therefore, is applied in this work. A study by Danubio et al. (2006) conducted on a sample Italian adults aged 18 to 36 years old, finds that on average men overreport height by 1.2% and underreport weight by 1.9%, while women overreport their height by 1.8% and underreport their weight by 3%. Height and weight of the individuals in this sample have been corrected using this information on the average bias.[47] Table 3.14 reports the probit estimated with and without correction. Given that the sample analised by Danubio et al. (2006) consists of young individuals and that the extent of misreporting increases with age, the analysis has been restricted only to the subgroup of young individuals (aged 18 to 39).[48]

[46]see Cawley (2004), Bound et al. (2002) Lee and Sepanski (1995)

[47]Greve (2006) applies a similar strategy for Denmark.

[48]The results are similar if the correction is applied to the whole sample of individuals.

Table 3.14: Probit estimates with and without correction for misreporting the anthropometric measures

Probability of being employed				
	Without correction		With correction	
Body size measure	*Men*	*Women*	*Men*	*Women*
Log(BMI)	0.032	- 0.072	0.032	-0.072
Height	0.001	0.002	0.001	0.002
Weight	0.000	-0.001	0.000	-0.001
Top quintile	0.002	-0.022	0.002	-0.022
Second top quintile	0.020	-0.009	0.010	-0.009
Bottom quintile	-0.008	0.000	-0.008	0.000
Obese	0.006	-0.044	0.011	-0.036
Overweight	0.006	-0.034	0.008	-0.019
Underweight	0.002	0.003	0.010	-0.002
Probability of being a manager				
Log(BMI)	0.012	0.006	0.012	0.006
Height	0.000	0.001	0.000	0.001
Weight	0.000	0.000	0.000	0.000
Top quintile	0.002	0.003	0.002	0.003
Second top quintile	0.001	0.002	0.001	0.002
Bottom quintile	- 0.001	0.001	-0.000	0.001
Obese	0.004	0.009	0.004	0.014
Overweight	0.003	-0.007	0.001	-0.000
Underweight	0.004	-0.003	0.009	-0.008

No major differences emerge after correcting for misreporting. The biggest discrepancies emerge when the clinical definition of obesity, overweight and underweight are used as measures of body size. Once correcting for misreporting, the positive effect of overweight and obesity on the probability of being employed is even bigger for men, while the estimated negative effect for women is reduced.As already highlighted in other studies, systematic errors in reporting anthropometric measures do not affect in a sensible fashion the results and can be, therefore, disregarded.[49]

[49] See for example Lakdawalla and Philippson (2002), Greve (2006)

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Eidesstattliche Versicherung

Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebene Anregungen sind als solche kenntlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

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