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Consumer prices and wages in Germany, 1500 - 1850

Ulrich Pfister [†]

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[†] Department of Economics, University of Münster, Germany

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Ulrich Pfister
Westfälische Wilhelms-Universität Münster
Historisches Seminar
Domplatz 20–22
D-48143 Münster
email pfister@uni-muenster.de
phone +49 251 832 43 17

Abstract

The paper develops a consumer price index and two real wages series for Germany c. 1500–1850. Consumer price indices (CPI) based on eleven goods can be developed for ten towns; one of the two real wage series includes another six towns. Since German bullion markets were little integrated far into the early modern period it is difficult to establish a reliable national CPI. Preference should therefore be given to wage series that can be deflated by local CPIs. The analysis of the aggregate real wage series produces the following insights: First, there was a strong negative feedback between population and the real wage until the middle of the seventeenth century. While the Thirty Years War benefited the material welfare of the survivors through a huge decline in population size, the real wage was probably lower than extrapolated on the basis of the labour productivity schedule, suggesting a net loss in welfare. Second, the relationship between the real wage and population size was much weaker in the eighteenth than in the sixteenth century, which points to a continuous growth of labour productivity. Third, already between the 1810s and 1820s the Malthusian relationship between the real wage and population size prevailing in the eighteenth century was broken. The reasons for this structural rupture remain obscure and require further study.

Introduction

In the course of the nineteenth century Germany emerged as a leading industrial nation, and during the preceding era the Holy Empire, though fragmented, constituted the largest political community in the western part of the European continent. Yet, the level and development of material welfare during early industrialisation and the centuries preceding it remain little studied. The present investigation contributes to our knowledge of this field by constructing two time series of the real wage of unskilled urban workers, mostly in the building sector. The usual method would be to collect information on nominal wages, which are then deflated by a national consumer price index. This approach, however, is problematic on the grounds that until the middle decades of the nineteenth century Germany was characterized by weak market integration. In general terms, her territory was split up between two contrasting macro-regions of Europe, namely, a maritime north-west characterised by an advanced level of market integration and, correspondingly, favourable welfare conditions, and an inland area where market integration was limited so that prices tended to follow local climatic conditions and real incomes remained on a lower level (Acemoglu et al. 2005; Studer 2009). At the same time, population density was higher in the southwest than in the northeast (Ch. Pfister 1994: 16–7), which under a given agricultural technology would produce high prices for land-intensive goods and lower wages in comparison with the north and northeast.

On this background, I develop two variants of a national real wage series. First, I construct separate real wage series for ten towns with sufficient information on local consumer prices, which are then combined into a single national real wage index. As a second variant I consider additional wage information from six towns for which no or insufficient data on consumer prices exist. With the whole data set I compute a real wage index based on the deflation of silver wages for individual towns with a national consumer price index. It turns out that the two approaches yield largely consistent results.

Beyond a mere description of the long-term evolution of material welfare the paper develops a partial analysis of the aggregate production function of the German economy in the long run by relating the real wage to population size, which approaches the marginal product of labour schedule. This leads to the identification of three consecutive patterns of economic development: In a first phase dating from c. 1500 to 1650 there was a strong negative relationship between population growth and the real wage, suggesting a static technology and a steeply falling marginal product of labour. During a second phase from c. 1650 to 1800 the negative relationship between population growth and the real wage still existed but was much weaker. This may have been due either to a gradual increase of labour productivity and/or a change in demographic adjustment to changes in the real wage. Finally, the negative relationship between population and the real wage disappeared from c. 1820, implying a final break with a Malthusian regime a couple of decades before the advent of industrialization.

The study is organized as follows: The first section discusses individual price series and constructs town specific consumer price indices as well as a synthetic national price index. The second section develops the two variants of the real wage series. There follows the description and interpretation of the evolution of the real wage over time. The conclusion provides a summary of the results.

Prices and consumer price index (CPI)

The methodology and part of the data used for constructing town specific CPIs are from Allen (2001), who has carried out the first comprehensive analysis of the material assembled by the International Committee on Price History during the 1930s. For Germany, this refers in particular to the work by Elsas (1936–1949). Several collections of price series published more recently, particularly those by Gerhard and others (Gerhard and Engel 2006; Gerhard and Kaufhold 1990, 2001), are used to extend this database, particularly for the late eighteenth and early nineteenth century. Additional archival research was carried out to gather information on wood prices in Leipzig. In total, price series could be constructed for ten towns. Geographical coverage refers to the borders of 1871 excluding Alsace-Lorraine (cf. Fischer et al. 1982: 15), but Strasbourg is included until it was taken by the French crown in 1681.

None of the series for these towns covers the entire time span from 1500 to 1850, however, the shortest ones being those for Quedlinburg (1750–1774) and Nürnberg (1810–

1850). At both ends of the observation period information density is much less satisfactory than in the middle. From two towns in 1500 coverage rapidly rises to five in 1510 and six in 1535. It oscillates between five and seven towns until 1800 and then rapidly falls to three (Göttingen, Leipzig and Nürnberg). Even for this restrained number of towns price information is often deficient and the creation of the series required for the construction of a consumer price index sometimes required heavy inter- and extrapolation. Appendix 1 provides the details on the sources and the procedures applied with respect to data handling.

Table 1: Presumed structure of household expenditure in six towns, 1750–1759

	(1) Quantity per person per year	(2) spending share per cent		(3) spending share per cent
Bread	182 kg	34.9		
Beans/peas	52 litre	6.1	vegetable food	41.0
Meat	26 kg	14.0		
Butter	5.2 kg	7.6		
Eggs	52	1.8	animal food	23.4
Beer	182 litre	17.3	food and drink total	81.7
Soap	2.6 kg	2.5		
Linen	5 m	4.5	non food consumer goods	7.0
Candles	2.6 kg	3.2		
Lamp oil/tallow	2.6 liter/kg	2.3		
Firewood	5.0 million BTU	5.8	energy	11.3

Sources: For the composition of the consumer goods basket, see Allen (2001: 421); cheese has been omitted, however (see explanation in the text). The spending shares refer to the unweighted mean of the six towns of Augsburg, Gdansk, Hamburg, Leipzig, München and Quedlinburg; cf. Appendix 1 for data definitions.

Following Allen I construct the CPI as the silver price of a basket with fixed quantities of eleven goods consumed annually by an adult town dweller. Except for cheese (see below) I use the same goods and quantities to compose the basket. The quantities are specified near a supposed poverty line (cf. column 1 in Table 1): The daily nutritional value is assumed to be only 1888 calories and 77 grams of proteins. 73 per cent of calories and 78 per cent of proteins stem from vegetable sources (bread, beans and peas). The yearly ration of meat is set at 26 kg. In addition, modest amounts of animal products, beer, soap, linen, candles, lamp oil or tallow, respectively, and fuel for heating are included. In contrast to some budget studies rent is not included in the index because of a complete lack of data.

The second and third columns of Table 1 translate the rations of the consumer basket into spending shares on the basis of the prices prevailing in 1750–1759. The resulting picture is fairly consistent with what is known from early budget and consumption studies for Germany (Saalfeld 1975: 241–7, 1978: 85–6, 92–100, 111; Gömmel 1978: 219–13). This is particularly true of the shares of vegetable food and drink. Also the share of animal food consumption is in line with information from the 1850s (about 26 per cent, house rent excluded) when real wages were already a bit higher than during the 1750s. Nevertheless, the absolute level of meat consumption was probably somewhat lower than suggested in

Table 1, namely, around 16–18 kg per person per year (Teuteberg and Wiegelmann 1972: 120).

An outstanding feature of Allen's basket, which differentiates it from much of the existing literature on pre-modern living standards, is the use of bread rather than grain as the major vegetable food. This is based on the simple fact, which also holds for Germany, that town dwellers bought bread rather than grain (Dirlmeier 1978: 328–57, 367–90; Krug-Richter 1994: 201–13). For an analysis of the long-term development of the price level (and, by implication, of the real wage) the use of either bread or grain prices may make a considerable difference: Given its higher labour content, bread experiences weaker price increases than grain during periods of population growth. This is because an increase of population leads to a rise of the man-land ratio, a reduction of the marginal product of labour and, hence, a decline of the real wage. Conversely, the bread price falls less than the grain price during periods of stable and declining man-land ratios, when downward pressures on grain prices go together with high real wages. A price index based on bread thus fluctuates less than a price index based on grain. To illustrate this point, I calculated two alternative price indices for Göttingen during the period 1758–1850, one based on the weights given in column 1 of Table 1, the other replacing bread by 225 kg of rye. Both indices have virtually the same mean, but the coefficient of variation is 0.207 for the former and 0.251 for the latter. The index based on grain displays a particularly low level during the early 1820s, which were a golden period for wage labour and bad years for grain surplus producers, and overshoots during the food crises of 1771/72, 1817 and 1846/47. In order not to overdraw long-term fluctuations of the price level of consumables and the real wage, therefore, I decided to stick to Allen's basket despite serious data problems.

Of the five German towns considered by Allen only Strasbourg records bread prices. Where data on bread prices lack, he extrapolates them using a regression that is based on rye prices and the silver wage of masons to proxy the labour share (milling, baking) in the bread price. In addition, the regression equation in its full specification also includes statistically significant town-specific effects. This implies that a significant share of the regional variation in the nominal bread price cannot be captured by extrapolation.

The robustness of the extrapolation can be checked by comparing Allen's parameters with estimates of analogous bread equations on the basis of fragmentary material from towns other than Strasbourg (Table 2). The baseline case is presented by a regression of bread prices in Chemnitz on rye prices and wages of carpenters in Leipzig during the late eighteenth and early nineteenth century (equation 2). Apart from the constant it almost exactly reproduces the coefficients of Allen's equation (displayed as equation 1).[1]

While it is impossible to compute a CPI for Köln, the available material provides interesting insights into bread price formation since bread prices were regulated by the urban authorities (Ebeling and Irsigler 1976: XV). Equation (4) produces a wage coefficient that is

1 Other runs were made with mason journeymen wages from Chemnitz itself, which renders possible a somewhat larger dataset (50 observations). The coefficient for the labour input is 0.045, but the wage of carpenters in Leipzig also exceeds those of mason journeymen in Chemnitz by 44 per cent. The grain input turns out slightly lower at 1.16. — Apart from the towns analysed in Table 2, bread prices are also available for Quedlinburg in 1750–1774. Since wages of masons were practically stable apart from the period of monetary disturbances in 1761–1764 it was not possible to estimate a bread equation. A linear regression of the price of rye bread on the rye price yields an input-output coefficient of 1.256, which is very close to Allen's estimate.

only little below Allen's figure, but the input-output ratio for rye is estimated at a low 1.037. Interestingly, the authorities applied input-output coefficients that differed considerably from those in equation (4). One Malter of 144 litres containing approximately 93 kg of rye had to yield 32 loaves of 3.3907 kg each, implying an input of 1.32 litre of grain per kg bread, which is fairly close to Allen's coefficient. The authorities then added the excise, which was equivalent to 0.065 g silver per kg of bread in 1756 (the year for which detailed guidelines of urban bread price policy subsist). Only the equivalent of 0.032 g silver per kg of bread was allocated to the labour costs of baking and the remuneration of market intermediaries and carriers. Since the silver wage of journeymen in the building trades amounted to 5.07 g silver per day in that year, this implies a mere 0.006 day of work for buying grain and have it baked into 1 kg of bread — the estimates discussed so far are in the 0.02–0.03 range.

Table 2: Bread equations (OLS regression coefficients, standard errors in parentheses; dependent variable: bread price in g silver per kg)

	constant	rye price	wage	time	time * rye price	adj. R^2	n
(1) Allen's bread equation	0.075	1.244	0.029			--	--
(2) Chemnitz/Leipzig	-0.017	1.270	0.035			0.952	37
(1774–1850)	(0.044)	(0.062)	(0.006)				
(3) Göttingen (1758–1850)	-0.040	1.531	0.078			0.884	90
	(0.223)	(0.065)	(0.036)				
(4) Köln (1700–1772)	0.044	1.037	0.024			0.921	73
	(0.040)	(0.036)	(0.006)				

Explanations: All variables are in grams of silver, the rye price refers to one metric litre. Notes on individual equations: (1) Allen's bread equation is taken from the electronic source, which excludes town-specific effects (http://www.iisg.nl/hpw/data.php#europe; cf. Allen 2001: 418–9). (2)–(4) For data definitions, see Appendix 1. In equation (2) bread prices are from Chemnitz, rye prices and wages of carpenters from Leipzig. Gaps in the wage series have been replaced by neighbouring values if those were identical. The years 1804–1817, which were characterized by extreme real and monetary disturbances, were omitted.

What explains the discrepancy between the input-output relationships used by contemporaries and the estimate in Table 2? Ebeling and Irsigler (1977: XXII) note that urban policy in Köln implied a cross-subsidization of cheap rye bread to the disadvantage of the prices of the bread types consumed by the rich; in fact, most of the time the price was fixed even at a level some percentage points below the price that would have resulted from a strict application of the rules described above. The bread equation estimate, which considers a single type of bread alone, cannot take account this rationale behind urban policy and thus produces input-output coefficients that are too low compared to real production processes. This also implies that Allen's bread equation, while it overestimates the price of cheap rye bread, is capable at least to adequately capture average bread prices.

In contrast to Köln, the bread price equation for Göttingen does not yield a coherent picture. In this town bread prices were regulated by the urban authorities, too, but the source used provides no information as to the procedure followed in fixing prices. Extrapolating bread prices for Göttingen with Allen's estimation function yields a mean which is 30 per cent below the observed value. The absolute difference of the silver price (0.381) is larger than any of his estimated town-specific effects. It may well be that town authorities stipulated maximum prices that did not reflect effective market prices. In fact, recorded bread prices are higher in Göttingen than in other towns for which I have bread prices, and the same goes for the ratio of bread to rye prices. As a result, hypothetical income shares spent on bread approach 40 per cent, which is considerably above the average share of about a third (cf. Table 1). All this makes me somewhat suspicious of the quality both of the data and my regression estimate in equation (3) of Table 2. The parameter for the rye price (1.59) is very close to the input-out relationship used by the authorities of Köln around 1700, and the low value of this coefficient in Allen's equation may explain a major part of the difference between extrapolated and observed data. However, the wage coefficient is extremely large (0.078), implying an implausibly low labour productivity. Two facts further undermine my faith into equation (3): First, the values extrapolated on the basis of Allen's equation correlate exactly as well with the observed values as my regression estimates (R^2=0.88); apart from the difference in level, Allen's function has the same predictive quality as my regression. Second, the low value of the Durbin Watson test statistic (0.89) suggests that the residuals are serially correlated. While I finally decided to retain the bread price information provided by the source all this suggests that regulated prices may not always be as unproblematic to use as in the case of Köln and may be less accurate than an extrapolation on the basis of Allen's equation (cf. also Gerhard and Kaufhold 2001: 36–8). Taken as whole, the results in Table 2 suggest that Allen's bread equation is fairly robust and warrant its use for extrapolating bread prices.

Bread prices are not the only data that are hard to come by. Cheese prices, which are included by Allen, were omitted from the consumer basket since data are scarce, interpolation appears difficult and because, as mentioned above, the level of animal food consumption in the hypothetical consumer basket of Table 1 appears already relatively high compared to what is known about German diet around 1800.[2] Prices of ordinary textiles and of fuel for heating purposes are also quite rare, and individual series had sometimes to be used for several towns.

In particular, the construction of adequate price series for firewood may well hold the key to a proper understanding of welfare development during the transition between the pre-modern and the early industrial economy. Contrary to earlier scholarship (Radkau 1986) Germany was clearly subject to a severe energy shortage during this era. From a low point in 1700 the real price of firewood — defined as the mean of the price of the equivalent of 1 million BTU in five towns divided by the CPI presented below — rose by 62 per cent until 1790. Its evolution during the following period is more difficult to track because sources change and become less abundant. The three series becoming available around 1810 suggest that the real price of firewood may have risen further by about a quarter dur-

2 Allen (2001) sometimes extrapolates cheese with multiplying the meat price with a factor of 2.86. However, in Gdansk, Frankfurt and Speyer the price ratio between locally produced cheese and beef seems to lie in the 0.75 to 1.5 range (for the latter two towns see Elsas 1940: 477–8, 556–8). The high ratio certainly refers to fat cheese entering long-distance trade. For Augsburg the hospital records indicate prices of Dutch cheese, whose price ratio with meat was close to 1 in the long run. According to Elsas (1936: 390), however, only one loaf was bought per year to serve as a gift to hospital functionaries on New Year. Its price, therefore, tells us little about everyday diet.

ing the previous decade, followed by a dramatic rise by 121 per cent in 1810–1850 (centred five year means). Clearly, the energy crisis was much more severe than the food crisis (cf. Hoffman et al. 2002: 331–3).

So far only one published series of annual firewood prices exists for a German town in the early nineteenth century, namely, for pinewood in Nürnberg from 1810. Together with other price information from Nürnberg this series was used by Gömmel (1979) to deflate his wage data. A possibility to check its representativeness is to compare it with price information from Prussian state forests, which, however, are only known by decade and whose construction cannot be reproduced in detail (Eggert 1883). Firewood prices (beech, various coniferous species) were 11.7 per cent higher during the 1820s compared to the 1810s. During the 1830s and 1840s the difference amounted to 17.7 and 45.8 per cent, respectively. By contrast, the Nürnberg series rose much stronger: The mean price ratio between subsequent decades and the 1810s amounted to 25.4, 40.3 and 60.9 per cent, respectively. This may result from the fact that Nürnberg was an important location of metal processing in the later Middle Ages and the 16th century and that a shortage of energy supplies emerged already during that era (Stahlschmidt 1971: 236–9; von Stromer 1986: 82–3). As a consequence, re-industrialization in the early nineteenth century must have been confronted with a highly inelastic natural resource supply. It is thus highly probable that a CPI based solely on firewood prices in Nürnberg will lead to an overly pessimistic assessment of welfare development during the first half of the nineteenth century.

To broaden the data base, information on wood prices in Leipzig has been collected from archival sources, and part of Eggert's information was considered in the construction of the CPI for Göttingen (cf. Appendix 1). Together, Göttingen, Leipzig and Nürnberg are the only towns for which sufficient information exists to construct a consumer price index after 1810. The mean price of firewood in the three towns moves broadly parallel to those recorded by Prussian state forests: The ratios between decade-wise prices and the level obtained for the 1810s are, respectively, 17.1 per cent (1820s), 23.1 per cent (1830s) and 39.8 per cent (1840s). The small differences relative to the Eggert series suggests that the information used for the construction of the present index correctly captures the general evolution of energy prices. If the Nürnberg wood price series would be applied to all three towns, by contrast, the level of the CPI would be about 18 per cent higher in 1850. The big difference illustrates the importance of energy prices for the proper assessment of the evolution of the costs of living during the first half of the nineteenth century.

The calculation of a CPI on the basis of a basket that remains stable over more than three centuries can be criticised on grounds that it does not allow for changing patterns of consumption. It is difficult to handle this argument since very little empirically grounded information is available on consumption in Germany for periods before the early nineteenth century. Nevertheless, what follows explores the probable impact of three major changes in popular diet on the evolution of the consumer price level.

First, there is an established view that meat rations collapsed during the sixteenth century by possibly as much as two thirds — from some 80 kg to a about 25 kg per head and year — and were partially substituted by vegetable foods (Abel 1981: 30, 39–43, 62–64; Dirlmeier 1978: 357–364). Since real income undoubtedly fell strongly and it is plausible to assume a positive income elasticity of food consumption a substantial part of the reduction in meat consumption should be attributed to an income effect. Placing the income elasticity of food consumption at roughly 0.5 (Allen 2000: 13–4) and the fall in real income at about 50 per cent (see below) we get an income effect of 0.25 or 20 kg in absolute terms. The reduction due to substitution thus amounted to some 35 kg or about half of the meat ration prevailing around 1500. To get a rough estimate of the impact of substitution on consumer prices I increased the meat ration in 1500 by 150 per cent (from 26 to 65 kg) and reduced the grain ration by the equivalent number of calories. This yields a consumer basket which cost about 8 per cent more than the consumer basket with constant quantities. This is also the rate at which an index based on constant weights overstates the rise of consumer prices — and, correspondingly — the fall of the real wage — during the sixteenth century.

Second, the potato gained in importance as a labour-intensive substitute for grain from the subsistence crisis of the early 1770s. In 1800 about 1.5 per cent of the arable was under this crop, and by the middle the nineteenth century the proportion had increased to 9.5 per cent (Achilles 1993: 198). In 1800 Germans possibly ate 50 kg potatoes per year; fifty years later the quantity had risen to 130–140 kg (Saalfeld 1975: 242; Teuteberg 1979: 343). The ratio of caloric intake stemming, respectively, from potatoes and grains was 0.08 and 0.49 in these two years — substitution occurred obviously at a rapid speed. Potatoes were cheaper than bread. The price ratio was 0.16 in Göttingen (1772–1850) and Leipzig/Chemnitz (1819–1850), and 0.26 in Nürnberg (1810–1857). To place these ratio in the proper context one needs to consider that the caloric value of potatoes is only about one third compared to bread. In order to gauge the possible impact of the growing relevance of the potato in food consumption on the costs of living I replace one third of the bread ration in Table 1 by 180 kg of potatoes. Assuming that potatoes cost one fifth the price of bread, a basket thus modified would have been 4 per cent cheaper in the 1840s than the basket of Table 1. Whereas the potato certainly made an important contribution to substitute land for labour in vegetable food production its impact on the price level of consumer goods was rather modest.

A third important shift in consumption patterns concerns the rise of tropical groceries in the course of the consumer revolution of the late seventeenth and eighteenth centuries (Sandgruber 1982: 182–217; Menninger 2004: ch. 5). In the wake of the Thirty Years War tobacco smoking spread in German lands, and at least part of the peace dividend in the form of a high real wage (see below, Figures 2 and 3) seems to have been consumed in the form of increased lung cancer risk. This at least is suggested by contemporary reports of widespread tobacco abuse and failed attempts at prohibition. Estimates of consumption levels are difficult to come by, however. In the western part of the Habsburg lands (the extreme south of Germany), annual per capita consumption is reported to have risen from 0.5 to 1.2 kg between 1783 and the 1850s. Coffee consumption seems to have spread into the population at large mainly during the latter part of the eighteenth century. Particularly outworkers in proto-industries were reputed to be heavy coffee drinkers. During the first half of the nineteenth century coffee, together with potatoes, emerged as the staple diet of the labouring poor. Actual consumption levels remained low, however, and did not exceed 0.3 to 0.5 kg per capita annually. Partly this was due to the wide use of local substitutes. The spread of tropical groceries was aided by their declining real price: Relative to an unweighted price index of 34 commodities traded in Hamburg non-European foodstuffs cost about 20 per cent less in the 1760s to 1780s than during the 1740s and 1750s (Denzel and Gerhard 2003: 11). Between the 1760s and the 1840s nominal prices of coffee and sugar traded in Hamburg were roughly halved (Gerhard and Kaufhold 2001: 108–9, 112–3). Despite the relevance of non-European groceries for issues related to cultural aspects of consumption their inclusion in budget studies is difficult and probably not worth the effort. I therefore only consider the case of sugar: In 1850, Germans consumed some 4.5 kg of sugar and honey per person and year (Teuteberg 1979: 344). This corresponds to 50 kcal per day, slightly less than 3 per cent of the presumed daily caloric intake. At the prices prevailing in the 1840s 4.5 kg of sugar corresponded to about 2 per cent of total expenditure as defined by the basket in Table 1. Consumers would have paid more than double this expenditure share for the same quantity during the later eighteenth century. I therefore assume that the spread of tropical groceries reduced the cost of living by about 2 per cent during the first half of the nineteenth century.

In sum the construction of a CPI based on constant weights as in Table 1 overrates the long-term increase in the cost of living since first meat and later grain were partially replaced by cheaper substitutes. For the period 1500–1600 the effect of substitution on the price level can be placed at roughly 8 per cent and at 6 per cent for the first half of the nineteenth century. Conversely, real wage growth is underestimated by about the same amount. The following calculations were therefore carried out in two variants, namely, a first one based on fixed quantities and another one adjusted for changing consumption patterns in the sixteenth and early nineteenth centuries.

A synthetic national CPI is constructed by aggregating the centred means for five year periods of the CPIs calculated separately for each town. Since coverage varies over time the index is estimated using panel regression with fixed effects for cities and years:

$$\ln(P_{ij}) = c + \sum_{i=1}^{k-1} \alpha_i C_i + \sum_{j=1}^{l-1} \beta_j T_j + \varepsilon_{ij} \qquad (1)$$

with P_{ij} being the mean price index in city i and five year period j, C containing city-specific dummies without Frankfurt, and T being a set of dummies for all five year periods except the last one, which relates to 1848–1850. Price indices are put in natural logarithms in order to reduce the weight of outliers. CPI values for individual five year periods are then calculated as the exponential of the sum of the constant c and the individual elements of the parameter vector β. As mentioned at the beginning of this section its values can be interpreted as the annual cost of a basket of goods consumed by an adult urban dweller in grams of silver.

It should be stressed that the aggregation of local CPIs into a national price index presupposes that the silver content of local currencies is exactly known and that markets for metallic currencies are well integrated. Both conditions were not met in Germany at least during the sixteenth century (Gerhard and Engel 2006: 43–4; Boerner and Volckart 2008). The synthetic national CPI proposed here is therefore of a highly tentative nature.

Two estimates of equation (1) were carried out; in the first variant all data points were weighed equally (OLS), in the second they were weighed according to the number of years entering into the calculation of an individual five year mean (WLS). For most five year periods the difference between the CPI values obtained by the two estimation methods is less than 0.5 per cent; therefore, only the results obtained on the basis of WLS are presented (Appendix 2.1). There are three data points with discrepancies larger than 2 per cent, namely, 1620, 1760 and 1810. The first two relate to monetary disturbances (see below) which create serious data problems. Both episodes were characterized by rampant currency debasement. Since the composition of the circulating money stock is unknown, silver prices (usually based on information of the metallic content of monies in pre-crisis years), where they can be constructed at all, are probably wrong. Therefore, the index values given for these years should be used with care in further research. The discrepancy between the

WLS and OLS estimates in 1810 (5.3 per cent) is mainly owed to the fact that Nürnberg, for which only three of potentially five data points are available, enters the series with a price level that is low compared both with the mean level of this town and with other towns. Since Gdansk displays a similarly low price level around this time, the lower CPI value that results from the OLS estimate (which attributes an equal weight to all observations) may be quite appropriate. In any case, the value for 1810 should be used with care, and the assessment of the price level during this five year period depends on the weight one wishes to attribute to the rapid rise of fuel prices in Nürnberg in the ensuing years.

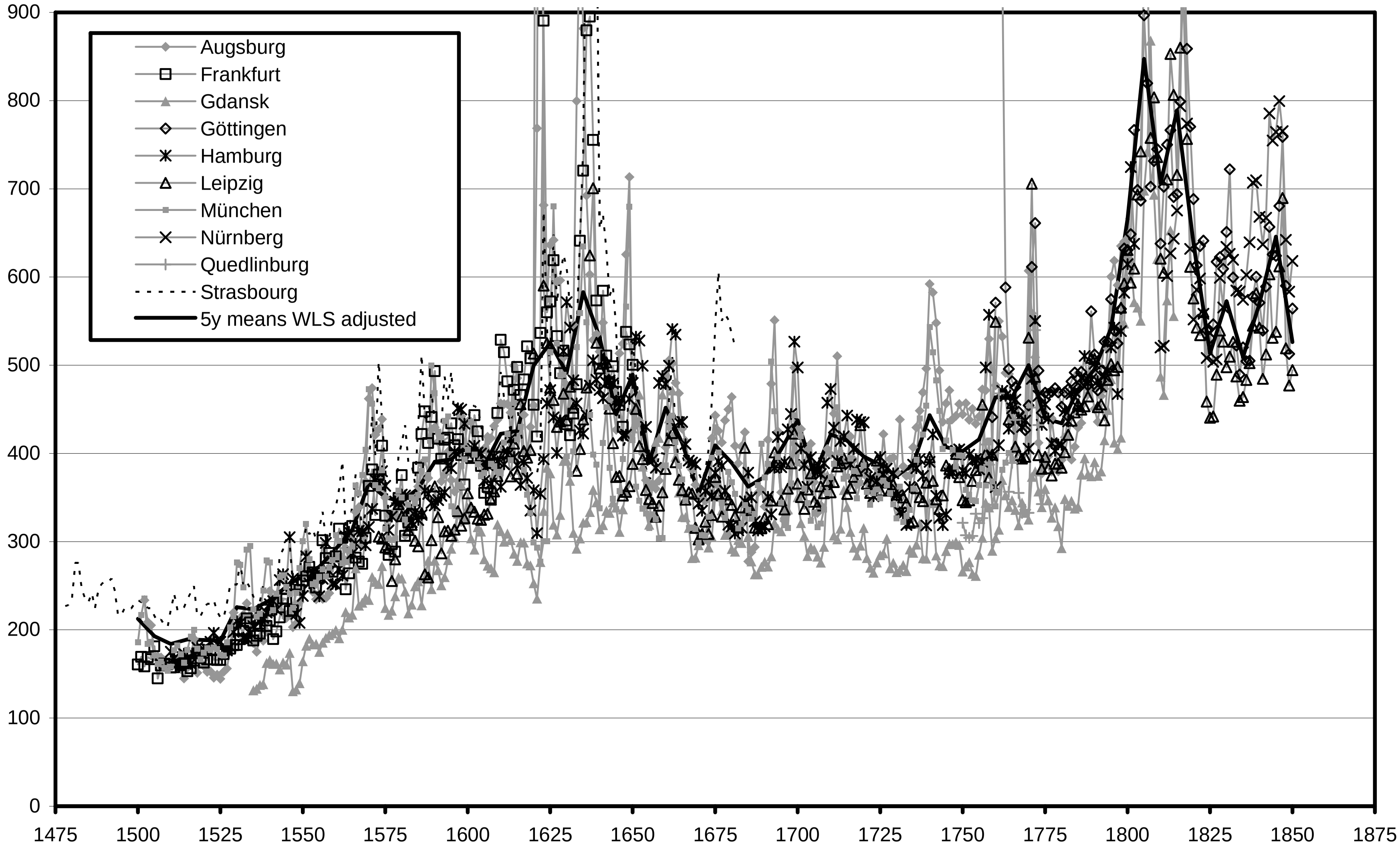
In addition to the series obtained with WLS Appendix 2.1 also reports a version of the same series that is adjusted for changes in consumption patterns. In concrete terms, the time-points before 1600 are subjected to an exponential upward adjustment corresponding to an increase of 8 per cent in 1500 and an analogous reduction of 6 per cent over the period 1800–1850. Figure 1 only presents the adjusted series — due to the enormous changes of the price level over the long run, the difference between the two variants would become hardly visible.

Inspection of Figure 1 suggests the following three observations about the evolution of consumer prices in Germany: First, the long-term evolution conforms to a European pattern, which itself was strongly influenced by the time pattern of the influx of American silver (Braudel and Spooner 1967; Allen 2001): From 1500 to the 1630s there occurred a rise by the factor of 2.5 followed by a rapid reduction by about a third until 1670. Following a half-century without a clear long-term trend a new persistent rise of the price level set in after 1730. With strong fluctuations related in part to the Revolutionary and Napoleonic wars it continued into the nineteenth century.

Second, a number of short-term shocks become apparent, most of which being of a European nature, too. They can be divided into monetary and real shocks, the latter being connected with harvest failures. The first include the culmination of debasement during the *Kipper und Wipper* era around 1620, which was partly related to inflationary methods of war finance (Kindleberger 1991), a similar experience during the Seven Years War around 1760 (Denzel and Gerhard 2003: 16–21) and the financing of the wars against Napoleon again in part through currency debasement (peak around 1805). As mentioned above the silver content in the circulating monetary base was reduced by an unknown amount during these periods. Hence, calculated silver prices are grossly inflated and the CPI values for the respective years are unreliable.

During the first one-and-a-half century of the observation period real shocks notably include the serious harvest failures during the early 1530s and around 1570, which inaugurated the age of mass pauperism of the late sixteenth century, as well as the subsistence crisis of the 1630s, which was coupled with epidemics of bubonic plague. Figure 1 suggests that this was probably the most serious economic crisis in early modern Germany. The three-quarter century following the Thirty Years War, while being characterized by a relatively stable and low price level in the long run, experienced repeated short-term price rises connected to subsistence crises. This was the case around 1660, during the second half of the 1670s and the early 1690s, followed by crises on a more regional level until 1719. As in France (Weir 1989) food crises became less frequent in the course of the eighteenth century, the most important ones being those around 1740 and during the early 1770s. The last short-term increases in the price level of consumer goods being connected with major harvest failures were those in 1816/17, 1830/31, 1846/47 and (outside the period of observation) 1854/55.

Figure 1:
Annual cost of a consumer basket in grams of silver, 1500–1850



Third, there are differences in the price level between towns that tentatively suggest a regional pattern although it cannot be excluded that these differences are partly related to problems of currency and measurement conversions. Both Figure 1 and the city fixed effects reported in Appendix 2.2.a suggest that Gdansk and Leipzig enjoyed a relatively low price level, whereas the inhabitants of Strasbourg were confronted with consumer prices above average. This suggests a distinction between the northern lowland characterized by a comparatively modest man-land ratio and a strong integration into maritime long-distance trade and Upper Germany, where population density was higher and long-distance commerce faltered after the third quarter of the sixteenth century. The characteristics of the former region seem to have contributed to a relatively low price level, whereas the higher man-land ratio in the latter was conducive to Malthusian pressure and higher prices for food and energy.

The real wage

This section develops two real wage series of unskilled male workers mostly occupied in the urban construction sector. The main reason for the choice of this category of labourers is that remuneration in kind, while not totally absent, was rare in comparison with other types of work, particularly in the agricultural sector (Reith 1999: 345–85, cf. Elsas 1936: 57–73). This renders wages in the building sector a privileged object of study in any analysis of welfare in pre-modern economies. In addition, building labourers were a highly mobile work-force so that their wages can be held representative for the labour market at large. A certain drawback, by contrast, stems from the fact that particularly for the eighteenth century administered, rather than actually paid waged had to be used. A detailed study for Cologne demonstrates, however, that at least hospitals perfectly followed the wage policy of the urban authorities. Wages usually differed between seasons, and the time points of the transition between seasons varied across towns. The present study uses summer wages when season specific pay rates were given. Because of the seasonal fluctuation of wages and since employment was not continuous it is impossible to calculate the annual income of a building worker (Gerhard 1984: 4–12; Gömmel 1985: 203–35; Ebeling 1987: 165–75).

The coverage of wages for unskilled labour is somewhat broader and more homogeneous than for artisans who are divided between masons and carpenters and between masters and journeymen. I therefore used wages for unskilled building labourers to assess the evolution of real wages (except Hamburg; see Appendix 1 for details). Inspection of the wage material shows that in most towns the skill premium fell in a range between 1.3 and 1.8, the mean being around 1.5–1.6 (the European average; cf. van Zanden 2009) with no clear time trend. Hence, the choice of the qualification level has no implication for later results with respect to general trends of wage incomes.

To derive a real wage index, the daily pay of unskilled labourers in terms of grams of silver was divided by the cost of living index, that is, the yearly cost of the consumer good basket required by an adult person. Contrary to a usual real wage index, the present one has an intuitive meaning: It designates the fraction of the annual consumer basket that can be bought with a day wage. A value of 0.010 means that an unskilled building worker needed to work 100 days at the remuneration of a summer wage to purchase the annual consumer basket for one person. The fact that this or a lower value prevailed over much of the time period between 1500 and 1850 (Figure 2 and Appendix 2) already tells us a lot about the low living standards during this era.

Data density is considerably lower than for prices, partly because less data have been intra- and extrapolated: Whereas the construction of the price index rests on 1900 data points on the level of individual towns and years, only 1314 data points are available to study real wages in the ten towns for which it is possible to construct a local CPI. From 1535 to the end of the eighteenth century real wages can be calculated in principle for five, in 1583–1602 even for six cities. Until about 1650 these are Augsburg, Frankfurt, Gdansk, Hamburg, Leipzig (from 1583) and Strasbourg. Between 1650 and 1800 data are available for Augsburg, Gdansk, Hamburg, Leipzig, München (1630–1765), Quedlinburg (1750–1774) and Göttingen (from 1759). There are many gaps, however, particularly with respect to the first phase of the Thirty Years War (1618–1630), during which coverage shrinks to three towns (Augsburg, Frankfurt and Gdansk). The first ten years of the observation period are also covered by only three towns (Augsburg, Frankfurt, Strasbourg; 1500–1509), and information again becomes scarce with the end of the Ancien regime; the analysis of the period from 1811/12 is based exclusively on the three towns of Göttingen, Leipzig and Nürnberg.

The first variant of a national real wage series makes use exclusively use of these wage data, which all relate to towns for which it was possible to construct a local CPI. In a first step five year means of the real wage were calculated on the level of individual towns. In a second step the natural logs of these means were regressed on the fixed effects of five year periods and cities, the period 1848–1850 and Frankfurt serving as basis for calibrating the series (cf. equation 1 above). Again two estimates based on OLS and WLS were performed, the latter weighting individual data points according to the number of years that entered into the calculation of each five year mean. An aggregate real wage series can then be calculated as the exponential of the sum of the constant plus the regression parameter of each individual five year period. In a final step, index values were adjusted backward from 1600 to 1500 and forward from 1800 to 1850 to take into account the fact that the consumer basket cheapened during these two periods by approximately 8 and 6 per cent, respectively, as a consequence of changing consumption patterns.

The second variant of the national real wage index makes use of additional data on nominal wages for towns and years for which no local CPI exists. In such cases the real wage can be approximated by dividing the silver wage by the national CPI. Hence, a second national real wage index was constructed on the basis of the ratio of the silver wage in each town to the national CPI. The procedure followed is identical with the index derived from wages deflated by the respective local CPI. The inclusion of towns and years with silver wages but insufficient information on the prices of consumer goods broadens the data base by about 35 per cent (457 data points). Until the mid-1550s Xanten can be added to the dataset, Köln improves coverage of the eighteenth century, and from the third quarter of the eighteenth century to the end of the observation period silver wages are available for another four towns (Ansbach, Bremen, Chemnitz, Köln, and Neustadt/Holstein; see Appendix 1). In addition, the series for München and Quedlinburg can be extended until 1850 and 1815, respectively.[3] As a result, coverage in 1750–1790 rises to 10 to 12 towns and still

3 The main source is Gerhard (1984). Information provided by this compilation for Stauf and Windsbach, a small town and a rural parish, respectively, is not considered.

amounts to eight towns from the 1810s. The price of this extension of the data base is a loss in precision, however. What has been said earlier about the lack of product market integration until the early nineteenth and the lack of monetary integration at least until the sixteenth century comes into full force when silver wages are deflated with a national CPI that does not rely on price information of the localities from which wages are drawn. I therefore consider the real wage series based only on wages deflated by their respective local CPIs — that is, the first variant — as more accurate than the series based on the extended dataset in which silver wages are deflated by the national CPI.

A challenge to implementing the design described so far arises from positive shocks affecting Hamburg in the middle of the seventeenth and München during the early nineteenth century (the latter shock applying only to the extended variant). Already with the rise of the North Sea emporia that substituted the formerly dominant position of Antwerp real wages in Hamburg moved towards the upper end of the range of all towns from the 1580s. With the establishment of peace in 1648 and the unhindered development of the long-distance trading system centred on the North Sea real wages in Hamburg virtually exploded and reached the same level as in Amsterdam and London, distancing other German towns by a wide margin.[4] The drastic improvement of material welfare probably went together with a massive influx of immigrants; between 1643 and 1660 population size seems to have increased by about 75 per cent (Mauersberger 1960: 47). Because of the extremely high remuneration for unskilled labour in Hamburg an uncorrected national real wage series is dominated by the values for Hamburg in the period ca. 1655–1755, and, since data density is low for this town, differences between estimates obtained with OLS and WLS are large.

Since a major part of the real wage increase in Hamburg occurred between four scattered data points in 1636–1653 and 1654–1659 (increase by 45.5 per cent) it was decided to work with two separate town dummies for Hamburg, one for the period up to 1648/52, the other from 1653/57. In the series based on wages deflated by the respective local CPI (but not in the one where silver wages are deflated by the national CPI) this has the effect of underestimating the peace shock that affected the German economy after the end of the Thirty Years war: A WLS estimate that excludes Hamburg shows an increase of 23.9 per cent from 1648/52 to 1653/57, whereas the estimate with two Hamburg dummies produces an increase of only 14.6 per cent. Therefore, the series that is used henceforth is adjusted upwards so that its increase matches the rise experienced by the towns other than Hamburg. This is tantamount to the assumption that the peace shock experienced by Hamburg did not matter more to the German economy as a whole than the average peace shock experienced by the other towns. This is justified by the later investigation into the wages of rural labour in early nineteenth century Prussia, which shows that the north-

The same holds for building wages in Nürnberg from 1500 to 1800 reported by Gömmel (1985: 273–4). Silver wages of this town deflated by the national CPI show a decline of 38 per cent between 1503/07 to 1600, which is clearly below average. By contrast, the fall of the grain wage during the same period is the strongest recorded for any town in the sample (see below, footnote 7). The national CPI is obviously not an adequate substitute for local price series of consumer goods in this case.

4 Cf. Appendix 2.2.b; Israel (1989: chs. 3, 6). During the 1690s and the second quarter of the eighteenth century the real wage in Amsterdam and London averaged 0.019–0.020 (Allen 2001, recalculated following the methodology of the present study).

western high-wage zone was constricted to a narrow strip of marshy coastlands and that no wage equalization took place with a larger hinterland.[5]

The second positive shock experienced by an individual town occurred in München at the beginning of the nineteenth century. Since this series is solely based on silver wages and because the silver content of local currency is not exactly known the extent of this shock is difficult to determine, however. The available information suggests that the real wage in 1808/12 exceeded the level recorded in the mid-1790s by about 68 per cent. This positive shock may have been related to successful state-building; the Napoleonic period saw a dramatic expansion of Bavaria's territory and the enactment of far-flung institutional reforms (Spindler and Kraus 2002: 4–95). The attractiveness of München as the capital of one of the most dynamic German states was also mirrored in the growth of its population between 1800 and 1850 (175 per cent), which was in the upper range of the growth rates recorded for other rapidly expanding capitals (Berlin, Hannover, Stuttgart; Bairoch et al. 1988: 4–9). In analogy to the procedure applied in the case of Hamburg a separate town dummy was introduced for München from 1808/12, which corresponds to the assumption that the shock experienced by this town was marginal within the context of the German economy as a whole.

Thus, the two principal series on which the subsequent discussion relies are, first, a WLS estimate based on wages deflated by the respective local CPIs corrected for the peace shock from 1648/52 to 1653/57 and adjusted for the effects of changes in consumption patterns in the sixteenth and early nineteenth century, respectively (broken thin line in Figure 3 and column 4 in Appendix 2.1). The second series consists of a WLS estimate based on the extended data set of silver wages deflated by the national CPI adjusted for the effects of changes in consumption patterns (bold line in Figure 3 and column 5 in Appendix 2.1). Additionally, Figure 3 (thin line) also presents a version of the estimate based on wages deflated by the respective local CPIs without upward correction for the peace shock in the 1650s, which presents a sort of lower bound of the evolution of the real wage from the middle of the seventeenth century. Appendix 2.1 also provides a series based on locally deflated real wages without adjustment for changes in consumption patterns (column 3). All series use two town-specific dummies for Hamburg and München (extended variant).

5 The fixed effects coefficients reported in Appendix 2.2.d suggest that wages of rural labourers on the North Sea coast, which was characterized by fertile marshy lowlands, exceeded the average in other parts of early nineteenth-century Prussia by 78 per cent (implied linear mean value). The larger hinterland of the Provinces of Hannover (largely identical with present-day Lower Saxony) and Schleswig-Holstein displayed means close to the average (deviations of -1.5 per cent and 4.6 per cent, respectively).

Figure 2:
Real wages of unskilled building labourers in sixteen towns, 1500–1850
(silver wages deflated by national CPI)

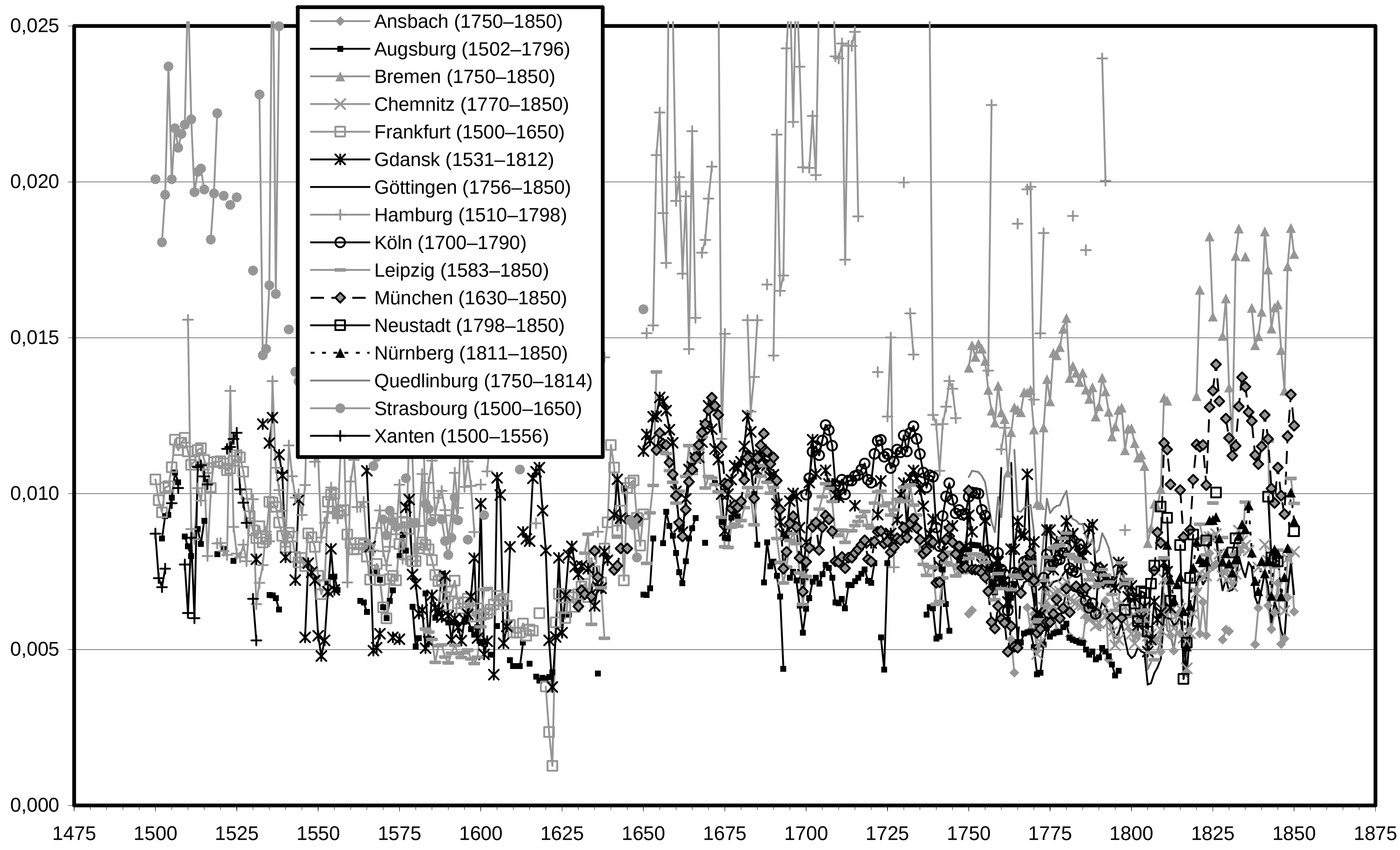
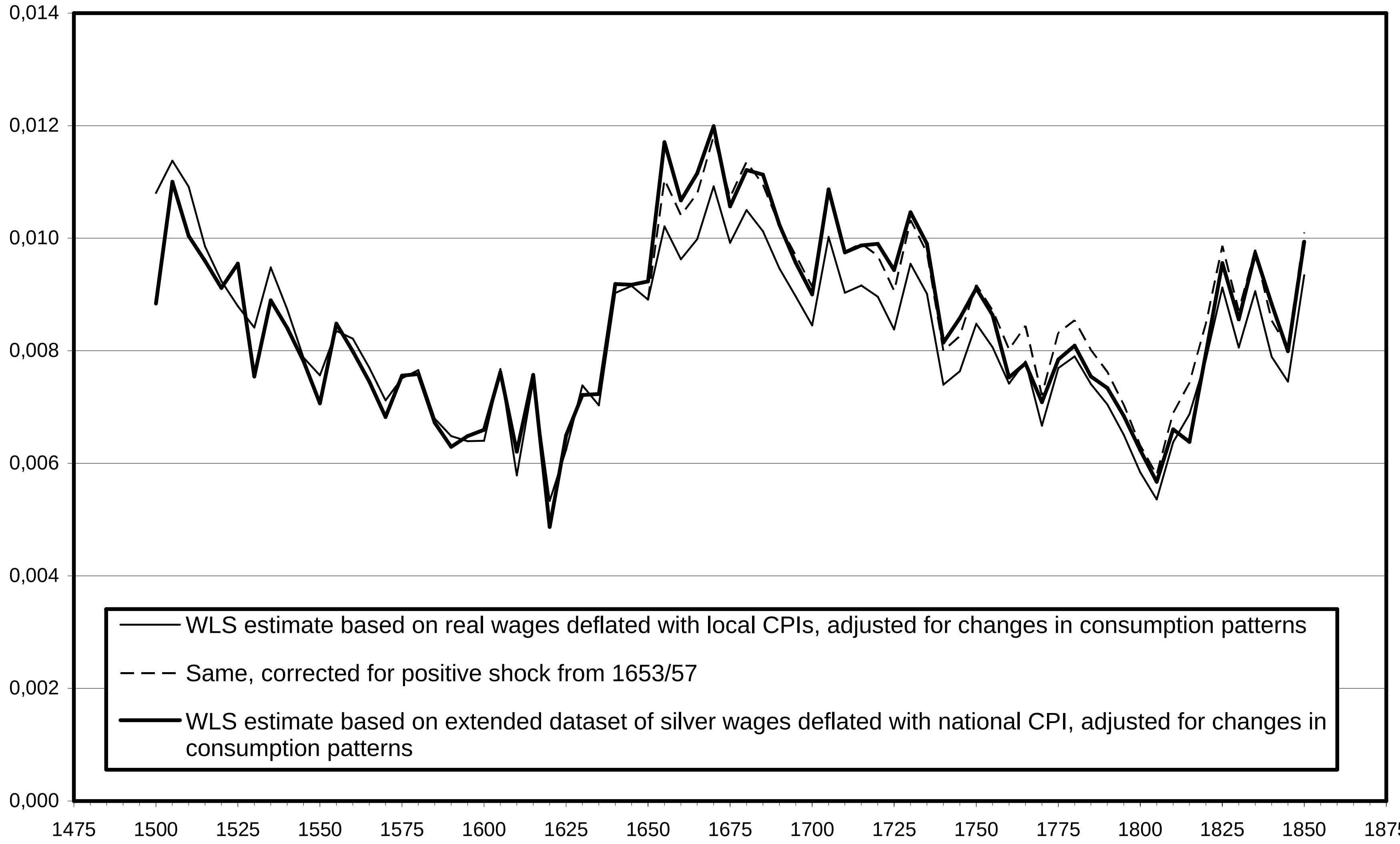


Figure 3:
Aggregate real wage series of unskilled building labourers, 1500–1850



The robustness of the real wage estimates for individual five year periods can be assessed by comparing the WLS and OLS estimates (latter not shown) for the two variants (that is, four series in total). Due to lower data density substantial discrepancies between the indices obtained with WLS and OLS occur more frequently for the real wage series than in the case of the CPI. If adjustment is made for the mean difference between the two estimates the discrepancy is larger than five per cent for 16 (wages deflated by local CPIs) and 13 (extended data set of silver wages deflated by the national CPI) of the 71 data points. For wages deflated by local CPIs nine of these discrepancies occur during the early period up to 1580 alone; for the extended dataset of silver wages deflated by the national CPI the number is only four. Low data density translates into some uncertainty over the course of the real wage decline during the sixteenth century. In general, the WLS estimates yield a somewhat steeper decline of the real wage during the first half of the sixteenth century than the OLS estimates. Even larger is the difference between the series based on locally deflated real wages and the one that uses silver wages deflated by the national CPI: As Figure 3 shows the latter declines much smoother over the sixteenth century. This is basically due to the fact that the real wage in Xanten, for which no local CPI can be constructed, actually rises during the first half of the sixteenth century, whereas it falls in all other cases.[6] As a result of this, the difference between the two WLS estimates in 1500 is 18.2 per cent, the two OLS estimates yielding intermediate values. For this reason the later discussion will take as a starting point the values in 1503/07 and 1508/12, which rely on more data points and show a much smaller discrepancy.

Deviations between different estimates are again large in 1610–1620. This period was the culmination of the *Kipper und Wipper* era, a time of competitive coin debasement, so that price and wage data are unreliable (see above). During the rest of the observation period there exist three major discrepancies between different specifications. First, some uncertainty surrounds the exact extent of the peace shock occurring in 1648/52 to 1653/58. Figure 3 shows that the results of the corrected estimate based on real wages deflated locally and the (uncorrected) estimate based on silver wages deflated by the national CPI are very close, but due to the conservative assumption underlying these estimates it may well be that the shock was even stronger. The uncorrected estimate based on locally deflated real wages clearly presents the lower bound of post-war income growth. Second, the variant based on silver wages deflated by the national CPI is more pessimistic for the late eighteenth century, particularly the 1760s, the mid-1770s and the 1780s. Third, there is a new clustering of discrepancies between WLS and OLS estimates in the five year periods centred on 1805, 1810 and 1815. They are related to relatively low data density during a period of strong real wage fluctuations, in particular to an unequal coverage of wages during the major food crisis in 1816/17. The estimate for 1813/17 based on locally deflated real wages, which suggests smooth recovery from the disruption caused by the Revolutionary and Napoleonic wars, appears implausibly high, and the lower value derived from the extended data base of silver wages deserves more credence.

Before developing an interpretation of the evolution of the real wage it is useful to compare the present series with the results of earlier studies. Almost no research exists for the early modern period. For the sixteenth century, at least, the fall of the grain wage in six

6 Grain prices are available, though, and the grain wage also displays a rising trend. The trends of the wage deflated by the national CPI and the wage deflated by local rye prices are thus mutually consistent.

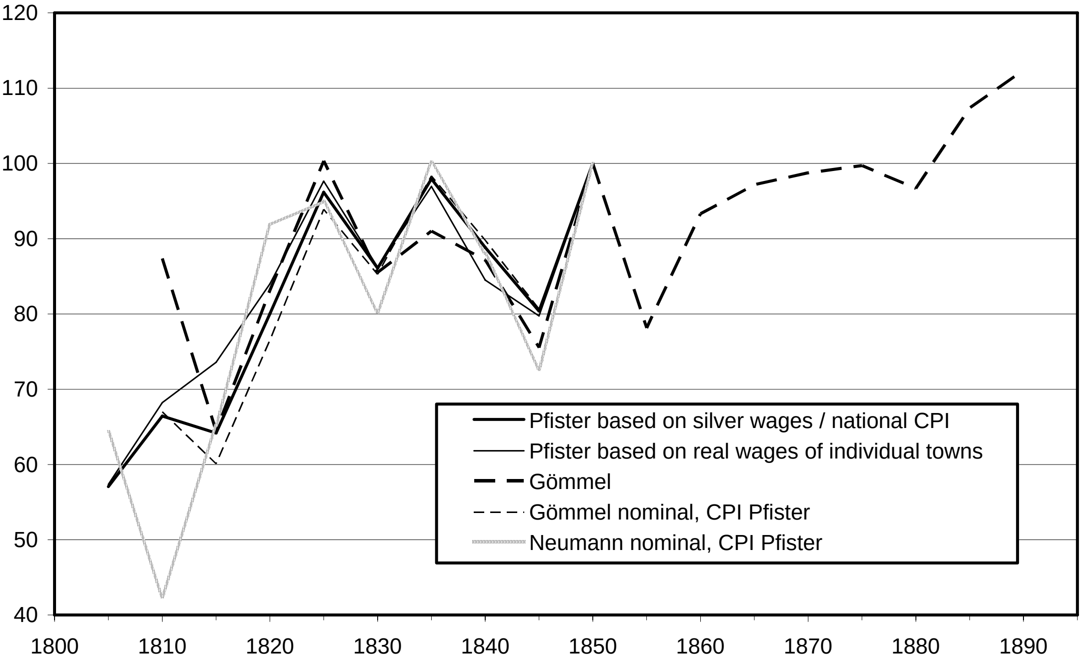
towns (three of which being also part of the present investigation) by about 48 per cent recorded by Abel (1978) and others may provide some kind of yardstick.[7] According to this study real wages fell about 40 to 43 per cent between 1503/07 and 1598/1602. Since the grain wage takes into account neither the possibility of a decline of the relative price of labour-intensive against land-intensive consumer goods nor changes in consumption patterns, one expects the grain wage to fall more than a real wage index. The results obtained with the present real wage indices and the information on the grain wage are thus mutually consistent.

More research exists on the first half of the nineteenth century; Figure 4 brings it together with the results of the present study (centred five year means). The standard reference certainly is Gömmel (1979). Gömmel uses nominal wage information from eight towns (six of which being also object of the present study) plus wages from cotton mills and deflates this composite nominal wage series by a consumer price index of Nürnberg. As mentioned earlier, this town was haunted by a serious energy crisis from the 1810s unknown in other regions to this extent, producing a steep rise in consumer prices. As a consequence, Gömmel's real wage index is higher than mine in 1823/27 and particularly in 1808/12 (30 per cent; Gömmel's series starts in 1810), producing a much more pessimistic assessment of material welfare development during the early nineteenth century than the present investigation. Deflating Gömmel's nominal wage series with the national CPI developed in the previous section produces a rather different picture, however: The revised Gömmel index and my own real wage indices display almost the same values in 1810, and for the rest the former follows closely the series based on silver wages deflated by the national CPI. As mentioned earlier, the correct assessment of the extent and timing of the energy crisis immediately preceding industrialization proves crucial for making statements about the evolution of material welfare during the first half of the nineteenth century. Unless further research demonstrates that Nürnberg's experience was widely shared in Southern Germany and that the price information used by this study underrates the rise of energy prices during the early nineteenth century, my own and the revised Gömmel series deserve more credence than the original Gömmel index.

Another point of reference is Neumann's (1911) investigation into the wages of rural labourers in Prussia. It is based on about 370 pieces of information on wages in localities, administrative units or whole provinces at different points in time, with a heavy emphasis on the late 1840s (about one third of all data points). The nature of the information is heterogeneous in the sense that it often relates to different types of work during different seasons of the year. For the purpose of the present study these data were recompiled using the author's original adjustment to a yearly average. A nominal wage series was then constructed following the procedure used for creating the CPI and the real wage indices, respectively (Appendix 2.1). This nominal wage was then deflated by the CPI developed above.

[7] This is derived from the graphical representation of the evolution of the grain wage in five towns from 1491/1510 to 1591/1610 given in Abel (1978: 140–1), the mean reduction being about 45 percent, plus the change of the grain wage in Nürnberg from 1496–1504 to 1596–1604 to the amount of -66.8 percent (Gömmel 1985: 273–4; Bauernfeind 1993: 438–441).

Figure 4:
Alternative real wage indices for the first half of the nineteenth century (centred five year means, 1848–1850=100)



The major deviation with respect to the other indices displayed in Figure 4 occurs in 1808/12; however, this estimate is based on only two administrative units and, therefore, should be discarded from the analysis. Most other values are in the same order of magnitude as my own and Gömmel's revised real wage indices. Nevertheless two nuances stand out: First, the Neumann index is somewhat lower than the other series in the five year periods centred on 1830 and 1845, which comprise serious food crises. This reflects the fact that harvest failures affect rural workers not only through a decline of the food supply but also through a decline of employment opportunities and, hence, food entitlements. By contrast, urban workers, who dispose of incomes that depend at worst indirectly from agricultural business cycles, suffer only from the deterioration of the food supply (Bass 1991: 27, 87–8).

Second, during normal times the wage index of rural labour was above the one for urban construction workers, and the difference is larger at the beginning of the period than towards its end (see notably 1803/07 and 1818/22). This implies that rural wages developed less favourably than the remuneration of urban labour during the first half of the nineteenth century: From the low point in 1803/07 to 1848/50 real wages of urban workers rose by 72 to 74 per cent while those of rural workers in Prussia rose by only 52.3 per cent. This finding of a rising urban-rural wage gap is consistent with the acceleration of the pace of urbanization during the first half of the nineteenth century (Reulecke 1985: 202; Bairoch et al. 1988: 259).

A more general result that is relevant both with respect to method and substance stands out from this comparison of the three studies. In nominal terms, all wage series move largely in parallel. Systematic urban-rural variation exists, but it is minor compared to temporal fluctuations resulting from price shocks. This implies that the synchronization in the movement of the indices displayed in Figure 4 is neither due to high data quality nor to an advanced level of labour market integration. In fact, as the analysis of Neumann's (1911) data show, wages of rural labourers were subject to strong regional variation (cf. the mean values implied by the region fixed effects provided in Appendix 2.2.d). Rather than by labour market integration co-movement of wages in different regions and sectors was caused by the frequent occurrence of climatic shocks that affected all of them almost equally. With respect to method the comparison of different wage indices demonstrates the importance of gathering better price data as an important element in the future improvement of our knowledge of the evolution of material welfare during the pre-industrial era.

Interpretation

The description and interpretation of the long-term evolution of the real wage can be enhanced through an investigation of its relationship with population size. To the extent that the CPI and the GDP deflator evolve more or less in parallel and the labour-force participation rate remains stable over time, the log(real wage)-log(population size) diagram approaches the aggregate marginal product of labour schedule. A stable negative relationship between the real wage and population size would then point to the existence of a Malthusian world characterized by a static technology and a strong negative feedback of population growth into material welfare.

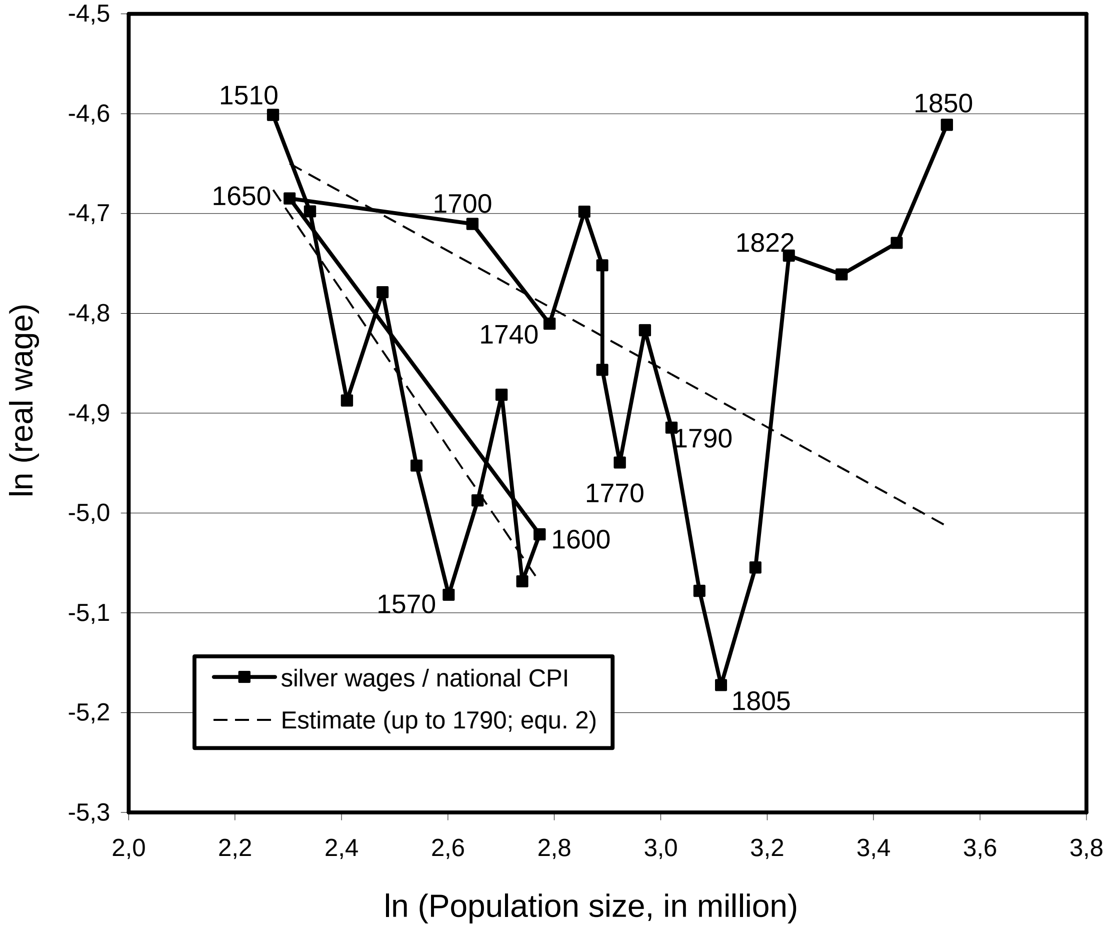
Table 3: The changing relationship between the real wage and population, 1510–1790 (OLS regression coefficients, standard errors in parentheses, n=19)

	(1) Constant	(2) ln(pop)	(3) >1600	(4) >1600*ln(pop)	(5) R^2_{adj}
(1) ln (real wage based on local CPI)	-2.58	-0.88	-1.68	0.70	0.71
	(0.35)	(0.14)	(0.47)	(0.18)	
(2) ln (real wage based on national CPI)	-2.89	-0.78	-1.08	0.49	0.63
	(0.42)	(0.16)	(0.56)	(0.21)	

Sources: Real wage (centred five year means; 1822: mean of 1818–1827): Appendix 2.1, cols. 4 and 5; population (pop) in million: 1500–1700 Ch. Pfister (1994: 10, 74–76), 1740–1815 Gehrmann (2000: 97); 1822–1850 Fischer et al. (1982: 21). >1600 is a dummy variable with the value of 1 for all years from 1650 and 0 otherwise. — Given the uncertainty surrounding the real wage and population size in 1500 I use population and real wage in 1510 instead, population in 1510 being extrapolated on the basis of population size in 1520 and its growth rate in 1520–1530. Ch. Pfister also extrapolates population size in 1618 on the basis of the growth rate recorded for the 1590s. Since this is rather speculative and because the level of the real wage in 1618/22 is highly uncertain I renounce on using this data point. The real wage in 1822 is defined as the mean estimate for the five year periods 1818/22 and 1823/27.

Figure 5 combines the real wage series developed in the present study with tentative estimates of population size in Germany during the pre-statistical era. Its inspection suggests the presence of two periods with different structural relationships between the real wage and population size, one for the sixteenth century and another lasting from the mid-seventeenth century until the end of the Ancien regime: During the latter the negative slope was considerably weaker than during the former. This shift can be modelled using the regression equations shown in Table 3: For both real wage series there is a statistically significant interaction effect between the time dummy and population size. The results are stronger for the variant based on locally deflated wages because its fall is steeper during the first half of the sixteenth century and declines smoother during the later eighteenth century than the series based on silver wages deflated by the national CPI. To present a conservative picture Figure 5 is based on the latter variant.

Figure 5:
The trajectory of the real wage and population size



Taken together, the material assembled so far lends itself to the following five statements about the evolution of the real wage in Germany from the sixteenth to the middle of the nineteenth centuries:

First, the sixteenth century was characterized by a dramatic decline of the real wage by about 40 to 43 per cent between 1503/07 and 1598/1602, which was only definitively reversed in the mid-1880s, when the German economy embarked on a path of rapid aggregate growth.[8] The decline started from 1508/13 and minima were reached in 1593/97, 1608/12 and 1618/22 — given the imprecision of the estimates for the latter two five year

8 This conclusion results from splicing the Gömmel index displayed in Figure 4 with the index shown in column 5 in Appendix 2.1. The resulting values for the five year periods centred on 1885, 1890 and 1895 are, respectively, 0.0103, 0.0108 and 0.0122.

periods it is impossible to determine exactly when the downward movement ended. The first five year period corresponds to the general European crisis of the 1590s (Clark 1985), the second and the third relate to the culmination of the *Kipper und Wipper* era and the onset of the Thirty Years War. The secular reduction of living standards was a common European phenomenon, but its extent may have been more drastic in Germany than elsewhere (Allen 2001: 428). It is noteworthy that a significant portion of the decline occurred already during the first part of the century; between 1503/07 and 1527/32 the real wage fell between a fifth and a third, depending on the estimate one uses. This fact sheds new light on the background of the widespread social unrest during this period, which culminated in the Peasant War of 1525. Over the sixteenth century as a whole there is a negative elasticity of the real wage on population size of about -0.78 to -0.88 (column 2 in Table 3). In England this coefficient seems to have amounted to about -1.25 during the later Middle Ages and the early modern period (Lee 1985: 651, 654–6; Clark 2007: 121). If the real wage index is left unadjusted for changes in consumption patterns the value for Germany gets closer to the English figure (-1.02; wages deflated by local CPIs). The existence of a fairly close negative relationship between the real wage and population size during the sixteenth century suggests the prevalence of a static aggregate production function. Given the absence of significant technological progress and a declining marginal product of labour, 1 per cent population growth translated into a decline of the real wage by a roughly equal proportion. The fact that population grew unabatedly despite a strong decline of the real wage also suggests that Malthusian checks were weak or non-existent. Future research into the demographic history of Germany will have to verify whether this conjecture holds or not.

Finally, the existence of stable elasticity of the real wage on population size during the whole sixteenth century implies that the deterioration of climatic conditions from the late 1560s, which is sometimes held responsible for mass poverty and social dislocation in late sixteenth-century Germany (Ch. Pfister and Brázdil 1999; Behringer 2005), had at best a secondary impact on material welfare (cf. Bauernfeind and Woitek 1999). Otherwise, a clear downward shift of the labour productivity schedule should have occurred during the final third of the sixteenth century, which was obviously not the case.

The second statement refers to the effects of the Thirty Years War (1618–1648). From 1598/1603 to 1648/52 the real wage rose by some 40 per cent. The mean of 1653–1672, which marked the heyday of lower-class living standards during the three centuries preceding industrialization, was about another 23 per cent higher (with a wide margin of error); it stood about 73 per cent above the level in 1598/1602 and was roughly equal to the value prevailing at the beginning of the sixteenth century. Since between 1600 and 1650 the combination of the real wage and population size moves upwards left along the regression line in Figure 5 it was not technological progress which lay behind this spectacular improvement of material welfare among wage earners, at least until 1650. Rather, the rise of the real wage during the first half of the seventeenth century was entirely due to the huge population losses (40 per cent or more) during this time, most of them being the result of devastating epidemics of bubonic plague whose spread was facilitated by war-related geographical mobility. Depending on the steepness of the real wage decline one wishes to accept for the sixteenth century the extrapolated real wage for 1650 actually lies considerably above the observed level; equation (1) in Table 3 — based on wages deflated by the respective local CPIs, which I consider more accurate in most cases than silver wages deflated by the national CPI — suggests a difference of 11 per cent. This constitutes a rough estimate of the war-related welfare loss net of the effect of the fall in population size: Given a static technology, the war benefitted its survivors through a huge loss in human resources, but probably the effect of the reduction of population size on welfare would have been greater if population size had been reduced in a peaceful context.

Of course, we can only speculate about the nature of a probable war-related welfare loss net of population decline (cf. Stier and von Hippel 1996: 240–3): Many regions suffered a decline of their capital stock that surpassed the reduction of the work force as a result of plundering by marauding troops, particularly with respect to the size of cattle herds and seed stocks. In addition, local networks of production were disrupted by the dislocation caused by war-related mobility and high mortality rates in the wake of epidemics.

The assessment of the size of the war-related welfare loss crucially bears on the interpretation of the positive income shock occurring during the 1650s. If it was close to nil, as suggested by Figure 5 and equation (2) in Table 3, then it must have been due to some exogenous force, such as the integration into the emerging North Sea trading system. By contrast, if the existence of a war-related welfare loss is admitted there is room for post-war reconstruction. Placing the former at about 11 per cent of the real wage in 1648/52 implies that roughly half of the real wage increase between that five year period and the average in 1658–1672 (23 per cent) may have resulted from reconstruction taking place in the first decade after the conclusion of peace. Given the crudeness of the presently available information it is impossible both to assess the share of post-war reconstruction in the income shock of the 1650s and to identify an exogenous source of income growth during this period.

The third observation relates to the period from the third quarter of the seventeenth to the late eighteenth century. After reaching a climax around 1670 the real wage again entered into gradual decline. Considering the parallel growth in population size, which by 1740 reached the level attained in 1600, the fall of the real wage was modest compared to the sixteenth century. This fact is expressed by a rather flat relationship between the real wage and population size (-.2 to -.3; the sum of columns 2 and 4 in Table 3). This change of the implied labour productivity schedule at some time point during the second half of the seventeenth century constitutes the most salient finding of the present study with regard to the long-term evolution of the German economy.

There are two plausible and mutually reinforcing explanations of this result whose verification has to be left to future research, however. First, there may have occurred a continuous outward shift of labour productivity within the framework of Smithian growth. The rise of the North Sea trading system referred to earlier led to a decline of transaction costs in the long-distance trade of goods with a high ratio of value to bulk and thus fostered the development of regional export industries. Population growth in the areas concerned led to an expansion of the demand for basic foodstuffs, which was satisfied by growing agricultural specialization both in proto-industrial and neighbouring agricultural regions (Kaufhold 1986; Ogilvie 1996). The gains from specialization helped to check the decline of the real wage in face of growing population size and weakened the effect of Malthusian feedback.

The second hypothesis states that Malthusian checks may have grown in strength. The regional state and church apparatuses that had emerged by the middle of the seventeenth century, by a bureaucratization of the property and family relations and by disciplining youths (Rebel 1983; Robisheaux 1981), provided for new mechanisms for regulating family formation and access to property. This may have increased the elasticity of the marriage rate on the real wage and thereby reduced the mid-term negative relationship between population growth and the real wage. In fact, existing research on the relationship between grain prices and vital rates in Germany during the post-Thirty Years War period suggest a substantial preventive check and the absence of "demographic hothouse" conditions (Galloway 1988: 291–4; Fertig 1999; Guinnane and Ogilvie 2008).

The fourth observation refers to the evolution of the real wage during the first half of the nineteenth century. The Revolutionary and Napoleonic Wars presented an enormous shock to the world economy. As many battles were fought on German territory, the wars brought hardship and serious dislocation in numerous regions (O'Rourke 2006; Planert 2007: 125–335). Because bubonic plague had disappeared from German lands in the course of the second half of the seventeenth century, unlike the Thirty Years War later wars were no more linked with massive population decline. Hence, the turn of the nineteenth century saw a deep plunge of the real wage far below the level that would be expected on the basis of the relationship between the real wage and population size prevailing in the eighteenth century (Figure 5). It is important to stress the difference between the nadir of material welfare in the modern era occurring in the early 1800s and the dire conditions prevailing around 1600: The former resulted from an external political shock at the end of a period characterized by rather weak negative feedback of population growth on the real wage; the latter resulted from the combination of population growth and a steeply declining marginal product of labour.

After the war period the real wage-population size trajectory in Figure 5 moved quickly in upward right direction, suggesting a definitive end of Malthusian feedback by the early 1820s. This structural break, which occurred well before the onset of industrialization in the 1840s, finds no mention in existing scholarship. Rather, the favourable conditions of wage labourers during the early 1820s are considered as a reflection of low grain prices which in term resulted from a series of bumper harvests. Perhaps the property rights and labour market reforms enacted in several German states during the early 1800s partly as a reaction against threatening French dominance deserve renewed attention as a more fundamental explanation of real wage growth during this period (Dipper 1980; Kaufhold 1982; Harnisch 1984).

Whatever positive shock there happened in the German economy during the late 1810s and early 1820s it only had a one-time effect: The real wage level attained in 1823/27 was reached again in later five periods centred on 1835, 1850 and 1875 but was only topped in the mid-1880s (Figure 4). At the same time serious food crises produced progressively dipper dips in 1828/32, 1843/47 and 1853/57, which justifies contemporary concern about mass poverty (Wehler 1987: 281–96). Only from the late 1850s did a sustained rise of the real wage set in.

In this context the signs of a widening urban-rural wage gap should be recalled, which occurred at a time when urbanization began to gain momentum (see above). The growing cities were faced with major sanitary challenges, testified for instance by the cholera epidemics that raged in several large towns around 1831/2, 1837 and 1848–50 (Bass 1991: 292). In general, mortality was higher in large cities than the population at large and tended to fall later (Vögele 2001: 91–3). Heights of males in the Kingdom of Saxony, which was an early industrializer, declined considerably during the first half of the nineteenth century (Ewert 2006; Steckel 2009: 12–3). It may thus well be that the rise of urban wages between c. 1815 and a couple of favourable years between c. 1820 and the late 1860s only compensated for a declining biological standard of living, as has been argued for the English case (Feinstein 1998; Voth 2004).

The fifth and very tentative observation refers to regional differences. If one considers only wages that can be deflated by the respective local CPI the imputed mean real wages in the southern cities of Augsburg, Frankfurt and Nürnberg, which range from 0.0070 to 0.0088, are considerably lower than in Gdansk (0.0124), Hamburg (0.0108 up to 1648/52, 0.0192 from 1653/57), Leipzig (0.0095) and Quedlinburg (0.0136), which all lay north of the central mountain range (cf. Appendix 2.2.b). In the extended dataset based on silver wages deflated by the national CPI the southern towns characterized by low incomes are joined by Ansbach, whereas the list of northern towns with a high real wage is extended by Bremen, Köln and Neustadt/Holstein.[9] There was thus a tendency for material welfare to be higher in the north, where the man-land ratio was lower than in the south and where integration into the North Sea trading system produced gains from specialization. The differentiation between the two regions seems to have occurred mainly in the sixteenth century: Between 1510/11 and 1600/01 the real wage in Hamburg fell by a modest -13.6 per cent, while it actually rose in Xanten until 1555/56. In the three towns of Gdansk, Hamburg and Leipzig real wages rose by an average of 20 per cent between 1583/84 and 1600/01. It fits into this picture that between c. 1600 and the spectacular rise of Berlin from the middle decades of the eighteenth century, Gdansk and Hamburg were the two largest German towns (Bairoch et al. 1988: 4–9, 55). By contrast, long distance trade and industry faltered in Upper Germany after the 1560s. Correspondingly, the real wage fell by more than 40 per cent on average in the three towns of Augsburg, Frankfurt and Strasbourg from 1510/11 to 1600/01.

However, not all towns fit into this pattern of a north-south divide with respect to the real wage.[10] The first case is Göttingen, which also belongs to the northern part of Germany, but whose mean real wage tends to the lower range of all towns. Given the implausibly high bread prices in this town referred to above, the low real wage may reflect problems with data quality or measurement conversion. But in interpreting the case of Göttingen one should also take into account the fact that the later province of Hannover (excluding the narrow strip of marshlands on the North Sea coast), of which Göttingen was a part, displayed the lowest mean wage of rural labourers west of the Elbe river, which separated former *Grundherrschaft* from *Gutsherrschaft* regions, during the first half of the nineteenth century (Appendix 2.2.d). Second, Strasbourg displays a mean real wage that approaches the upper end of the range of all towns considered. However, this is essentially due to a high level prior to the serious subsistence crises from c. 1570, and the series ends in 1650. If the pre-revolutionary eighteenth century (1702–1788), when the Alsace still remained outside the French tariff regime and Strasbourg retained a considerable degree of autonomy, is included into the analysis with a separate dummy, its regression coefficient is only little above the value recorded for Augsburg, the lowest one. The high mean real wage for

9 See Appendix 2.2.c and Figure 2. Note that in Bremen probably a third of the wage of unskilled labourers was retained by the masters who employed them (Gerhard 1984: 10). Nevertheless, even the reduced figure (c. 0.0110) is clearly above average. The real wage in Gdansk and Leipzig is below average in this version. This suggests that the high real wage evidenced by the specification that uses the respective local CPIs as deflators is primarily due to a low price level which may have resulted from the low man-land ratio prevailing in the eastern parts of Germany.

10 I leave aside towns where the real wage can only be deflated by the national CPI.

Strasbourg therefore is consistent with the impression that at least from the last quarter of the sixteenth century the south fell behind the north with respect to material welfare. Third, the real wage in München was higher than in other southern towns already during the early modern and approached the one recorded for Leipzig, at least if the wage deflated by the local CPI is considered. This can be interpreted as an early capital effect: As a result of the formation of territorial states on a regional level, residences of a court and a government apparatus increasingly attracted resources from their surrounding territories (François 1978).

Conclusion

Beyond providing information on the long-run evolution of material welfare, the present investigation into consumer prices and wages in Germany during the three-and-a-half centuries preceding industrialization provides novel insights into development patterns and turning points of the German economy during this era. First, there was a strong negative feedback between population and the real wage until the middle of the seventeenth century. While the Thirty Years War benefited the material welfare of the survivors through a huge decline in population size, the real wage was probably lower than extrapolated on the basis of the labour productivity schedule, suggesting a net loss in welfare that created room for a gain from post-war reconstruction. Second, the fall in the marginal product of labour with rising population size was much less drastic in the eighteenth than in the sixteenth century. This points to a continuous outward movement of labour productivity as part of Smithian growth recorded elsewhere in Europe, possibly in conjunction with a strengthening of Malthusian adaptation, in particular the preventive check. Third, already between the 1810s and 1820s the Malthusian relationship between the real wage and population size prevailing in the eighteenth century was broken. The reasons for this structural rupture, which occurred well before the onset of industrialization during the 1840s, remain obscure and need further study. Despite this upward shift of the real wage around 1820, however, Germans had to await the late 1850s for the onset of a sustained rise of the labour income, and only during the two last decades of the nineteenth century was the level of material welfare prevailing at the beginning of the sixteenth century surpassed.

In a methodological perspective, the present study has developed two variants of a national real wage series, one based on wages deflated by the local consumer price of the respective town, the other using an extended data set of silver wages that were deflated by a synthetic national consumer price index. The results obtained with these two variants were roughly consistent, suggesting that the statements derived from the analysis of locally deflated real wages, which are more precise than those that can only be deflated by a national price index, are fairly robust. The existence of numerous discrepancies between the two series, but also the comparison of the present findings with those of an earlier study on the early nineteenth century that uses a price index derived from only one town, points to the importance of a broad regional coverage of prices of consumer goods. Particularly the first part of the nineteenth century, for which data are at present less abundant even compared to the eighteenth century, deserves the attention of future research.

Appendix 1: Sources and data definitions

Years in brackets indicate the period covered by information on prices. Unless indicated otherwise regressions for the purpose of extrapolation were performed on silver prices for metric units.

Ansbach
Nominal wages for unskilled masonry work in 1750–1850 and silver content of currency are from Gerhard (1984: 52–8, 623). In the case of multiple entries the weighted average is used.

Augsburg (1502–1800)
Taken from Allen's database, accessed through http://www.iisg.nl/hpw/data.php#europe; cf. Allen (2001: 437). Data refer to harvest years. Modifications:
Firewood: No price series seems to be available for southern Germany; Allen uses prices from Vienna. Instead, I rely on price data from Würzburg for wood supplied by Karren, which are available with satisfactory density from the 1650s (Elsas 1936: 627–31). Before that period I draw on the synthetic firewood price series established for Frankfurt (see below). Currency conversion of Würzburg prices relies on Metz (1990: 436–443, variant with high silver content). The heating value is assumed to be 213.21 l per million BTU, the value of pine wood. The ratio of seven scattered values covering the years 1617–1643 with the synthetic wood price in Frankfurt in the respective years is 0.9712. For the period up to 1650 I fitted the two series by transforming the Frankfurt data with that factor. The resulting price series is slightly higher than the Vienna series in the early sixteenth century and roughly double the Vienna price in the later eighteenth century. It suggests firewood prices usually a bit higher than in Strasbourg but still considerably lower than in Gdansk, Hamburg and Leipzig.
Wages: Summer wages for unskilled building labourers ("ungelernte Bauarbeiter") were taken from Elsas (1936: 733–4) from 1674. For earlier years wages of "Mörtelrührer" (mortar mixers) show a much higher data density than the unskilled wage. Therefore, the former were used and spliced to the unskilled wage on the basis of the mean ratio between the two in 1675–1678. In both series missing data were replaced by the values of neighbouring years if these were identical.

Bremen
Wages for masonry work in 1750–1850 and silver content of currency are from Gerhard (1984: 89–105, 623). In the case of multiple entries the weighted average is used. Note that journeymen received the same wage as unskilled labourers, but the latter were deducted an overhead sum by masters that amounted to about a third of the pay rate (Gerhard 1984: 10). I use the unadjusted figure.

Chemnitz
Wages for unskilled masonry work in 1770–1850 are from Strauß (1962/IV: 159–61). For currency conversion refer to Leipzig.

Frankfurt am Main (1500–1650)
Wage and price data are from Elsas (1940: 19–29, 93–256, 461–515, 570–8). Important portions of data relate to Speyer (Elsas 1940: 39–46, 386–457, 550–69). Information on currency is from Metz (1990: 426–35). Price data refer to harvest years.

Bread: Since no wage data for building craftsmen are available the bread price was extrapolated by multiplying the unskilled wage (see below) with 1.6 (the average skill premium) and a synthetic rye price series. The latter was constructed as follows: First, missing data were extrapolated using prices for oats using the equation rye = -0.0277 + 2.0703 oats (all fallowing regressions refer to silver prices; extreme values of 1635/36 omitted; Pearson r=0.88). Second, the larger part of the remaining missing data (seventeenth century) was extrapolated using rye prices in Speyer using the equation Frankfurt = 0.1804 + 0.5105 * Speyer (1510–1650; Pearson r=0.76). The remaining gaps were filled using linear interpolation.

Peas: Only 36 observations are available (1500–1650). Data were extrapolated first on the basis of peas prices in Speyer using the equation Frankfurt = -0.0122 + 0.9522 * Speyer (extreme value in 1632 excluded; Pearson r=0.97). Second, the resulting series was regressed on oats prices in Frankfurt yielding the equation peas = 0.0028 + 2.4790 * peas (extreme values in 1634 and 1637 excluded; Pearson r=0.86), which was then used to extrapolate further data. Remaining gaps (n=17) were filled with linear interpolation; the value of 1500 was set to the mean of 1501–1504.

Beef: Prices for 1537–1614 were taken from Speyer (except 1602, for which a price is available from Frankfurt). These data contain moderately dense information on the prices of oxen and beef. The price ratio between these two types of meat changes over time: Until 1573 price equality was assumed. 1574–1585 a linear declining trend of the price ratio beef / oxen from 1 to 0.74 was applied, to be followed by a fixed ratio of 0.77 during the years 1585–1596. Beef prices were extrapolated from oxen prices using these ratios. The synthetic series was regressed on beef prices in Augsburg in order to extrapolate beef prices for 1500–1537; the equation is Frankfurt_Speyer = 0.5347 + 0.6839 * Augsburg (extreme values of 1619–1623 excluded; Pearson r=0.77). Finally, seven missing data points during the seventeenth century were closed using the means of the two neighbouring years.

Butter: Most missing data could be extrapolated with data from Speyer using the equation Frankfurt = 0.4236 + 1.0218 * Speyer (extreme values in 1621, 1623, 1635–1637 omitted; Pearson r=0.77). The remainder was filled with linear interpolation; the values of 1500–1502 were set equal to the mean in 1503–1505.

Eggs prices were extrapolated by dividing the beef price by 20.

Wine: Gaps were filled with linear interpolation; 1650 was set equal the mean of 1646–1648. The weight in the consumer basket was modified according to Allen (2001: 421, note to Table 3).

Linen: No continuous series is available. I spliced moderately dense series for Southern German fustians (middle quality) with prices of linen used to envelop corpses, which — perhaps symptomatically — become available from 1619. For this, I first extrapolated missing values in the Biberach series on the basis of Ulm prices using the equation Biberach = 1.9118 + 0.5377 * Ulm (1500–1615, Pearson r=0.79). The resulting series was then used to extrapolate prices of fustians from Augsburg on the basis of the equation Augsburg = -2.8264 + 1.6153 * Biberach (Biberach series with extrapolated values; outlier 1550 omitted; period 1500–1615; Pearson r=0.89). I then deflated this synthetic fustian price series by 0.43 and linked it with the price series for linen used to envelope corpses. The choice of this ratio was informed by two considerations: First, between 16105–1617 and the 1640s the resulting synthetic series displays a marginally smaller mean price change than tickling (23.1 and 23.8 per cent, respectively). Second, the ratio of the mean of the five to six scattered data points of linen price and fustian price during the period 1620–1631 is 0.448.

Soap: Only 21 years covered by original data. Missing data were extrapolated on the basis of prices for tallow using the following regression: Soap = 2.7501 + 0.6089 * Tallow (1500–1615; Pearson r=.89). The remaining missing values were interpolated; the values 1500–1502 were set equal to the mean of 1503–1505.
Candles: Omitting the outlier in 1635 the regression on the price of tallow yields Candles = 0.2225 + 1.1145 * Tallow (Pearson r=0.93). This was used to extrapolate missing values. Remaining gaps were interpolated; the values of 1500–1502 were set equal to the mean of 1503–1505.
Tallow: The above equation was used to extrapolate some missing values on the basis of candle prices. The few remaining gaps were interpolated; prices in 1500–1502 were set equal to the mean of 1503–1505.
Firewood: From 1564 the price of Dürrwellen is used. Missing values are substituted by the means of adjacent values (often identical or close). 1650 has been assumed identical to 1649. To extrapolate values before 1564 two series were used: prices of Dornwellen and a synthetic series of charcoal prices. The latter was constructed by regressing the price of charcoal bought by the town on the price of charcoal bought by the Heilig-Geist Hospital yielding the estimate Community = 0.0026 + 0.8384 * Hospital (Pearson r=0.95). This equation was used to extrapolate missing data in the community series. Since nominal wood prices stayed constant over several years I did not use regressions to extrapolate wood prices. The ratio between the charcoal and Dürrwellen prices per litre is 16.98 (1500s), 18.47 (1510s), 22.90 (1520s), 27.14 (1530s), 24.29 (1540s), 31.66 (1550s) and 31.30 (1560s). Between the 1560s and 1590s, when several series overlap, the price ratio Dürrwellen / Dornwellen rose at about the same pace as the price ratio charcoal / Dornwellen, albeit at a much lower level of 0.07. Therefore, for years until 1562 I extrapolated Dürrwellen prices on the basis of Dornwellen prices by dividing them by the charcoal to Dornwellen price ratio in the respective decade, scaled by 0.07. Six more missing values were replaced by dividing the values from the synthetic charcoal series (without interpolations) by 14. The few remaining missing data points were interpolated. Dürrwellen seem to come from shrubs and, therefore, must have had a rather low density. To arrive at a BTU price, I took the heating value of pine (313.21 l per million BTU) multiplied with 5. This leads to values close to Strasbourg (1500–1650) and Würzburg (seven data points in the first half of the seventeenth century; cf. sub Ausburg above). Regressing the price per million BTU of firewood bought by the Heilig-Geist hospital on this synthetic series in 1513–1548 (13 data points, Pearson r=0.89) produces a slope of 0.9410. Thus, the synthetic series appears consistent with other information on energy prices in south-western Germany.
Wage data refer to the summer wage of unskilled workers employed in construction and the maintenance of town fortifications. The values of 1620/21 have not been used in calculations.

Gdansk (1535–1814)
Taken from Allen's database, accessed through http://www.iisg.nl/hpw/data.php#europe; cf. Allen (2001: 441). Data refer to harvest years.
Extremely high prices of meat in 1808 and 1814, of eggs in 1813 and of oil in 1807 were replaced by the means of the two respective adjacent years.

Göttingen (1759–1850; 1761/62 missing because of monetary disturbances)
Wages for mason journeymen and unskilled building labourers are from Gerhard (1984: 212–31, 238–66; weighted averages in the case of multiple entries), prices from Gerhard

and Kaufhold (2001: 134–36, 161–5, 210–3, 239–42, 258–62, 271–4, 291–3, 325–6, 350–1, 411–6, 427–8, 521–2, 539). All data refer to calendar years.
Bread is "1-Mariengroschen-Roggenbrot" (1848 extrapolated using equation 2 from Table 2); meat is beef.
Butter: Prices in Göttingen and the neighbouring manor of Waake are closely correlated (Pearson r=0.91). Missing values in 1759, 1760, 1763 and 1832–1850 were extrapolated using the equation Göttingen = 2.6566 + 0.6045 * Waake. 1762 was interpolated using the mean of 1760 and 1763.
Eggs: Prices in Göttingen and the neighbouring manor of Waake correlate reasonably well (Pearson r=0.82). Therefore, missing values in 1759–1761 and 1832–1850 were extrapolated using the equation Göttingen = 0.0626 + 0.7950 * Waake.
Beer: "Broyhan" sold in retail trade in Kessel were used. Using the metric volume of Kessel indicated on p. 539 yields a price that is only about one tenth of the price of the same quality traded in bulk in "Fässer". I was unable to check the source for the weights and measures used and I multiplied the values by 10. Values until 1772 were extrapolated (before correction by the factor of 10) from bulk prices (Pearson r=0.96) using the following equation: Retail = 0.0029 + 0.1297 * Bulk.
Series for the following goods are taken from Hamburg price lists. From 1823 many prices were quoted in Mark with 16 Schilling instead of Reichstaler with 48 Schilling (Gerhard and Kaufhold 1990: 51–2) but the precise nature of the currency change is not clear in every case.
Linen: Osnabrück linnen traded in Hamburg. Prices approximately tripled from 1822 to 1823; hence, from 1823 prices were divided by 3.
Soap: Russian soap traded in Hamburg. For 1736 to 1784 its price is moderately correlated with the one of French soap also traded in Hamburg (Pearson r=0.67). Nevertheless, I used the following equation to extrapolate missing values in 1765–1775: Russian = -0.8666 + 1.2504 * French. Missing values in 1788/89 and 1804 were interpolated using the means of the two neighbouring years, respectively. From 1822 to 1823 prices approximately double. By contrast, French soap experiences a price reduction by roughly one quarter, which is consistent with the transition of quotations from Mark currant (6.887 g of silver) to Mark banco (8.66 g of silver). I therefore spliced the series up to 1822 and from 1823 in such a way that there was no price change in 1822/23. — Despite all these difficulties I opted for Russian rather than French soap because at least from the 1820s it was about 10 per cent cheaper than the French product and because price fluctuations were less extreme during the Revolutionary and Napoleonic Wars period. With French instead of Russian soap the consumer price index would be 1–2 per cent higher for most years 1793–1817 and less than 1 per cent lower in the period up to 1783.
Candles and fat for lightning: Prices for tallow candles are given for the nearby manor of Waake, albeit with many gaps. They are reasonably well correlated with tallow imported into Hamburg from Russia (Pearson r=0.85). Therefore, missing values in 1759–1767, 1784–1794, 1812 and 1827 were extrapolated using the equation Candles = 3.0570 + 0.9242 * Tallow. The latter price was used as a proxy for the price of lightning oil/fat (cf. also the notes on Leipzig below).
Firewood: Prices for hard wood of the St. Hiob hospital in Hamburg are used until 1811. After this year they are replaced by mean prices for beech wood by decade sold by state forests in what became later the Prussian province of Hannover (Eggert 1883: 26). Since this information refers to "forest" or farm-gate prices these data cannot be compared to

retail prices. They were therefore scaled according to the ratio between the mean price in Hamburg in 1800–1809 and the price of Hannover state forests indicated for the first decade of the nineteenth century. Note that the firewood price in 1850 was extrapolated using Eggert's figure for the 1850s.

Hamburg (1510–1802)
All price and wage data are from Gerhard and Engel (2006: 108–308) and refer to calendar years. For currency conversion I rely on valuations of the *Rheinischer Gulden* and the *Reichstaler*, respectively, reproduced by Gerhard and Engel (2006: 321–322) and on the gold content and of these currencies and the gold-silver price ratio in Cologne as given by Metz (1990: 368–375, 391–391) to derive the silver content of the Hamburg shilling until 1567. From 1568 Gerhard and Kaufhold (1990: 415) is used. The change of the information base leads to a revaluation of the shilling in the order of 1.2 per cent.
Bread: From 1540 rye prices of the St. Hiob hospital is used. Prices for 1510–1539 are extrapolated from the series of the St. Georg hospital using the following equation (1540–1612): St. Hiob = 0.0185 + 0.8400 * St. Georg (Pearson r=0.82). For the bread price calculation the wage of skilled labour was proxied with the wage of unskilled labour multiplied by 1.6, the average skill premium.
Peas: Prices from St. Hiob in 1540–1733 form the heart of the series. Wherever possible missing values were extrapolated using the following equation: peas = 0.1350 + 0.8796 * beans (Pearson r=0.69; bean prices also from St. Hiob). For the six data points in the period 1540–1545 regressing beans prices of the two hospitals with each other yields St. Hiob = 0.0867 + 0.8051 * St Georg. The two regressions are used to extrapolate St. Hiob peas prices in 1510–1539. The resulting series is moderately correlated with peas prices in Gdansk (Pearson r=0.63; 1535–1719), but the regression parameters are not suitable to be used for interpolation. Therefore, the difference between the two series (0.14 g silver) is added to the Gdansk prices, and these data are used to interpolate prices from 1734 and to substitute for missing values from 1719.
Meat: Beef prices from the records of the St. Hiob hospital for 1539–1729 constitute the heart of the series. For 1510–1538 prices from Frankfurt are used because for the years 1539–1558 the means of the two series are identical. During the period 1615–1719 the means of beef and pork prices in the St. Hiob records are identical, and the two series are reasonably correlated (Pearson r=0.71). Therefore, missing values in the beef price series were substituted by pork prices, and the latter data are used to extend the series until the end of the eighteenth century. The remaining missing data from 1699 were extrapolated using the following regression: beef Hamburg = 0.9717 + 0.8259 * beef Gdansk (Pearson r=0.75; three outliers in 1665, 1668 and 1669 were removed).
Butter prices are essentially from the records of St. Hiob (from 1539). During the years 1539–1545 this series overlaps with prices from St. Georg. The regression parameters (St. Hiob = 0.2303 + 0.6914 * St. Georg; Pearson r=0.96) is used to extrapolate prices in 1510–1538. 1682–1801 the prices of butter and soft cheese provided by the records of St. Hiob are correlated as follows: butter = 0.0412 + 1.8888 * soft cheese (Pearson r=0.84). This equation was used to extrapolate about half the missing values from 1680 (in total about a third of all years). The remainder was filled with the means of adjacent years; the price in 1802 was set to the value of 1801.
Eggs: Extrapolated using beef / 20.
Beer: Information from St. Hiob covers the years 1539–1755. Before 1539 the series from St. Georg was used. Regressing the two series on each other yields St. Hiob = 0.1719 +

0.5012 * St. Hiob (Pearson r=0.74; 1539–1607). This equation was used to extrapolate missing values in the St. Hiob data in 1560–1584. After 1755 the St. Hiob records contain information on beer prices only for 1781–1792. Both in the 1750s and 1780s beer prices in Hamburg are only slightly higher than in Göttingen; hence, Göttingen prices augmented by the small difference (0.025 g silver per litre) is used for 1759 to 1802, except for 1781–1792. The remaining gaps in the data were filled with linear interpolation.

Linen: Sales prices from St. Hiob in 1539–1620 (plus an isolated data point in 1633) constitute the heart of a synthetic series. A slightly less dense price series for purchased linen is available from St. Georg, but sales prices of St. Hiob were usually at the same level or even somewhat higher than the prices recorded by St. Georg. While the regression St. Hiob series on synthetic linen prices in Frankfurt shows a low fit (Pearson r=0.50) it yields plausible parameters: St. Hiob = 1.8355 + 2.2050 * Frankfurt. Therefore, it was used to extrapolate missing values in the St. Hiob series and to extend it backward to 1500 and forward to 1734. Data for later years were generated by attaching the series developed for linen drill prices in Leipzig (see below) to the Frankfurt series through the following equation: Frankfurt = -1.0413 + 0.7387 * Leipzig (Pearson r=0.86; 1623–1734, outlier in 1624 removed).

Soap: Priced recorded by St. Hiob for the years 1603–1665 and 1702–1721 constitute the starting point for constructing a synthetic series. The best correlation with prices of other animal fats is with butter (Pearson r=0.68; 1607–1721): Soap = 0.7206 + 1.0092 * butter. These parameters were used to interpolate a complete series from 1500 to 1802. A few prices recorded after 1721 were so low compared to imported Russian and French soap that they were replaced with extrapolated values.

Tallow: The regression on the soap price series yields tallow = 1.1209 + 0.4401 * soap. (Pearson r=0.65; 1547–1719). These parameters were used to interpolate prices for 1510–1546 and 1720–1802. Gaps in between were filled by linear interpolation.

Candles: No price information is available. The regression of candles on tallow prices obtained for Frankfurt is used to extrapolate candle prices on the basis of the price series for tallow in Hamburg.

Firewood: Prices for hard wood recorded by St. Hiob were used for 1539–1541 and from 1547. A heating value equal to beech was assumed; 151.03 l of wood are required for 1 million BTU. Values back to 1515 were extrapolated by regressing hard wood prices from the St. Hiob hospital on charcoal prices recorded in the *Kämmereirechnungen* of the town community (Koppmann 1883–1892; data kindly made available in electronic form by Oliver Volckart): wood = 4.0086 + 1.3972 * charcoal (Pearson r=0.77; 1549–1562, but excluding the maximum and the minimum of the charcoal series). Missing values in the charcoal price series were extrapolated by regressing them on prices of hard wood recorded by the St. Georg hospital: charcoal = 0.5758 + 0.2589 * St. Georg (Pearson r=0.71; 1522–1545). The values in 1510–1514 were set to the mean value of the years 1515–1517.

Wages: The day wage paid by the St. Hiob hospital for unskilled work of males is used from 1547, but data density is low until 1650. For 16 data points in 1547–1611 the regression on the day wage of unskilled male labour at the St. Georg hospital yields St. Hiob = 0.5061 + 0.9214 * St. Georg (Pearson r=0.76). These parameters are used to extrapolate missing values during this period and to extend the series backward until 1510. For the purpose of bread price calculation gaps in the resulting wage series have been closed using linear interpolation.

Köln (1700–1772)
Price information from Köln is only used for bread equation estimation in Table 2: Mean rye price and regulated bread price ("Taxe") for "Malterbrot" are from Ebeling and Irsigler (1976: 672–83, 1977: 266–8). Data refer to harvest years.
Regulated nominal wages ("Taxen") for journeymen (used for bread price analysis) and unskilled labourers in the construction trades for 1700–1790 are from Ebeling (1982: 97). The conversion into silver values follows Metz (1990: 366–95).

Leipzig (1573–1850; 1761/62 missing due to monetary disturbances)
Data until 1818 with some modifications explained below are taken from Allen's database, accessed through http://www.iisg.nl/hpw/data.php#europe; cf. Allen (2001: 437–8); the data covering the period 1819–1850 are from Koehler (1967) and Strauß (1962/63) for Chemnitz.
Data from Allen (original source Elsas 1940) refer to harvest years, those from other sources to calendar years. In Allen's file, the number of Groschen per Taler during the period 1763–1809 was corrected to 24 according to Elsas (1940: 12), and the silver content of currency 1811–1815 was specified according to Koehler (1967: 356).
Bread: Until 1799 the price is extrapolated using rye prices and the carpenter wage described below, from 1800 the price of "Zweipfundbrot" for Chemnitz is used.
The second vegetable food is peas; meat prices refer to beef.
Linen: Missing values mainly until the 1650s were extrapolated by regressing prices for linen drill on the synthetic linen price developed for Frankfurt in the period 1573–1734: drill = 2.0981 + 0.8313 * Frankfurt (Pearson r=77; outlier in 1624 removed). Gaps from the 1650s to the 1720s were filled with linear interpolation from neighbouring data points. The regression of linen drill prices on Osnabrück linen traded in Hamburg is drill = 0.3713 + 0.8011 * Osnabrück (Pearson r=0.90; 1736–1812, five outliers in 1787–1792 removed). These parameters were used to extrapolate missing values from 1741. From 1813 Osnabrück/Hamburg linen prices as defined for Göttingen are used.
Candles: Data are for Chemnitz.
Tallow: For 1815–1820 prices in Leipzig (Elsas/Allen) are virtually identical with the silver price of Russian tallow imported through Hamburg. Therefore, the latter series was used for the period 1819–1850 (see Göttingen).
Firewood: Volume conversion modified using (Elsas 1940: 36, 38). From 1724 unweighed annual means of weekly prices of pine wood recorded by an urban commissioner are used (Town archive Leipzig RSt Tit XLIX 19). In 1830 this source stops, but the price information was henceforth published by the Leipziger Tageblatt und Anzeiger. The heating value is set at 213.21 l per million BTU. The correlation between oak prices of the St. Georg hospital recorded by Elsas and the pine wood series of the Ratsstube is a mere Pearson r of 0.54 (1724–1799, 24 missing data points), which may indicate that the hospital did not appear on the wood market regularly. At least the BTU equivalents of the respective prices deviate only 2 per cent in 1724–1730.
Wages: Series of summer wages of carpenters and unskilled labourers were used. From 1799 data from Koehler (1967) are used. During this period, some of the missing data were extrapolated in local currency on the basis of winter wages using the following equations: Carpenter summer = -36.9334 + 1.5195 Carpenter winter; Labourer summer = -14.1684 + 1.4172 * Labourer winter. Wages of labourers refer to construction workers during this period.

In order to obtain a continuous series of bread prices for the period before 1799 the carpenter wage was first regressed on the labourer wage (both in grams of silver) for the period 1583–1700 yielding the equation Carpenter = 0.6829 + 1.5577 * labourer. This served to extrapolate missing data, particularly for the 1650s and the last two decades of the seventeenth century. The remaining gap were filled with the means of the adjacent years, except for 1618–1620, which were set to the value of 1617, and 1761/62 (inflationary episode), which were left blank. For the eighteenth century, interpolation was done on the basis of only 18 data points. As for the unskilled wage, data for the years 1701–1799 were extrapolated from the carpenter wage using the above equation. Since the resulting series moves in close parallel to the mean real wage for Germany as a whole (Figure 2) this heavy interpolation appears justified. It should also be mentioned that unskilled work relates to all kinds of unspecified work carried out for the St. Johannis hospital; the context suggests this included mostly agricultural tasks. Nevertheless, the skill premium with respect to carpenters (see the slope in the equation above) is the same as observed for building labourers in other towns.

München (1500–1765)
Taken from Allen's database, accessed through http://www.iisg.nl/hpw/data.php#europe; cf. Allen (2001: 437). Data refer to harvest years.
Firewood: A synthetic price series based on Würzburg and Frankfurt was used; see Augsburg.
From 1763–1850 nominal wages for unskilled building labourers and currency conversion are from Gerhard (1984: 440–462, 623–4; weighted averages in the case of multiple entries). In 1750–1762 this pay rate is 10 per cent below the wage of "Mörtelkocher und –rührer" given in the Elsas/Allen data; the wages for the period 1763–1850 were adjusted upward by this proportion.

Neustadt/Holstein
Wages for unskilled construction workers in 1798–1850 and silver content of currency are from Gerhard (1984: 516–8, 624). In the case of multiple entries the weighted average is used.

Nürnberg (1810–1850)
Wages are from Gömmel (1978: 204) and Gerhard (1984: 542–552), prices from Gömmel (1978: 216–7). Information on currency and weights has been drawn from Gömmel (1978: 215), Gerhard (1984: 623) and Witthöft (1993/94, vol. 2: 353 [Handelspfund]). Data refer to calendar years.
Prices for beans or peas are missing; those for potatoes were used instead. On the basis of an equivalent caloric intake the ratio was fixed at 87.94 kg per capita per year.
Prices for candles were extrapolated by multiplying the price of tallow with 1.67 (ratio obtained for Göttingen during the same period of time).
Firewood: Prices are for Zentner pine wood. I assume a heating value of 104.5 kg for one million BTU (heating value of volume as for Leipzig, specific weight of pine 0.49). According to Witthöft (1993/94, vol. 2: 354), a Zentner contains 51.03 kg. I assumed Doppelzentner (i. e., twice this amount). Calculated this way, 5 million BTU cost 5.5 per cent of the annual income of building workers in 1810/11–1814. This is very close to the budget share of heating suggested by Gömmel (1978: 204, 211).
Daily wage for unskilled building labourers: Gömmel reports estimated annual incomes of craftsmen in the building trades. I divided this amount by 240 (Gömmel assumes 60 days

of unemployment) to arrive at a daily wage. Gerhard reports paid wages for unskilled building labourers in 1836–1850. The mean skill premium during this period is 1.5334. I used this ratio to extrapolate the wage of unskilled labourers from the Gömmel data for the years 1811–1835.

Quedlinburg (1750–1774)
Data are from Schulze (1965/66). Conversion of measures and weights are based on Engel (1970: 2), Verdenhalven (1998: 43, 52, 64) and Witthöft (1993/94, vol. 1: 393–4, vol. 2: 401). The silver content of currency was assumed equal to the neighbouring Brandenburg territories, of which Quedlinburg depended (16,704 g silver per Taler, 24 Groschen per Taler; Rittmann 1975: 365).
Bread price relates to the regulated price ("Taxe") of rye bread weighing 6 lb.
Peas: November prices were used (for some years, additional prices are given for January).
Beef: The price of meat of lesser quality was used.
Butter: regressing prices in 1753–1789 on prices in Göttingen and Leipzig (but omitting extreme values in 1760, 1762/63; 27 observations) yields: Quedlinburg = -1.1528 + 0.7182 * Göttingen + 0.2130 * Leipzig (adjusted R^2=0.44). This equation was used to replace 8 missing values in 1750–1774. The price in 1761 was set to the mean in 1760 and 1762.
Eggs: The source provides only 5 data points based on varying units and showing wildly fluctuating price levels. Egg prices in Göttingen were used instead.
Soap: See Göttingen.
Linen: Two isolated data points are on average 0.47 grams of silver per meter above the mean value of Osnabrück linen traded in Hamburg (1750–1774; see Göttingen). The latter series is used by adding 0.47.
Candles and fat for lightning: Missing values for candle prices were extrapolated with the following equation: Candles = 3.7177 + 0.6706 * Tallow (Russian tallow quoted in Hamburg, see Göttingen; an extreme value in 1759 is omitted, 15 observations, r=0.59). The latter series is also used to proxy fat for lightning purposes.
Firewood: The mean of the series developed for Hamburg and Leipzig was used.
Wages relate to unskilled masonry work (1750–1814). Data for the early nineteenth century are from Schulze (1967: 306–9). In 1801–1814 wages of unskilled construction workers are identical with the pay rate of unspecified day labour in 6 of 8 cases. Therefore, 4 missing values were replaced with the information for the latter category of work.

Strasbourg (1500–1681)
Taken from Allen's database, accessed through http://www.iisg.nl/hpw/data.php#europe; cf. Allen (2001: 439). Data refer to harvest years.
Originally a free Imperial city, Strasbourg was conquered by the French crown in 1681. For the construction of a national CPI, data are used until 1681. Due to a lack of data, the real wage series ends in 1650.

Xanten
Nominal wages for unskilled construction workers in 1500–1556 are from Beissel (1889: 162, 164), silver content of currency is from Metz (1990: 418–9).

Appendix 2: Consumer prices and real wages

2.1 Time series

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1500	196.8	212.6	0.0117	0.0108	0.0088		
1505	179.2	192.8	0.0122	0.0114	0.0110		
1510	171.7	184.0	0.0117	0.0109	0.0100		
1515	177.2	189.2	0.0105	0.0099	0.0096		
1520	177.3	188.6	0.0098	0.0092	0.0091		
1525	176.9	187.4	0.0093	0.0088	0.0095		
1530	213.8	225.6	0.0089	0.0084	0.0075		
1535	212.5	223.4	0.0100	0.0095	0.0089		
1540	222.9	233.5	0.0092	0.0087	0.0084		
1545	238.6	248.9	0.0082	0.0079	0.0078		
1550	252.6	262.6	0.0079	0.0076	0.0071		
1555	262.1	271.4	0.0086	0.0084	0.0085		
1560	283.0	291.9	0.0085	0.0082	0.0080		
1565	304.9	313.2	0.0079	0.0077	0.0075		
1570	357.9	366.2	0.0073	0.0071	0.0068		
1575	343.6	350.3	0.0077	0.0075	0.0076		
1580	340.3	345.6	0.0078	0.0077	0.0076		
1585	356.3	360.4	0.0069	0.0068	0.0067		
1590	387.4	390.4	0.0065	0.0065	0.0063		
1595	391.9	393.4	0.0064	0.0064	0.0065		
1600	409.3	409.3	0.0064	0.0064	0.0066		
1605	386.1	386.1	0.0077	0.0077	0.0076		
1610	422.3	422.3	0.0058	0.0058	0.0062		
1615	425.6	425.6	0.0075	0.0075	0.0076		
1620	499.5	499.5	0.0053	0.0053	0.0049		
1625	525.5	525.5	0.0062	0.0062	0.0065		
1630	491.4	491.4	0.0074	0.0074	0.0072		
1635	582.8	582.8	0.0070	0.0070	0.0072		
1640	531.4	531.4	0.0090	0.0090	0.0092		
1645	444.4	444.4	0.0092	0.0092	0.0092		
1650	489.2	489.2	0.0089	0.0089	0.0092		
1655	389.4	389.4	0.0110	0.0110	0.0117		
1660	451.8	451.8	0.0104	0.0104	0.0107		
1665	411.9	411.9	0.0108	0.0108	0.0112		
1670	353.9	353.9	0.0118	0.0118	0.0120		
1675	409.0	409.0	0.0107	0.0107	0.0106		
1680	389.4	389.4	0.0114	0.0114	0.0112		
1685	362.3	362.3	0.0109	0.0109	0.0111		
1690	373.7	373.7	0.0102	0.0102	0.0102		
1695	405.1	405.1	0.0097	0.0097	0.0096		
1700	437.6	437.6	0.0091	0.0091	0.0090		
1705	375.5	375.5	0.0108	0.0108	0.0109		
1710	421.6	421.6	0.0098	0.0098	0.0097		
1715	414.4	414.4	0.0099	0.0099	0.0099		
1720	396.5	396.5	0.0097	0.0097	0.0099		
1725	386.9	386.9	0.0091	0.0091	0.0094		
1730	374.2	374.2	0.0103	0.0103	0.0105		
1735	387.9	387.9	0.0097	0.0097	0.0099		

1740	443.3	443.3	0.0080	0.0080	0.0081		
1745	407.1	407.1	0.0083	0.0083	0.0086		
1750	402.6	402.6	0.0092	0.0092	0.0091		
1755	416.0	416.0	0.0087	0.0087	0.0086		
1760	463.7	463.7	0.0080	0.0080	0.0075		
1765	463.4	463.4	0.0084	0.0084	0.0078		
1770	500.0	500.0	0.0072	0.0072	0.0071		
1775	439.7	439.7	0.0083	0.0083	0.0078		
1780	434.1	434.1	0.0085	0.0085	0.0081		
1785	472.3	472.3	0.0080	0.0080	0.0075		
1790	495.5	495.5	0.0076	0.0076	0.0073		
1795	542.0	542.0	0.0070	0.0070	0.0068		
1800	666.0	666.0	0.0063	0.0063	0.0062	90.1	4
1805	852.5	847.3	0.0058	0.0058	0.0057	93.1	16
1810	715.1	706.3	0.0068	0.0069	0.0066	51.0	2
1815	803.6	788.9	0.0073	0.0074	0.0064	87.7	24
1820	654.0	638.0	0.0083	0.0085	0.0080	99.0	8
1825	529.6	513.4	0.0096	0.0099	0.0096	82.7	24
1830	594.1	572.5	0.0084	0.0087	0.0086	79.3	11
1835	531.6	509.1	0.0094	0.0098	0.0097	87.5	34
1840	599.0	570.0	0.0081	0.0085	0.0088	85.1	12
1845	682.8	645.8	0.0076	0.0081	0.0080	80.2	4
1850	559.7	526.1	0.0095	0.0101	0.0099	89.9	124

(1) CPI: Annual cost of a basket of consumer goods in g silver, WLS estimate. (2) CPI, adjusted for the effects of changes in consumption patterns 1500–1595 and 1805–1850. (3) Real wage: fraction of the annual basket of consumer goods that can be purchased with the day wage of an unskilled construction worker; WLS estimate based on real wages deflated by the respective local CPIs with two Hamburg dummies and corrected upwards for the shock in 1648/52 and 1653/57, but without adjustment for changes in consumption patterns. (4) Same, but adjusted for changes in consumption patterns 1500–1595 and 1805–1850. (5) Real wage, extended dataset, based on silver wages deflated by the national CPI given in (1), WLS estimate with two dummies for Hamburg and München, adjusted for changes in consumption patterns 1500–1595 and 1805–1850. (6) Nominal day wage of rural workers in Prussia in Mark (for the construction of this series, see below). (7) Number of observations underlying series (6). — All series refer to five year means centred on the indicated year, except for 1500 (1500–1502) and 1850 (1848–1850).

Nominal wages of rural wages in Prussia were compiled from Neumann (1911: 276–328). Adjusted mean annual wages provided for individual localities and administrative units (*Landkreise*, *Regierungsbezirke*) by Neumann were used (cf. Neumann 1911: 70–1). Where the information relates to several years, the mean year was coded (+0.5 in the case of an even number of years). Abnormally high wages given by a printed source for Eastern Prussia in 1818 were omitted. The same holds for the Stadtkreis of Remscheid.

To create a time series of nominal wages, information on time was coded into five year periods. In analogy to equation (1) the natural log of the individual wage information was then regressed on a constant and fixed effect dummies for province (Brandenburg excluded) and five year period (1848/50 excluded). The nominal wage for a given five year period was then calculated as exponential of the sum of the constant and the coefficient of the respective time dummy.

2.2 Town and regional fixed effects

The fixed effect coefficients for the town and regional dummies in the regressions of equation (1) used to create the above time series are as follows:

a) Consumer price index (WLS estimate)

	b	t	P	implied linear mean value
Constant (Frankfurt)	6.327	50.81	0.000	559.7
Augsburg	0.019	0.66	0.508	570.5
Gdansk	-0.304	-10.30	0.000	412.8
Göttingen	0.021	0.48	0.632	571.8
Hamburg	-0.041	-1.41	0.160	537.3
Leipzig	-0.084	-2.74	0.006	514.5
München	-0.050	-1.72	0.087	532.5
Nürnberg	0.030	0.47	0.637	576.7
Quedlinburg	-0.207	-2.80	0006	454.9
Strasbourg	0.134	4.36	0.000	639.8

b) Real wage of urban construction workers, deflated by local CPI (WLS estimate, specification as in column 3 of Appendix 2.1)

	b	t	P	implied linear mean value
Constant (Frankfurt)	-4.735	-34.39	0.000	0.0088
Augsburg	-0.226	-6.15	0.000	0.0070
Gdansk	0.348	9.88	0.000	0.0124
Göttingen	-0.127	-2.41	0.016	0.0077
Hamburg up to 1648/52	0.203	5.49	0.000	0.0108
Hamburg from 1653/57	0.780	15.70	0.000	0.0192
Leipzig	0.083	2.11	0.036	0.0095
München	0.073	1.66	0.097	0.0094
Nürnberg	-0.022	-0.29	0.771	0.0086
Quedlinburg	0.436	5.71	0.000	0.0136
Strasbourg	0.321	6.92	0.000	0.0121

c) Real wage of urban construction workers, extended dataset, silver wages deflated by national CPI (WLS estimate, specification as in column 5 of Appendix 2.1)

	b	t	P	implied linear mean value
Constant (Frankfurt)	-4.673	-57.44	0.000	0.0093
Ansbach	-0.262	-4.90	0.000	0.0072
Augsburg	-0.256	-7.97	0.000	0.0072
Bremen	0.567	13.17	0.000	0.0165
Chemnitz	-0.125	-2.72	0.007	0.0082
Gdansk	0.010	0.33	0.744	0.0094
Göttingen	-0.154	-3.56	0.000	0.0080
Hamburg up to 1648/52	0.199	6.13	0.000	0.0114
Hamburg from 1653/57	0.670	15.43	0.000	0.0183
Köln	0.051	1.24	0.214	0.0098
Leipzig	-0.094	-2.73	0.007	00085
München up to 1803/07	-0.114	-3.08	0.002	0.0083
München from 1808/12	0.338	5.81	0.000	0.0130
Neustadt/Holstein	0.102	1.40	0.161	0.0103
Nürnberg	-0.036	-0.63	0.627	0.0090
Quedlinburg	0.104	2.27	0.024	0.0104
Strasbourg	0.513	12.64	0.000	0.0156
Xanten	-0.089	-1.38	0.168	0.0084

d) Nominal wage of rural workers in Prussia, first half of nineteenth century (OLS; mean)

	b	t	P	implied linear mean value
Constant (Brandenburg)	4.493	79.14	0.000	89.4
Hannover	-0.211	-3.39	0.001	72.3
Hessen-Nassau	-0.168	-2.57	0.013	75.6
Ost-/Westpreußen	-0.458	-7.27	0.000	56.5
Pommern	-0.140	-1.97	0.046	77.7
Rheinland	0.020	0.29	0.759	91.2
Sachsen	-0.333	-4.79	0.000	64.0
Schlesien	-0.563	-8.99	0.000	50.9
Schleswig-Holstein	-0.151	-2.00	0.043	76.9
Westfalen	-0.107	-1.58	0.136	80.3
Marshlands	0.381	6.24	0.000	130.8

"Marshlands" refers to localities and administrative units located on or very near the North Sea coast. Nominal values are in Mark.

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