Evolution or revolution? a study of price and wage volatility in England, 1200-1900

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A study of price and wage volatility in England, 1200-1900

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Abstract

Using annual data 1209-1914, this paper examines whether there are structural breaks in the movements of prices and wages that correspond to the major 'revolutions' identified in historical narratives. Econometric modelling of trend and volatility in prices and wages confirms the importance of the Commercial Revolution and the Glorious Revolution, but suggests that the Industrial Revolution may be better described in evolutionary terms. The evidence also points to a late medieval revolution at the time of the Good Parliament, shortly after the Black Death and just before the Peasant's Revolt. This supports Britnell and Campbell's commercialisation hypothesis - that the institutional pre-conditions for the Industrial Revolution began to develop at a very early date.

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1. Introduction

This paper investigates long-term economic changes in the English economy, using annual data on prices and wages, 1209-1914. It focuses on market volatility, which decreased markedly over the period. This study examines whether changes in volatility were evolutionary or revolutionary, or a combination of the two. We address this issue by testing for structural breaks in volatility. The presence of structural breaks is interpreted as suggesting revolutionary change, and their absence as suggesting evolutionary change (Jones, 1988). A variety of statistical methods are used in order to generate robust results. The data are analysed in context, with reference to existing historical narratives.

The historical literature makes numerous claims regarding revolutionary change (*e.g*. Israel, 1991; Brenner, 1993), but with a few notable exceptions (*e.g*. Allen, 2009) their measurable impact is not always clear. This study therefore sets out to test specific claims by examining whether structural breaks occurred at the time that historians have indicated. Several significant breaks in volatility are identified from the data. The most important is at the time of the Good Parliament of 1376 and the Peasants Revolt of 1381. Other important breaks occur at the time of the Commercial Revolution, around the start of the Stuart monarchy in 1603, and the Glorious Revolution of 1689. All of these breaks reduce volatility. Volatility increases around the time of the Industrial Revolution and decreases again during the Railway Revolution of the mid-nineteenth century.

These findings suggest that change was not purely evolutionary, and that many changes occurred much earlier than previously suggested – before 1600 rather than after. It is possible that early radical changes brought potentially disruptive factors under control and ushered in a subsequent period of progressive incremental change. Under this interpretation, the Commercial Revolution and Glorious Revolutions remain true revolutions whilst the Industrial Revolution becomes an Industrial Evolution instead. It must be emphasised, however, that this interpretation is based solely on prices and wages, and does not relate to productivity or GNP per head.

A downward trend in volatility may be interpreted in terms of commercialisation – as evidence of institutional progress which reduces the shocks impinging on the economy and increases its flexibility to adjust to them (Britnell and Campbell, 1995). For example, the tightening of political constraints on a monarch may generate a more stable policy regime, with fewer unexpected taxes or debasements of the currency (Haber *et al*, 2008). Improvements in commercial law, combined with investments in transport infrastructure, may allow local shocks to be accommodated through trade instead of through changes in local demand or local production. Furthermore, investments in warehouses by entrepreneurial middlemen may have allowed stocks to be carried over from surplus periods to shortage periods, thereby smoothing out fluctuations over time (Casson, 2011).

To place the analysis of prices in context, data on wage rates are also examined. Institutional changes can also impact on the labour market, *e.g.* increasing labour mobility may have reduced wage volatility in local markets (Karanassou and Snower, 1988). Evidence on relative wages can also be used to assess whether changes in policy and institutions were also associated with structural changes in the economy.

Revolutions may generate structural breaks in trends as well as volatility. The paper discusses whether breaks in trend occurred at the same time as breaks in volatility, and whether they were due to structural changes in the economy. It argues that, while revolutionary changes had structural implications, structural change was more evolutionary than was institutional change.

The layout of this paper is as follows. The data source is introduced in Section 2 and the statistical methods explained in Section 3. The results are presented in Section 4 (prices) and Section 5 (wages). Changes in the trend of prices and wages are examined in Sections 6 and 7, and the implications for levels of prices and wages are considered. The historical significance of the results is discussed in Section 8 and implications for future research are discussed in Section 9.

2. Sources

The source is Clark's data on English prices and wages 1209-1914, which synthesises previous series constructed by Thorold Rogers, Beveridge, Farmer, Phelps-Brown and Hopkins, and others (Clark, 2004). It is based on the records of large estates, monasteries, dioceses, university colleges, market towns and other reputable institutions. The recorded prices do not usually reflect the actual prices paid by consumers but are wholesale prices received by sellers; the margin between wholesale and retail price may vary across space and time, *e.g.* higher margins in booms and lower margins in recessions (Farmer, 1988). When prices vary across locations, weights are used, where appropriate, to combine information from different localities. Clark's data is particularly useful for assessing volatility because he did not interpolate missing observations; linear interpolation would tend to understate volatility.

Clark's data is in nominal terms and is available in both sterling and an international silver standard. Similar data covering Europe has been published by Allen, but with a greater emphasis on real wages. The techniques developed in this paper can also be applied to Allen's data, but further refinements would be required. The data can be converted to real terms using a consumer price index, but no conversions have been made. Commodity prices are normally analysed in real terms only where a very accurate cost of living index, such as a modern GNP deflator, is available. Even when a deflator is used for analysing trends, it can prove problematic for analysing volatility – particularly when the commodity whose price is deflated carries a heavy weight in the index, as is the case in this study. Alternative methods have been used to adjust for inflation (see below).

Clark provides annual time series for a wide range of commodities, but not all the series are suitable for long-run volatility analysis. Twelve series were identified that satisfied most of the following criteria. Series should comprise long runs of data, commencing as early as possible (*e.g.* the thirteenth century), and have relatively few missing observations. To minimise the risk that volatility is created by the data collection process, series should not be compiled by linking different series from very different types of source. The commodities should not have been highly taxed or regulated for prolonged periods. The prices of the commodities should be governed by factors mainly internal to the English economy. Since prices of internationally traded products will be influenced by external factors as well as internal factors, preference should be given to domestically traded products. Products should be of economic importance, being produced and consumed on a large scale; this makes the results of intrinsic interest, and reduces the risk that for thinly traded products there are errors in the recording of price.

No commodity satisfied all of these criteria; thus cloth is included even though it is exported and coal is included even though early observations are scarce, because both are important to the economy. However, spices are excluded because early observations are few, trade is often highly regulated, and external factors are important in supply.

Clark has not tested his data for structural breaks, but has used it mainly to examine how much of Britain's world dominance after 1850 can be explained by the Industrial Revolution. He emphasises the population boom that accompanied the Industrial revolution rather than its technological developments (Clark, 2007, 2011). Allen (2001), meanwhile, attributed Britain's dominance to a sharp rise in living standards between 1870 and 1913. The analysis in this paper supports both these views, but places them in a very long run context of political and institutional changes that supported market development.

Research on the volatility of agricultural prices has grown considerably in recent years, and many of the techniques used in this research are employed in this paper (Gilbert, 2006). Much of this work uses high frequency data (monthly or weekly) rather than annual data and is confined to the last fifty years. Key issues examined include bias created by temporal aggregation (*i.e.* the relation between monthly and annual series) and the impact of storage costs on price formation.

Historical studies of price formation have focused mainly on spreads (for other aspects see Abel, 1980). In spatial terms, the convergence of international and inter-regional commodity prices (especially grain) has been linked to improvements in transport and communications, political integration, and the emergence of international standards and organised wholesale markets (O'Rourke and Williamson, 1999; Persson, 1999). In temporal terms, convergence has been linked to speculation, hedging, and the development of new financial instruments such as forward contracts, futures, options and other derivatives (Findlay and O'Rourke, 2002). More recently, scholars have sought to the link price convergence to price volatility (Bateman, 2011). Although volatility is the focus of this study, it is recognised that factors that increase convergence are also potential causes of lower volatility.

3. Methods

Logarithmic transformation of price

Modern econometric studies of price usually work in terms of the logarithm of price (Cashin and McDermott, 2006). This is because the magnitude of price shocks tends to be proportional to the level of price and price inflation tends to generate an exponential trend. Taking the logarithm converts proportional changes to absolute changes, exponential trends into linear trends, and relative prices into price differentials. Many historians have measured price volatility by the coefficient of variation (*i.e.* the ratio of standard deviation to mean), but the standard deviation of the logarithm of price changes is easier to calculate and has simpler statistical properties; the latter measure is therefore used in this study.

The concept of volatility

Price volatility may be interpreted as a propensity for prices to vary. Volatility is always measured with respect to some benchmark, and different benchmarks generate different measures. A benchmark may be set externally (*e.g.* a target price set by a regulator), but in empirical research benchmarks are normally expressed in terms of actual prices. A common benchmark used in modelling the prices of financial assets is the price in the previous period. This method identifies zero volatility with no change in the price. It 'bootstraps' the benchmark by continuously updating it as price evolves. Using this approach, price volatility can be measured by the magnitude of period-to-period changes in price (Liu and Maheu, 2008).

An alternative is to measure volatility in terms of deviations from a trend or, more generally, in terms of deviations from the value predicted by some model. This study uses both estimates of volatility based on deviations from a fitted linear trend and estimates derived from changes in price as described above.

The measurement of volatility

Volatility is a property of the process generating price rather than a property of price itself and is usually measured over a period of time. In this study volatility is measured both annually and by decade. Optimising the period of measurement involves a trade-off. Volatilities in successive decades are more likely to be uncorrelated than volatilities in successive years, and so fewer complications arise from lag effects. However, because there are fewer observations on decades the statistical significance of the results may be reduced. A decade is long enough to estimate variation around a trend, but short enough to pin-point changes in volatility for narrative purposes. It is also short enough to justify an assumption that any trend is approximately linear.

Generating an annual measure of volatility in more problematic because as the period of measurement shrinks to a single year the underlying trend line disappears. As a result, annual volatility cannot be measured in terms of deviation from trend, but only in terms of the change in price from the previous year.

Two main statistical measures of volatility are available: the variance and the standard deviation. Both can be applied to either changes or deviations from trend. The variance is the square of the standard deviation, and both are used in this study.

Altogether, therefore, six measures of volatility are available:

1. Annual variance: the square of the change in the logarithm of price from the previous period;

2. Annual standard deviation: the absolute value of the change in the logarithm of price from the previous period (this is the square root of the annual variance);
3. Decadal variance based on changes in price: the average of the annual variances;
4. Decadal standard deviation based on changes in price: the square root of (3);
5. Decadal variance based on deviations from a linear trend: the average sum of squares of the residuals from a regression of price level on a linear time trend over the decade;
6. Decadal standard deviation based on deviations from trend: the square root of (5)

Explaining changes in volatility

Revolutions may be regarded as exogenous events with persistent effects, whose timing is explained by political and cultural factors outside the market arena. The historical literature has identified a number of potential revolutions, and five are investigated in this paper. They were selected because they are claimed to have had significant economic impacts and can be fairly easily dated:

- The Good Parliament of 1376;
- The Commercial Revolution, dated to1603;
- The Glorious Revolution of 1689;
- The Industrial Revolution, conventionally dated to 1760; and
- The Railway Revolution, dated to 1860 – a time when early trunk line schemes had all been completed and the Second Railway Mania began.

The Industrious Revolution and the Agricultural Revolution were both excluded because of difficulties in dating. Furthermore the ranges of their suggested dates overlap with the Glorious Revolution, making it difficult to distinguish their separate effects. For simplicity the dates of revolutions have been rounded to the nearest decade (see Table 1).

With the exception of the Good Parliament, these revolutions are all well-known. The Good Parliament marks the first significant occasion on which the English Parliament confronted the monarch with both allegations of corruption and a refusal to pay taxes (Holmes, 1975). It is a link between the baronial opposition that led to Magna Carta and the reconstitution of the monarchy at the Glorious Revolution. It took place in the aftermath of the Black Death, and shortly before the Peasants Revolt. It can be viewed as a cultural legacy of the Black Death, in which traditional sources of authority, such as the monarchy and the church, were undermined, and greater individualism stimulated geographical and occupational mobility. It marks the first appearance of the Speaker of the House of Commons and the first impeachment of royal officials. Although the acts of the Good Parliament were repudiated by Richard II, and some of its leaders executed, the threat of popular revolt achieved credibility, and future monarchs responded with greater self-restraint. Established power did not wane immediately, but attempts to sustain it, *e.g*. through sumptuary laws, ultimately failed. In the following century the status of warrior lords diminished and that of tradesmen and professionals (*e.g*. lawyers and administrators) increased.

The Commercial Revolution is linked with the growth of scientific experimentation, the formation of the English East India Company and the early development of empire (Brenner, 1993); the Glorious Revolution with the foundation of the national debt and the Bank of England, the reform of the currency, and the South Sea Bubble (Prestwich, 1966; Pincus, 2009); the Industrial Revolution with technological innovations in textiles manufacture, steam power, metallurgy and engineering (Allen, 2009); and the Railway Revolution with faster and cheaper transport, steam shipping, settler colonies and the globalisation of finance (Casson, 2009).

All five revolutions are hypothesised to reduce price volatility. Conversely, wars and periods of political instability are hypothesised to increase volatility. Wars include the Wars of the Roses, the Civil War and the Napoleonic War. The Wars of the Roses were episodic, and for the purposes of the paper cover a protracted period, whilst the active period of the Civil War was confined to a single decade. Political instability is exemplified by the Tudor period, dating from the accession of Henry VIII and ending with the succession of Elizabeth I.

Environmental changes (*e.g*. the Great Famines of 1315-22), financial crises (*e.g*. the Railway Mania of 1846) and other extreme events raise difficult issues. To exclude such events altogether leaves some important short-term price oscillations unexplained, but including all such events would remove much of the variation from the series. As a compromise, financial disturbances have been addressed using information on debasement and recoinage (*i.e*. changes in the silver equivalent of the pound sterling). This information has been used to identify price changes that were purely monetary in nature. Thus the effects attributed to revolutions are mainly concerned with their impact on the performance of the real economy, and not just with changes in monetary policy.

The concept of a structural break

A structural break occurs when the parameters of a process change. A break can affect both trend and volatility. A break in trend could be induced by long-term structural change in the economy, such as a shift from agriculture to manufacturing, or by adjustment to some disaster, such as the Black Death. A change in volatility, as suggested above, is likely to be associated with institutional changes that affect the efficiency of the market system. While this paper focuses on volatility, it is impossible to ignore trends. A revolution can, in principle, be associated changes in both trend and volatility.

Time series econometrics affords a variety of methods for analysing structural breaks. Some techniques mine the data to search for breaks, whilst others postulate specific breaks and test whether they exist (see *e.g*. Zeileis *et al*, 2003). Most empirical studies search for breaks whose dates are unknown. This study, by contrast, seeks to test whether breaks occurred at known dates identified by independent historical scholarship, and therefore uses the second approach.

The most common approach is to test for just a single break. It divides sample time into two sub-periods - before and after the break – and determines whether estimated parameter values for the two sub-periods are significantly different. In practice, however, multiple breaks may exist (Bai and Perron, 2003). In this case a test for any one break must be conditioned on whether other breaks exist, because the existence of other breaks will determine the duration of the periods on either side of any given break. Over the seven centuries included in this study multiple breaks are very likely. Indeed, Table 1 dates thirteen potential breaks; each revolution represents a break, while the beginning and end of each war generates a pair of breaks.

When the dates of potential breaks are known the simplest way to test for multiple breaks is to use dummy variables (Wooldridge, 2009). Each measure of volatility can be regressed on a set of dummy variables. One type of dummy variable measures the persistent effect of a revolution, and takes a value zero prior to the revolution and a value of one afterwards. The other measures the transitory effect of a war or a particular monarchy, and takes a value of one during the period of the war or reign, and zero before and afterwards.

An alternative approach would be to identify all thirteen break points separately and place them in temporal order. This would identify a set of eras that begin and end at successive breaks. A separate dummy variable could then be associated with each era. This approach involves thirteen dummy variables rather than nine, and ignores the pairing of the breaks associated with wars. Consequently the results are difficult to interpret in terms of conventional historical narrative.

Two additional variables are included to take account of changes in monetary policy. 'Debasement' measures the reduction in the logarithm of the silver content of the currency over a decade and 'Rebasement' measures the corresponding increase. Debasement is predicted to increase volatility around the time that they occur. However, the effect of rebasement is more ambiguous. An increase in silver content will tend to reduce prices, causing volatility in the short term, but by increasing confidence in the currency it may reduce volatility in the long term.

The dummy variables are assumed to impact additively on volatility, and so their impacts can be estimated by ordinary multiple linear regression. There are six different models, each of which postulates that the variables impact on a different measure of volatility.

A time trend is also included in the regressions. The evolutionary view asserts that volatility will decline steadily over time, and that any fall in volatility will be largely unconnected to revolutionary events. The evolutionary perspective is thus consistent with a negative and statistically significant time trend. In contrast, the revolutionary view asserts that, irrespective of the underlying trend, revolutions reduce volatility.

The sizes of the estimated coefficients in the regressions reflect, amongst other things, the units in which the dependent variable is measured. To simplify the presentation of results the logarithm of price has been scaled up by a factor of ten when calculating volatility, and time is measured by decades throughout, with a year corresponding to a tenth of a decade.

Random walks and deterministic trends

The dynamics of price movements are not, in general, well understood (Wang and Tomek, 2007). While the prices of financial assets can be successfully analysed as random walks, this model does not fit ordinary commodity prices particularly well. In a random walk the expected value of the future price is determined by the current price alone, and previous changes have no influence on the direction of future change. This fits with the notion that in speculative financial markets there are no discernable systematic factors influencing future prices that speculators can exploit.

Where ordinary commodities are concerned, however, prices changes have a tendency to reverse themselves. This difference between financial markets and commodity markets reflects the fact that financial markets trade homogeneous second-hand durable assets that are easily stored, whilst ordinary commodity markets often trade heterogeneous newly-produced perishable goods that are costly to store (Deaton and Laroque, 1992). While price changes in durable assets tend to persist, price changes in perishable goods are more transitory.

On the other hand, prices for ordinary commodities do not appear to follow a fixed trend, but to follow a continuous path that wanders away from trend. Superimposed on this path are year-to-year oscillations and occasional spikes. Such behaviour can be modelled as the additive effect of transitory and persistent shocks superimposed on a linear trend, but such modelling lies beyond the scope of this paper. This paper takes an agnostic view of price dynamics. The aim is to establish results that are robust with respect to the specification of the underlying data-generating process.

A simple pragmatic approach to 'path dependence' in volatility is to incorporate lagged values of volatility in the regressions. These lagged values reflect the legacy of the past, which is assumed to be exogenous to the current period. Failure to take account of lags can result in misleading conclusions in which the evolutionary view is wrongly rejected or where a genuine break is imputed to an earlier or later revolution. A similar approach to lags is used later in respect of trends. The use of lagged variables can also introduce problems, however, and so diagnostic tests need to be applied, and the results of the regressions interpreted with considerable care.

Missing observations

Missing observations are a major problem with the data set, and pose a particular problem for the estimation of lags. The longer the lags involved, the more degrees of freedom are lost. For this reason results without lags are sometimes reported in cases where missing observations are an issue.

Missing observations tend to occur during periods of high volatility and in the earlier centuries (because records have not survived and because trade in certain items was on a small scale). The impact of missing observations is greatest on volatility measures 1-4 because they are calculated from prices changes rather than deviations around a fitted trend. A trend can be estimated when alternate annual observations are missing, but changes cannot. Because different sets of observations may be used to calculate the various measures of volatility, results obtained may reflect differences in both the choice of method and in the availability of data.

There is also a differential impact on the annual and decadal models. Decadal estimates of volatility are used only when they are deemed reliable, namely when at least half the relevant annual observations are available and are reasonably spread-out across the decade.

4. Results: volatility by commodity

Having selected the twelve commodity series and the three wage series, the first step was to plot price levels, changes in levels, and the different measures of volatility against time (see Figures1-2). Decadal measures were most useful for this purpose. Visual inspection suggested that there were some potentially significant break points.

Autocorrelations between changes in annual prices were then examined. Results for lags from one to five years are shown in Table 2. The correlations for lags of up to three years are mostly negative. If changes in price were generated purely by a random walk then these correlations would all be close to zero. On the other hand, if the changes were generated purely by random fluctuations around a linear trend then the one-period correlation would be 0.5 and the other correlations would be close to zero. Finally, if price changes compensated for changes in previous periods then there could be negative correlations for every lag. The results suggest that elements of all these processes may be present in the data, which underlines the need for a robust approach.

Note that in the case of barley and wheat a substantial negative correlation does not appear until the second year. This may reflect speculation in these markets, with middlemen exploiting the potential for price changes to reverse by buying up and storing product when price is low with a view to releasing it onto the market when price recovers.

This analysis suggests that lags of up to five years are appropriate in annual analysis, but that one decade is sufficient in decadal analysis. Further lags were not introduced in order to conserve degrees of freedom.

All the regressions were estimated both with and without lags. Apart from the estimation of lag lengths, the basic model was not adjusted to retro-fit the data. Each regression was estimated separately for each commodity, and *p*-values are reported in brackets under each estimated coefficient. The results were pooled across commodities only where appropriate. Each regression was estimated in full and then insignificant variables were eliminated sequentially using a criterion of 10% significance. The suppression of insignificant variables simplifies the presentation of the results; it does not distort the findings because most of the variables that are significant in a reduced regression are also significant (though sometimes at a lower level) in the corresponding full regression. Results may be affected by autocorrelation, but the inclusion of lags reduces this problem.

Illustrative results for barley are presented in Table 3. Because the focus is on testing theory, attention is focused the signs and significance levels of the coefficients rather than their magnitude. When similar comparisons are made across all twelve commodities then:

- The results are robust with respect to the measurement of volatility. Coefficients never change sign unless they are insignificant in one of the regressions. Sometimes, however, the dating of revolutions changes, *e.g.* between the Commercial Revolution and the Glorious Revolution.

- The proportion of variance explained by the decadal regressions (measured by R^2) is on average more than twice that explained by the annual regressions. By calculating an average measure of volatility over a decade, noise contained in annual estimates is filtered out, thereby removing from the dependent variable components that the model cannot easily explain. Levels of significance achieved are lower, however, because there are far fewer observations.
- Decadal volatility is better explained when measured by changes in price than when measured by deviations from a linear trend.
- Standard deviations are consistently explained better than are variances. This seems reasonable because standard deviation, unlike variance, is measured on the same scale in which prices themselves are expressed.

In the light of this discussion, the results presented below concentrate on volatilities measured by standard deviation, and are calculated from changes in price rather than deviations from trend.

Table 4 compares regressions estimated with and without lagged dependent variables, using barley again as an example. The presence of lags does not affect the inferences concerning structural breaks, even though three of the five lags are statistically significant. The general picture for all twelve commodities is that the significance of revolutions is marginally reduced by the introduction of lags. Lags, it seems, are an important part of the evolutionary process, and add additional information to that contained in a linear trend. This paper therefore concentrates on the results of lagged regressions since the associated results are more robust.

Tables 5-6 present the main results for annual and decadal standard deviations respectively. Volatility is measured by change of price, lags are included, and only final stage regressions are reported. The results are quite striking. There is a remarkable consistency in the signs of the coefficients and across the two types of regression.

- The Good Parliament reduces volatility significantly for a wide range of commodities: barley, oats, peas, candles, coal and woollen cloth in the annual regressions and also wheat and firewood (but not oats, peas or cloth) in the decadal regressions. Five of the six annual coefficients are statistically significant at the 1% level and the remaining one at the 5% level. The decadal coefficients are somewhat less significant: two at the 1% level, two at the 5% level and one at the 10% level.
- The Glorious Revolution is almost as important, and affects many of the same commodities. In the annual regressions it significantly reduces volatility in oats, peas, firewood, coal and woollen cloth, and in the decadal regressions in wool as well (but not woollen cloth). In both sets of regressions three of the five coefficients are significant at the 1% level and the remainder at the 5% level.
- The Commercial Revolution also reduces volatility, but for a smaller range of commodities: barley, iron and linen in the annual regressions and barley, wheat, peas and linen in the decadal regressions. All the variables are significant at the 1% level in the annual regressions, but only two in the decadal regressions.

- Contrary to the maintained hypothesis, the Industrial Revolution increases volatility, though only for selected manufactured commodities. Volatility increases for iron manufacture in both the annual and decadal regressions (at the 1% significance level) and for woollen cloth in the decadal regressions (but only at the 10% significance level). The volatility in iron prices may reflect the influence of trade cycles on the demand for durable producer goods, whilst the volatility in wool cloth may reflect the impact of growing competition from cotton textiles.
- The Railway Revolution reduces volatility in the prices of two major agricultural commodities – barley and peas – in both the annual and decadal regressions (at the 5% significance level). The full regressions suggest that volatility may also have fallen in other agricultural markets, although results are not statistically significant. This is consistent with the role of railways in supplying foodstuffs to growing manufacturing towns from specialised agricultural areas (*e.g*. the South Midlands and Lincolnshire). The role of the Railway Revolution in increasing volatility in linen cloth is harder to explain; this is one of the few perverse results in the study.

Wars also demonstrate their predicted impacts: they tend to increase volatility. What is striking, however, are the importance of some wars, *e.g*. the Napoleonic Wars, and the unimportance of others, *e.g*. the Civil War.

- The Napoleonic War impacts on barley, suet and candles (1% significance level) and wheat, oats, and peas (5% significance level) in the annual regressions; in the decadal regressions iron is also affected (at the 5 % level) but wheat is not.
- The Wars of the Roses, though protracted, have a significant impact on candles (at the 1% significance level) and coal (at the 10% significance level) in both the annual and decadal regressions and on peas (at the 5% significance level) in the annual regressions.
- The Civil War has no discernable impact.

The Tudor period exhibits increased volatility, affecting barley, wheat, coal, wool and wool cloth in both the annual and decadal regressions, as well as peas (annually) and iron and linen (decadally). Two thirds of the impacts are at the 1 % level of significance. These results support the view that Tudor financial policy destabilised the economy.

Debasement has the predicted effect of raising volatility. Because it is measured in terms of a reduction in silver content, a negative coefficient indicates in increase in volatility. This increase in volatility is observed in woollen cloth (at the 1% significance level) and peas (at the 5% significance level) in the annual regressions and for peas, oats (at the 1% significance level) and barley (at the 5% significance level) in the decadal regressions. However, for suet, the process of debasement appears to reduce price volatility.

Rebasement is statistically insignificant in the annual regressions, but increases volatility for wheat (at the 5 % level) in the decadal regressions. This is consistent with the view that rebasement has an indeterminate effect upon price volatility.

Results provide only limited support for an evolutionary interpretation based on a trend decline in volatility. The time trend is negative and statistically significant for wheat and suet in the annual regressions, and for iron in the decadal regressions (at the 1% significance level). In contrast, the time trend is positive for wool in the decadal regressions (but is significant here only at the 10% level).

The Black Death has no significant impact in the decadal regressions, and a mixed impact in the annual regressions. Price volatility in coal increases but decreases for candles (both results are significant at the 1 % level).

Results indicate significant lagged effects, with past volatility having a positive and statistically significant impact on current volatility, particularly for wool and woollen cloth. In the annual regressions a one-year lag has a positive impact for ten of the twelve commodities, but longer lags are important for just four commodities: barley, linen, wool and wool cloth. In the decadal regressions a one-decade lag has a positive impact for suet, candles, wool and wool cloth, although for barley the impact is negative.

Overall, the impacts of the revolutions on volatility are most clearly displayed by the agricultural commodities: barley, wheat, oats and peas. Significant impacts can also be discerned in the manufacturing sector: woollen cloth, linen cloth, coal and iron. There is limited impact on wool and firewood, and no significant impact on candles and suet.

Pooled regressions confirm the above results. Six varieties of pooled regression are reported in the Table 7. Results show that:

- The Good Parliament is the most important revolution: it reduces volatility substantially in all six regressions. The Commercial Revolution and the Glorious Revolution are important too, but not to the same extent. The Commercial Revolution is more significant in the pooled regression than in the commodity regressions.
- Previous results for wars and the Tudor monarchy are corroborated. The Napoleonic war is by far the most significant; the Wars of the Roses are important too, but the impact of the Civil War is small and relatively weak (results are significant only at the 10% level in a single regression).
- The Industrial Revolution has a marginal impact in raising volatility and the Railway Revolution a marginal impact in reducing it.
- Both debasement and rebasement increase volatility through short-run impacts on the value of the currency, although debasement has the larger effect. These variables are significant in the decadal regressions but not in the annual regressions, suggesting that their effects are lagged and are therefore better captured when averaged over several years.
- The Black Death has no significant impact on volatility.
- Volatility exhibits persistence, but of an unusual kind: volatility from one year ago and from five years ago impacts positively on current volatility, but volatility from two to four years ago does not. Volatility from the previous decade has a small but statistically significant impact.
- The importance of linear trends is markedly reduced when lagged volatility is introduced. This suggests that evolutionary changes in volatility occur alongside lagged feedback effects.

- Trends vary considerably by commodity. Some commodities –notably coal, but also peas, firewood, iron, linen and woollen cloth – have negative linear trends, whilst others, notably wool, candles and suet, but also oats - have positive linear trends. This suggests that for about half the commodities price volatility would have increased over time had it not been for revolutionary changes that brought it down.

5. Wage volatility

In the long run, if money wages are flexible and workers' expectations adjust to inflation, then money wages will vary in line with inflation, and so debasement and rebasement will affect wage volatility in the same way as price volatility. In the short run, however, money wages may be inflexible, or at least slow to adjust. In this case, unexpected inflation or deflation will not be reflected in the money wage, leading real wages to fall under inflation and to rise under deflation. In this case debasement and rebasement will have no impact on volatility.

Wars may increase wage volatility if they increase inflation, and they can have real effects as well. Internal conflicts, such as the Wars of the Roses and the Civil War, may disrupt local economies, whilst external conflicts such as the Napoleonic Wars may disrupt international trade. Military conscription may reduce the labour force, whilst high taxes may discourage commerce and investment.

Revolutions too can influence real wage volatility. In particular, they can reduce wage volatility by promoting labour mobility, both between regions and between occupations. Local labour shortages can be accommodated through internal migration. Improvements in transport and communications, coupled with greater personal security, may encourage young men to travel further afield and settle in more prosperous areas of the country. Occupational mobility may also be fostered by more flexible apprenticeship systems. A more individualistic culture may mean that sons no longer follow fathers into the same occupation.

Table 8 presents the results of annual regressions of wage volatility for three categories of labour: farm labour, craft labour and building labour. Only final stage results are reported, with and without lags. Decadal regressions are reported in Table 9. Because the decadal lag is insignificant for farm labour, only the unlagged results are shown in this case.

The impact of revolutions on wage volatility is significant, and follows the predicted pattern, but smaller than for price volatility.

- The Good Parliament reduces wage volatility for craftsmen and building workers; results are significant at the 1% level in both sets of regressions. However, no significant impact on farm workers is found.
- The Glorious Revolution, by contrast, impacts on farm workers but not on craftsmen or building workers.
- The Commercial Revolution impacts mainly on building workers, although an impact on farm workers also appears in the decadal results.
- The Industrial Revolution has some impact on building workers according to the annual results. However, as was the case with price volatility, the industrial revolution increases wage volatility. The explanation may be

similar: namely that trade cycle fluctuations affected construction workers disproportionately.
- The Railway Revolution has no significant effect.

By comparison with prices, wars have little or no impact on wage volatility.
- The Wars of the Roses has a marginal impact on farm wages in the annual regression, which disappears when lags are introduced.
- The Civil War increases the volatility of craft wages in the decadal regressions whilst reducing that of farm wages in the annual regressions.
- The Napoleonic War, which was so important for price volatility, has no significant effect upon wage volatility.

Debasement and rebasement have no significant effects once lagged variables are introduced. This suggests a degree of money illusion or institutional wage rigidity.

The time trend for farm wages is positive, and for craft and building wages negative. This suggests that evolutionary factors have improved the efficiency of markets for skilled urban workers and reduced the efficiency of markets for unskilled rural workers, leaving revolutionary changes to improve the lot of the rural worker.

There is much greater inertia in the volatility of craft and building wages than there is for farm wages. Volatility in farm wages is influenced only by wages in the previous year before, while the volatility of craft and building wages is influenced by volatility up to four years before and by volatility in the previous decade.

6. Structural breaks in price trends

It is possible that structural breaks in the volatility may be accompanied by structural breaks in price trends (see Figure 2). Both wars and revolutions can cause breaks in price trends. If wars stimulate inflation, for example, then structural breaks involving wars may be associated with an increase in trend. On the other hand, the export of precious metals to pay troops overseas, and a shortage of small change, could depress prices during wartime. However, for most of the period covered by this study the economy was essentially on a silver standard or a gold standard, and so the scope for sustained inflation or deflation was limited. Long-run rates of inflation were regulated by a growth in the supply of precious metals.

Breaks in trend may also arise from structural changes in the economy brought about by revolutions. Structural change tends to be a long-term process, and may reveal itself via an increase or decrease in tend rather than as a sudden jump in the level of prices. This section tests the hypothesis that revolutionary structural change leads to changes in trend.

By analogy with our earlier discussion of volatility, a trend can be measured in three main ways:

1. Annual trend: the change in the logarithm of price from the previous period;
2. Decadal trend based on changes in price: the average of the annual changes, which is equal to the difference between the price level at the end of the decade and the level at the end of the previous decade, divided by ten;

3. Decadal trend based on an estimated linear trend derived from a linear regression of log price on time over the decade.

The third approach proved the least satisfactory in analysing trend, just as it did in analysing volatility, whilst the results using Methods 1 and 2 are sufficiently similar that it is appropriate to present just a single set of results. The aggregation of annual data into decades can have unintended effects where the analysis of trends is concerned (Rosanna and Seater, 1992), and so only results based on Method 1 are shown in Table 10. The absence of a strong time trend in volatility (Section 4 above) suggests that heteroskedasticity is not a major problem in the estimation of trends.

For each commodity the trend is regressed on the usual set of dummy variables, together with debasement, rebasement and a time trend. Lagged values of the trend are also included. In addition, a lagged value of price (namely the log of the price in the previous period) is included, as this makes it possible to carry out an Augmented Dickey-Fuller test for a unit root, which provides additional insight into the underlying volatility-generating process.

The key results pertaining to revolutions are as follows.

- The Good Parliament reduces price trends for agricultural products such as barley wheat and peas, and increases the trends for wool and wool cloth.
- The Commercial Revolution impacts mainly on wool and wool cloth, countering the legacy of the Good Parliament by reducing the trend; however, the impact is not sufficiently large to eliminate the earlier change altogether.
- The Glorious Revolution has diverse impacts, reducing trends in peas and firewood, and increasing the trend in wool prices.
- The Industrial Revolution reduces price trends for selected manufactured products, namely coal, iron, linen and woollen cloth.
- The Revolution Railway reduces price trends for some agricultural products, namely wheat, oats and peas.

In respect of wars:

- The Wars of the Roses reduces trends for a wide range of products: namely the agricultural commodities, firewood, coal and iron. The main exception is wool, where the trend is significantly increased.
- Conversely the Civil War stimulates upward trends in a similar but more limited range of products, namely barley, wheat, peas, coal and woollen cloth.
- The Napoleonic War stimulates trends in peas, suet, coal and woollen cloth.

The Tudor monarchy has mixed results, reducing trends in linen and firewood and increasing the trend in wool.

The Black Death has a major impact on trends for manufactured products, but no effect on trends for agricultural products. It increases trends in firewood, candles, coal, linen, wool and wool cloth.

Lags are very significant in the formation of trends. The values of the lag coefficients sum to about 0.85 for almost all the commodities. The impact of the lagged price level is negative in eleven cases out of twelve (the exception is wool), whilst the Dickey-Fuller (DF) test statistic is borderline significant in most cases. Overall, these results suggest that there is no unit root, and hence no random walk. On the other hand, the underlying process is not a linear trend either; the current trend is heavily influenced by its own previous values, which can drive it away from any fixed trend very easily, although it is unlikely to go too far because it tends to reverse itself. This confirms the earlier assessment based on the pattern of autocorrelations and suggests that commodity prices are mean reverting.

The regression in Table 10 can be reformulated as a regression of the price level itself. Because trend is measured by the difference between the current price and the previous price, adding the previous price to both sides of the equation transforms the equation into an equation for current price. At the same time, re-arranging terms on the right-hand side of the equation can transform a weighted sum of lagged trends into a weighted sum of price levels. The result is a new equation regressing price on lagged prices.

The simplest way to derive these new price equations is to re-estimate the regressions using price level data. The results are shown in Table 11. The coefficients on the dummy variables are almost identical to the previous ones. The main differences arise because a marginal change in significance can lead to a variable being excluded, which has consequences for the estimated coefficients of the remaining variables.

The lag coefficients are completely different, because the relation of current price to previous prices is logically different to the relation between current trend and previous trends. While past trends have a negative impact on current trends, past prices have positive impacts on current prices, making current price a weighted average of previous prices. In this weighting the most recent price is dominant. The greater this dominance (as indicated by the regression coefficient on the one–year lag), the more closely the process resembles a random walk. Barley, wheat and wool are the commodities whose prices most closely resemble a random walk, and it is surely no coincidence that they are commodities in which forward contracts and price speculation were very common. Conversely, firewood and linen appear to be the commodities whose prices least resemble a random walk, suggesting that these were the commodities in which organised speculation was most difficult to undertake.

7. Trends in wages

Trends in wages are presented in Table 12. The first three columns concern money wages and the last two columns relative wages. The craft wage is higher than the building wage throughout the period, and the building wage in turn is significantly higher than the farm wage. The craft-farm premium is the ratio of the craft wage to the farm wage, and the craft-building premium is the ratio of the craft wage to the building wage. Because all variables are expressed as logs, the premia are simply differences between the logs of the relevant wages. They are always positive.

Table 12 shows that the Good Parliament, the Commercial Revolution and the Glorious Revolution all impact significantly on trends in relative wages. This impact is much greater than their impacts on trends in absolute wages.

- The Good Parliament reduces craft wages relative to both building wages and farm wages. It also increases the trend in farm wages, but not in other wages.

Thus the trend in farm wages increases both absolutely and relatively, whilst the trend in building wages increases only in relation to craft wages.

- The Commercial Revolution increases trends in both the craft-farm premium and the craft-building premium, but does not affects trends in the absolute levels of wages.
- The Glorious Revolution also increases the trends in these premia, but reduces the trend in the absolute farm wage.
- The Industrial Revolution has no effect on wage trends, possibly because the impact of rising productivity is masked by increasing population which maintains absolute wages fairly close to subsistence levels.
- The Railway Revolution, on the other hand, raises both craft wages and building wages, increasing craft wages significantly in relation to farm wages. It is possible that the railways themselves stimulated the demand for craftsmen, as well as creating new craft jobs by fostering the growth of export-oriented engineering trades.

Overall, the Glorious Revolution and the Commercial Revolution have broadly similar impacts. The Glorious Revolution reinforces changes in trends that began with the Commercial Revolution. These impacts tend to reverse the changes effected by the Good Parliament, though the reversal is partial rather than complete. This interplay between the Good Parliament and the Commercial Revolution parallels the earlier situation regarding the reversal in the trend of the price of wool and could, indeed, be related to it. This reduction in the trend of farm wages effected by the Glorious Revolution could be due to the Enclosure movement, which gained momentum in the early eighteenth century, and dispossessed many small-holders, some of whom migrated to the towns and cities.

The Napoleonic War raises absolute wage trends across the board but leaves relativities unchanged. The effects of other wars are more subtle. The wars of the Roses increase building wages relative to craft wages, whilst the Civil War increases the absolute level of building wages and increases craft wages relative to farm wages.

As expected, the Black Death boosts trends in wages for all three categories of labour. The effects are large, and so too are the relative effects: farm wage trends increase more than building wage trends, which in turn increase more than craft wage trends, leading to a significant changes in the trends of wage premia. The trends in the premia are perpetuated by the Good Parliament (as indicated above), although (with the exception of farm wages) the trends in absolute levels are not.

Debasement and rebasement have no significant effect on either absolute or relative wages. This confirms the view that nominal wages did not adjust to monetary shocks in the same way as prices and that a degree of money illusion persisted in labour markets.

The Dickey-Fuller tests suggest that wages, like prices, are close to having a unit root. They do not follow a random walk, however, because the current trend is negatively correlated with previous trends.

The implications of these results for wage levels are shown in Table 13. The only difference in impacts concerns the Wars of the Roses, and relates to a marginal change in a single level of significance. The table highlights the existence of positive trends in all wage levels, and particularly in the farm wage. The wage for each category of labour is a weighted average of past wages. The most recent wage, corresponding to a one-year lag, carries the greatest weight, although its weight is not as great as in the commodity regressions. This may reflect, amongst other things, the fact that labour is a perishable commodity that cannot normally be re-sold.

8. Discussion of the results

This paper has examined how far changes in the volatility of English prices and wages over seven hundred years can be explained in terms of structural breaks associated with five key revolutions. To contextualise this study, trends and levels have been examined.

Most accounts of revolutions focus on a single revolution and confine themselves to its impact over a specific period. The legacy of earlier revolutions is sometimes understated, whilst long term effects, reaching into later periods, though claimed to be large, are often only discussed in general terms. This paper, by contrast, has focused on a sequence of revolutions, rather than a single one, and has followed the impact of early revolutions into much later periods. As a long-term thematic study, it has bridged the boundaries between medieval, early modern and modern history.

The study has used modern time series methods as applied in empirical finance and agricultural economics. The statistical results are exceptionally clear: three of the five revolutions had marked effects in reducing price volatility: The Good Parliament, the Commercial Revolution and the Glorious Revolution. The earliest revolution – the Good Parliament – is also the most important. The Glorious Revolution is more important than the Commercial Revolution, but by only a small margin. The Industrial Revolution has no effect in lowering volatility, and raises it for certain commodities. The Railway Revolution also has a limited impact, except for certain agricultural commodities. The three main revolutions also reduce wage volatility, and once again the Good Parliament has the most substantial effects

The importance of the Good Parliament can be explained in terms of the cultural legacy of the Black Death. The immediate impact of the Black Death was to increase wages – particularly for farm labour – both in money and real terms. It reduced the price of agricultural products relative to manufactured products, which is consistent with the view that higher wages induced a switch in demand towards manufactures. But the Black Death had long-term effects as well. This paper attributes these effects to the Good Parliament. Just as the Glorious Revolution is the political embodiment of wider economic, social and religious changes, so the Good Parliament may be regarded as the embodiment of similar changes that took place earlier. These changes anticipated to a limited extent the later changes of the Commercial Revolution and Glorious Revolution, which in turn prepared the way for later revolutions.

The importance of revolutions does not deny a role for evolution too, but it demotes it to a secondary role. The decline of price volatility is not simply the result of a stable long term trend. For some commodities a stable declining trend coexists with revolutionary changes, but in most cases there is an upward a trend or no significant trend at all.

There are trends in prices themselves, as well as in their volatility. Price trends vary continuously. The trend over any period has a tendency to reverse those of previous periods. Breaks in trend occur around the times at which breaks in volatility occur – namely when revolutions take place, or when wars begin or end. Price trends are linked to price levels. Prices tend to fluctuate randomly rather than follow a fixed trend; their path is anchored in previous levels of price, and guided by the impact of revolutions.

The impact of revolutions is persistent and cumulative, but can be distorted by intermittent wars. The biggest shocks to volatility come from the Napoleonic Wars; the Civil War, by contrast, has negligible effects.

The key results could be summarised by saying that development of the pre-conditions for the technological innovations described as the Industrial Revolution must be traced back a further two centuries, from the early seventeenth century to the late fourteenth century. The idea that origins lie further in the past than usually thought is not new; indeed, recent scholarship has argued that changes in finance and credit often attributed to the seventeenth century actually began in the fourteenth century instead (Munro, 2003; Bell et al. 2009). Linked to this is the view that evolution should perhaps be viewed, not as a continuous incremental process, but rather as the cumulative effect of intermittent radical changes. According to this view the earlier revolutions discussed in this study could be regarded as precursors of the later revolutions (Ormrod, 2003). This suggests that the study of the impact of revolutions on volatility could be just one aspect of a wider process in which early revolutions generate later revolutions according to very long-term processes which remain imperfectly understood (O'Brien, 2010).

9. Implications for Future Research

The study has a number of limitations which should be addressed in future research. The regression model assumes that causality runs directly from revolutions to prices, and so the potential for price movements to instigate revolutions is ignored. The causal link between the revolution and the subsequent change in price behaviour is not examined directly: the link is inferred from sequence of the events. This inference is supported by conventional economic models of price determination, which suggest that fundamental institutional changes will impact significantly on the behaviour of prices. However, specific evidence linking revolutionary changes to subsequent movements in specific prices is scarce, particularly for the medieval and early modern period. To better understand the direction and nature of causality, more long-run studies of individual commodity markets are required.

Mis-specification is a serious concern in time series analysis. Prices change over time in response to a sequence of transitory and permanent shocks to demand and supply, but it is uncertain how these shocks interact. This paper has addressed the problem through a robust approach, using a range of different measures of volatility and trend, and different regression specifications. To explicitly identify the underlying processes, signal extraction techniques are required. However, application of this approach to prices requires specialised techniques (Harvey and de Rossi, 2006).

As noted at the outset, extreme climatic events pose a particular problem for volatility analysis. Future research could use climate data to assess how far changes in volatility reflect changes in climate as distinct from changes in the ability of the economy to respond to such changes. It is difficult, however, to obtain sufficiently long time series that cover all the relevant aspects of climate.

Finally, the methods of this paper should be extended to an international level. This would involve identifying different revolutions in different countries, or similar revolutions occurring at different times in different countries. Price volatility in internationally traded commodities may be explained by the additive effects of revolutions occurring in exporting countries (as in this study), importing countries and other countries producing complementary or substitute commodities.

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Table 1: Variables explaining volatility

Variable	Period[a]
Good Parliament	1380 -
Commercial Revolution	1600 -
Glorious Revolution	1690 -
Industrial Revolution	1760 -
Railway Revolution	1860 -
Black Death	1348 – 1369, tapering off to 1400 in the annual regressions; 1340-1369 in the decadal regressions
Wars of the Roses	1430-89
Tudors (Henry VI – VIII)	1510-1559
Civil War	1630-39
Napoleonic Wars	1800-1819
Debasement	Net decrease in logarithm of silver content of currency over the decade. The value of the decrease is imputed to each year in the decade concerned
Rebasement	Net increase in logarithm of silver content of currency over the decade. The value of the increase is imputed to each year in the decade concerned

[a] Because much of the statistical analysis is by decade, periods are defined by decade as far as possible.

Table 2: Correlations between current and lagged values of the change in log price

	Number of years lag				
Variable	**1**	**2**	**3**	**4**	**5**
Barley	-0.066	-0.339	-0.147	0.032	0.034
Wheat	0.002	-0.293	-0.228	-0.063	0.110
Oats	-0.187	-0.222	-0.145	-0.019	0.103
Peas	-0.159	-0.221	-0.152	-0.069	0.067
Suet	-0.392	-0.011	-0.096	-0.007	0.034
Firewood	-0.421	-0.080	0.042	0.031	-0.014
Candles (tallow)	-0.297	-0.037	-0.075	0.002	0.066
Coal	-0.341	-0.097	0.047	0.158	-0.341
Iron: manufactured	-0.387	0.012	-0.050	-0.028	0.025
Linen cloth	-0.465	0.075	-0.088	0.039	0.109
Wool	-0.241	-0.046	-0.054	-0.117	0.097
Wool cloth	-0.341	-0.072	-0.045	-0.011	0.039
Farm wages	-0.359	-0.097	0.040	0.022	-0.130
Craft wages	-0.353	-0.005	0.009	-0.048	0.168
Building wages	-0.471	0.079	-0.049	0.097	-0.034

Table 3: Six alternative measures of volatility: regressions for barley, final stage results without lags

Variable	Annual		Decadal			
			Annual change		Deviation from trend	
	1. Variance	2. Standard deviation	3. Variance	4. Standard deviation	5. Variance	6. Standard deviation
Constant	1.653[a] (0.000)	1.022 (0.000)	1.969 (0.000)	1.295 (0.000)	1.334 (0.000)	1.125 (0.000)
Black Death						
Wars of Roses						
Tudors	1.378 (0.000)	0.490 (0000)	1.386 (0.001)	0.523 (0.002)	1.021 (0.000)	0.483 (0.000)
Civil War						
Napoleonic War	1.134 (0.007)	0.512 (0.000)	1.370 (0.014)	0.666 (0.000)	1.203 (0.006)	0.691 (0.001)
Good Parliament	-0.789 (0.000)	-0.272 (0.000)	-0.915 (0.001)	-0.353 (0.002)		
Commercial Revolution	-0.522 (0.002)	-0.234 (0.000)	-0.579 (0.014)	-0.295 (0.050)		
Glorious Revolution						
Industrial Revolution						
Railway Revolution		-0.216 (0.020)		-0.297 (0.050)		
Debasement	-0.071 (0.040)		-0.098 (0.042)	-0.033 (0.092)		
Rebasement						
Time					-0.011 (0.000)	-0.010 (0.000)
R^2	0.130	0.157	0.544	0.603	0.403	0.463
F	19.688 (0.000)	24.471 (0.000)	14.296 (0.000)	14.932 (0.000)	14.371 (0.000)	18.391 (0.000)
No. obs	661	661	65	65	67	67

[a] *P* values in brackets.

Table 4: Impact of lags: regressions of standard deviation of price for barley, final stage results with and without lags

	2. Annual		4. Decadal	
Variables	**With lags**	**Without lags**	**With lags**	**Without lags**
Constant	0.827 (0.000)[a]	1.022 (0.000)	1.380 (0.000)	1.295 (0.000)
Black Death				
Wars of Roses				
Tudors	0.431 (0.000)	0.490 (0000)	0.558 (0.000)	0.523 (0.002)
Civil War				
Napoleonic War	0.445 (0.002)	0.512 (0.000)	0.702 (0.001)	0.666 (0.000)
Good Parliament	-0.170 (0.021)	-0.272 (0.000)	-0.256 (0.020)	-0.353 (0.002)
Commercial Revolution	-0.206 (0.001)	-0.234 (0.000)	-0.350 (0.020)	-0.295 (0.050)
Glorious Revolution				
Industrial Revolution				
Railway Revolution	-0.190 (0.034)	-0.216 (0.020)	-0.352 (0.012)	-0.297 (0.050)
Debasement			-0.038 (0.031)	-0.033 (0.092)
Rebasement				
Time				
One period lag	0.066 (0.095)		-0.177 (0.090)	
Two period lag	0.149 (0.000)			
Three period lag				
Four period lag	-0.090 (0.028)			
Five period lag				
R^2	0.180	0.157	0.648	0.603
F	17.114 (0.000)	24.471 (0.000)	14.449 (0.000)	14.932 (0.000)
No. obs	633	661	62	65

[a] P values in brackets.

Table 5: Regressions of annual volatility by commodity with lags: final stage results based on the standard deviation of price changes

Variable	Barley	Wheat	Oats	Peas	Suet	Firewood
Constant	0.827 (0.000)[a]	0.935 (0.000)	0.068 (0.000)	1.078 (0.000)	0.397 (0.000)	0.306 (0.000)
Black Death						
Wars of Roses				0.225 (0.041)		
Tudors	0.431 (0.000)	0.301 (0.001)	0.266 (0.007)	0.551 (0.003)		
Civil War						
Napoleonic War	0.445 (0.002)	0.289 (0.041)	0.263 (0.048)	0.363 (0.033)	0.256 (0.009)	
Good Parliament	-0.170 (0.021)		-0.110 (0.000)	-0.254 (0.004)		
Commercial Revolution	-0.206 (0.001)					
Glorious Revolution			-0.228 (0.000)	-0.312 (0.000)		-0.150 (0.000)
Industrial Revolution						
Railway Revolution	-0.190 (0.034)			-0.304 (0.012)		
Debasement				-0.031 (0.032)	0.027 (0.002)	
Rebasement						
Time		-0.000 (0.000)			-0.000 (0.000)	
One year lag	0.066 (0.095)		0.126 (0.002)		0.263 (0.000)	0.410 (0.000)
Two year lag	0.149 (0.000)	0.080 (0.053)				-0.091 (0.059)
Three year lag					0.100 (0.010)	0.080 (0.080)
Four year lag	-0.090 (0.028)					
Five year lag						
R^2	0.180	0.088	0.097	0.163	0.152	0.219
F	17,114 (0.000)	14.065 (0.000)	13.362 (0.000)	15.507 (0.000)	18.377 (0.000)	34.365 (0.000)
No. obs	633	587	628	565	518	494

[a] *P* values in brackets.

Table 5 continued

Variable	**Candles (tallow)**	**Coal**	**Iron manf**	**Linencloth**	**Wool**	**Woolcloth**
Constant	0.446 (0.000)	0.744 (0.000)	0.559 (0.000)	0.199 (0.000)	0.263 (0.000)	0.264 (0.000)
Black Death	-0.209 (0.002)	1.444 (0.002)				
Wars of Roses	0.128 (0.000)	0.196 (0.035)				
Tudors		0.256 (0.000)			0.138 (0.066)	0.239 (0.000)
Civil War						
Napoleonic War	0.187 (0.001)					
Good Parliament	-0.257 (0.000)	-0.411 (0.015)				-0.173 (0.000)
Commercial Revolution			-0.429 (0.000)	-0.117 (0.000)		
Glorious Revolution		-0.182 (0.000)				-0.077 (0.018)
Industrial Revolution			0.263 (0.001)			0.062 (0.078)
Debasement						-0.013 (0.008)
Rebasement						
Time						
One year lag	0.198 (0.000)	0.218 (0.000)	0.258 (0.000)	0.315 (0.000)	0.177 (0.000)	0.416 (0.000)
Two year lag					0.090 (0.039)	-0.132 (0.003)
Three year lag						
Four year lag				0.096 (0.022)	0.090 (0.040)	0.131 (0.002)
Five year lag		0.080 (0.065)		0.119 (0.004)	0.091 (0.034)	
R^2	0.164	0.337	0.211	0.260	0.086	0.398
F	21.116 (0.000)	26.673 (0.000)	41.619 (0.000)	45.223 (0.000)	10.510 (0.000)	37.582 (0.000)
No. obs	543	374	470	519	567	462

Table 6: Regressions of decadal volatility by commodity with a lag: final stage results involving the standard deviation of price changes

Variable	**Barley**	**Wheat**	**Oats**	**Peas**	**Suet**	**Firewood**
Constant	1.380 (0.000)[a]	1.670 (0.000)	0.872 (0.000)	1.261 (0.000)	0.453 (0.000)	0.899 (0.000)
Black Death						
Wars of Roses						
Tudors	0.558 (0.000)	0.721 (0.048)			0.604 (0.001)	
Civil War						
Napoleonic War	0.702 (0.001)		0.484 (0.028)	0.524 (0.023)		
Good Parliament	-0.256 (0.020)	-0.617 (0.018)				-0.219 (0.056)
Commercial Revolution	-0.350 (0.000)	-0.533 (0.012)		-0.242 (0.042)		
Glorious Revolution			-0.399 (0.000)	-0.377 (0.004)		-0.329 (0.001)
Industrial Revolution						
Railway Revolution	-0.352 (0.012)			-0.360 (0.036)		
Debasement	-0.038 (0.031)		-0.064 (0.000)	-0.061 (0.002)	0.038 (0.072)	
Rebasement		-0.108 (0.014)				
Decade						
Lagged standard deviation	-0.177 (0.090)				0.257 (0.046)	
R^2	0.648	0.454	0.443	0.638	0.311	0.290
F	14.449 (0.000)	12.484 (0.000)	15.623 (0.000)	18.358 (0.000)	8.580 (0.000)	11.460 (0.000)
No. obs	62	64	62	57	60	58

[a] *P* values in brackets.

Table 6 continued

Variable	Candles (tallow)	Coal	Iron manf	Linen cloth	Wool	Wool cloth
Constant	0.404 (0.000)	2.094 (0.000)	1.270 (0.000)	0.567 (0.000)	0.160 (0.168)	0.100 (0.006)
Black Death						
Wars of Roses	0.158 (0.010)	0.376 (0.090)				
Tudors		0.431 (0.053)	0.472 (0.007)	0.247 (0.029)	0.245 (0.080)	0.420 (0.000)
Civil War						
Napoleonic War	0.248 (0.008)		0.782 (0.004)			
Good Parliament	-0.196 (0.008)	-1.451 (0.000)				
Commercial Revolution				-0.346 (0.000)		
Glorious Revolution		-0.356 (0.020)			-0.312 (0.028)	
Industrial Revolution			0.546 (0.001)			
Railway Revolution				0.514 (0.030)		
Debasement			-0.065 (0.004)			
Rebasement						
Decade			-0.019 (0.000)		0.007 (0.054)	
Lagged standard deviation	0.292 (0.028)				0.522 (0.000)	0.463 (0.000)
R^2	0.480	0.647	0.571	0.459	0.446	0.673
F	11.318 (0.000)	19.713 (0.000)	14.105 (0.000)	16.113 (0.000)	12.079 (0.000)	32.879 (0.000)
No. obs	53	42	58	60	64	51

Table 7: Pooled regressions involving standard deviation: final stage results using different measures of volatility[a]

Variable	Annual		Decadal			
			Change in price		Deviation from trend	
	With lags	Without lags	With lags	Without lags	With lags	Without lags
Constant	0.797 (0.000)[b]	1.047 (0.000)	0.978 (0.000)	1.234 (0.000)	0.878 (0.000)	1.058 (0.000)
Black Death						
Wars of Roses	0.069 (0.011)	0.068 (0.010)	0.092 (0.057)	0.085 (0.094)	0.068 (0.072)	
Tudors	0.183 (0.000)	0.254 (0.000)	0.268 (0.000)	0.261 (0.000)	0.195 (0.000)	0.168 (0.000)
Civil War					0.134 (0.083)	
Napoleonic War	0.139 (0.000)	0.176 (0.000)	0.308 (0.000)	0.349 (0.000)	0.275 (0.000)	0.300 (0.000)
Good Parliament	-0.151 (0.000)	-0.163 (0.000)	-0.193 (0.000)	-0.253 (0.000)	-0.192 (0.000)	-0.190 (0.000)
Commercial Revolution	-0.099 (0.000)		-0.081 (0.063)	-0.128 (0.005)	-0.070 (0.019)	-0.114 (0.001)
Glorious Revolution	-0.085 (0.000)	-0.097 (0.000)	-0.146 (0.000)	-0.159 (0.000)		
Industrial Revolution		0.062 (0.028)				
Railway Revolution	-0.090 (0.009)	-0.074 (0.059)				
Debasement	-0.007 (0.047)	-0.010 (0.002)	-0.025 (0.000)	-0.026 (0.000)	-0.013 (0.006)	-0.113 (0.008)
Rebasement			-0.014 (0.000)	-0.017 (0.017)	-0.009 (0.097)	-0.011 (0.045)
Barley trend		-0.560 (0.000)				
Wheat trend		-0.495 (0.000)				
Oats trend	0.710 (0.000)	0.347 (0.012)				
Peas trend	-0.399 (0.002)	-0.912 (0.000)			-0.003 (0.070)	
Suet trend	0.373 (0.011)		0.005 (0.066)	0.005 (0.035)	0.004 (0.049)	0.006 (0.009)

[a] The values of estimated constants for the eleven commodities other than barley (the control) are not reported as they merely reflect the units in which the prices are measured.
[b] *P* values in brackets.

Firewood trend		-0.542 (0.001)				
Candles trend	0.480 (0.000)		0.006 (0.031)	0.008 (0.011)	0.006 (0.000)	0.008 (0.001)
Coal trend	-0.478 (0.000)	-1.763 (0.000)	-0.006 (0.000)	-0.021 (0.000)	-0.011 (0.000)	-0.012 (0.000)
Iron trend		-0.413 (0.008)				
Linen trend		-0.035 (0.042)				
Wool trend	0.697 (0.000)	0.394 (0.008)	0.009 (0.000)	0.011 (0.000)	0.008 (0.000)	0.010 (0.000)
Wool cloth trend		-0.390 (0.000)				
One year lag	0.092 (0.000)	-		-		-
Two year lag		-		-		-
Three year lag		-		-		-
Four year lag		-		-		-
Five year lag	0.054 (0.000)	-		-		-
One decade lag	-	-	0.178 (0.000)	-	0.142 (0.000)	-
R^2	0.220	0.207	0.504	0.493	0.536	0.508
F	72.155 (0.000)	65.128 (0.000)	33.376 (0.000)	32.947 (0.000)	32.143 (0.000)	37.048 (0.000)
No. obs	6412	7030	711	733	721	739

Table 8: Annual wage volatility: regressions of standard deviation of price changes, final stage results with and without and without lags

	Wage farm		Wage craft		Wage building	
Variables	**With lags**	**Without lags**	**With lags**	**Without lags**	**With lags**	**Without lags**
Constant	0.105 (0.003)[a]	0.180 (0.000)	0.167 (0.000)	0.300 (0.000)	0.241 (0.000)	0.570 (0.000)
Black Death				-0.129 (0.000)		
Wars of Roses		0.117 (0.030)				
Tudors	0.128 (0.006)	0.188 (0.000)				
Civil War	-0.122 (0.090)	-0.154 (0.040)				
Napoleonic War						
Good Parliament			-0.039 (0.050)	-0.104 (0.000)	-0.102 (0.000)	-0.163 (0.000)
Commercial Revolution					-0.068 (0.000)	
Glorious Revolution	-0.228 (0.000)	-0.287 (0.000)				
Industrial Revolution						0.093 (0.008)
Railway Revolution						
Debasement						0.008 (0.052)
Rebasement						
Time	0.000 (0.002)	0.000 (0.000)	0.000 (0.005)	-0.000 (0.000)		-0.000 (0.000)
One year lag	0.310 (0.000)		0.367 (0.000)		0.319 (0.000)	0.279
Two year lag			-0.119 (0.002)		-0.070 (0.073)	62.618 (0.000)
Three year lag						650
Four year lag			0.083 (0.023)		0.138 (0.000)	
Five year lag						
R^2	0.198	0.123	0.221	0.151	0.322	0.279

[a] *P* values in brackets.

F	28.595 (0.000)	6.552 (0.000)	36.476 (0.000)	39.005 (0.000)	59.997 (0.000)	62.618 (0.000)
No. obs	585	619	648	661	637	650

Table 9: Decadal wage volatility: regressions of standard deviation of price changes, final stage results with and without and without lags

Variables	Wage farm	Wage craft With lags	Wage craft Without lags	Wage building With lags	Wage building Without lags
Constant	0.210 (0.008)[a]	0.183 (0.000)	0.410 (0.000)	0.777 (0.000)	0.777 (0.000)
Black Death			-0.127 (0.000)		-0.250 (0.018)
Wars of Roses					
Tudors					
Civil War		0.199 (0.046)			
Napoleonic War					
Good Parliament			-0.142 (0.005)	-0.169 (0.001)	-0.352 (0.000)
Commercial Revolution	-0.256 (0.030)			-0.094 (0.005)	
Glorious Revolution	-0.383 (0.001)				
Industrial Revolution					
Railway Revolution					
Debasement					
Rebasement					
Time	0.011 (0.002)	-0.002 (0.005)	-0.003 (0.004)		-0.005 (0.001)
One decade lag		0.441 (0.005)		0.346 (0.000)	
R^2	0.293	0.496	0.459	0.746	0.635
F	8.407 (0.000)	21.960 (0.000)	17.554 (0.000)	59.747 (0.000)	35.933 (0.000)
No. obs	64	64	65	64	65

[a] *P* values in brackets.

Table 10: Annual trend by commodity with lags: final stage regressions[a]

Variables	Barley	Wheat	Oats	Peas	Suet	Firewood
Constant	-0.731 (0.000)[b]	-0.637 (0.000)	-0.664 (0.002)	-1.534 (0.000)	0.014 (0.566)	0.256 (0.019)
Black Death						0.269 (0.039)
Wars of Roses	-0.249 (0.069)	-0.243 (0.084)	-0.339 (0.008)	-0.747 (0.000)		-0.189 (0.052)
Tudors						-0.268 (0.017)
Civil War	0.424 (0.039)	0.492 (0.022)		0.419 (0.079)		
Napoleonic War				0.593 (0.015)	0.211 (0.082)	
Good Parliament	-0.299 (0.060)	-0.279 (0.070)		-0.638 (0.003)		
Commercial Revolution						
Glorious Revolution				-0.539 (0.006)		-0.172 (0.053)
Industrial Revolution						
Railway Revolution		-0.618 (0.001)	-0.231 (0.068)	-0.684 (0.001)		
Debasement	-0.032 (0.043)					
Rebasement	-0.027 (0.041)					
Time	0.003 (0.000)	0.004 (0.000)	0.002 (0.001)	0.008 (0.000)		0.002 (0.000)
Price level lag	-0.113 (0.000)	-0.143 (0.000)	-0.076 (0.001)	-0.288 (0.000)		-0.105 (0.000)
One year lag	-0.118 (0.008)		-0.334 (0.000)	-0.118 (0.020)	-0.507 (0.000)	-0.554 (0.000)
Two year lag	-0.383 (0.000)	-0.252 (0.000)	-0.380 (0.000)	-0.206 (0.000)	-0.342 (0.000)	-0.337 (0.000)
Three year lag	-0.242 (0.000)	-0.197 (0.000)	-0.342 (0.000)	-0.223 (0.000)	-0.288 (0.000)	-0.130 (0.000)
Four year lag	-0.140 (0.001)	-0.131 (0.000)	-0.227 (0.000)	-0.148 (0.000)	-0.224 (0.000)	
Five year lag	-0.097 (0.016)		-0.086 (0.000)		-0.107 (0.016)	
R^2	0.226	0.196	0.228	0.256	0.219	0.307

[a] This table includes the *t*-statistic used for the Dickey-Fuller test is derived from a regression involving just the lagged price, a time trend and the lagged price changes, excluding the other variables that appear in the table.
[b] *P* values in brackets.

F	15.082 (0.000)	17.331 (0.000)	20.346 (0.000)	15.673 (0.000)	23.953 (0.000)	26.791 (0.000)
DF statistic	-2.881	-2.950	-2.023	-3.113	-0.427	-2.372
No. obs	633	648	628	558	518	553

Table 10 continued

Variable	Candles-tallow	Coal	Iron manf	Linen	Wool	Wool cloth
Constant	-0.131 (0.007)	-0.116 (0.518)	0.004 (0.967)	0.491 (0.000)	-0.849 (0.000)	-0.363 (0.000)
Black Death	0.154 (0.072)	1.416 (0.020)		0.407 (0.000)	0.433 (0.004)	0.268 (0.028)
Wars of Roses		-0.344 (0.011)	-0.199 (0.090)		0.334 (0.001)	
Tudors				-0.192 (0.013)	0.545 (0.000)	
Civil War		0.262 (0.047)				0.192 (0.026)
Napoleonic War		0.363 (0.014)				0.162 (0.060)
Good Parliament					0.482 (0.000)	0.218 (0.045)
Commercial Revolution					-0.361 (0.007)	-0.144 (0.059)
Glorious Revolution					0.854 (0.000)	
Industrial Revolution		-0.176 (0.089)	-0.308 (0.021)	-0.214 (0.003)		-0.177 (0.023)
Railway Revolution						
Debasement	-0.017 (0.009)					
Rebasement	-0.070 (0.000)					
Time	0.001 (0.080)	0.002 (0.010)	0.001 (0.009)	0.001 (0.000)	-0.003 (0.000)	0.001 (0.005)
Price level lag	-0.019 (0.080)	-0.098 (0.002)	-0.098 (0.001)	-0.093 (0.000)	0.216 (0.000)	-0.041 (0.051)
One year lag	-0.351 (0.000)	-0.369 (0.000)	-0.429 (0.000)	-0.515 (0.000)	-0.354 (0.000)	-0.515 (0.000)
Two year lag	-0.170 (0.000)	-0.289 (0.000)	-0.187 (0.001)	-0.265 (0.000)	-0.214 (0.000)	-0.293 (0.000)
Three year lag	-0.218 (0.000)	-0.221 (0.000)	-0.157 (0.004)	-0.179 (0.000)	-0.181 (0.000)	-0.284 (0.000)
Four year lag	-0.116 (0.006)	-0.207 (0.000)	-0.104 (0.031)		-0.196 (0.000)	-0.139 (0.005)
Five year lag		-0.256 (0.000)		0.104 (0.004)		
R^2	0.165	0.338	0.227	0.302	0.241	0.268
F	11.742 (0.000)	15.374 (0.000)	16.994 (0.000)	24.767 (0.000)	14.674 (0.000)	13.851 (0.000)
DF statistic	-1.753	-1.327	-1.931	-2.030	6.964	-1.692
No. obs.	543	374	470	524	566	466

Table 11: Annual price levels: regression of price levels by commodity with lags: final stage results[a]

Variables	Barley	Wheat	Oats	Peas	Suet	Firewood
Constant	-0.862 (0.000)	-0.656 (0.000)	-0.711 (0.001)	-1.247 (0.000)	-0.060 (0.355)	0.409 (0.000)
Black Death						0.311 (0.017)
Wars of Roses	-0.257 (0.060)	-0.248 (0.079)	-0.349 (0.006)	-0.597 (0.001)		
Tudors						-0.237 (0.030)
Civil War	0.463 (0.025)	0.498 (0.021)		0.411 (0.088)		
Napoleonic War				0.509 (0.037)		
Good Parliament	-0.387 (0.000)	-0.327 (0.039)		-0.595 (0.006)	-0.161 (0.073)	
Commercial Revolution						0.254 (0.069)
Glorious Revolution				-0.413 (0.031)		-0.200 (0.029)
Industrial Revolution						
Railway Revolution	-0.327 (0.034)	-0.459 (0.020)	-0.227 (0.073)	-0.586 (0.004)		
Debasement	-0.030 (0.055)				-0.042 (0.039)	
Rebasement		-0.031 (0.040)				
Time	0.003 (0.000)	0.004 (0.000)		0.006 (0.000)	0.001 (0.035)	0.002 (0.000)
One year lag	0.786 (0.000)	0.825 (0.000)	0.597 (0.000)	0.597 (0.000)	0.498 (0.000)	0.324 (0.000)
Two year lag	-0.276 (0.000)	-0.201 (0.000)		-0.074 (0.077)	0.200 (0.000)	0.209 (0.000)
Three year lag	0.202 (0.000)					0.209 (0.000)
Four year lag		0.102 (0.012)	0.129 (0.001)	0.070 (0.100)	0.105 (0.021)	
Five year lag	0.157 (0.000)	0.125 (0.001)	0.192 (0.000)	0.170 (0.000)	0.172 (0.000)	0.120 (0.000)
R^2	0.960	0.959	0.971	0.943	0.977	0.967
F	1507.000 (0.000)	1466.000 (0.000)	3516.000 (0.000)	840.831 (0.000)	3187.000 (0.000)	1783.000 (0.000)
No. obs	635	650	630	572	526	558

[a] *P* values in brackets.

Table 11 continued

Variables	Candles, tallow	Coal	Iron manfg	Linen	Wool	Wool cloth
Constant	-0.129 (0.007)	0.176 (0.000)	-0.009 (0.918)	0.547 (0.000)	0.231 (0.023)	-0.217 (0.013)
Black Death	0.152 (0.075)			0.469 (0.000)		0.242 (0.015)
Wars of Roses		-0.276 (0.055)	-0.204 (0.077)			
Tudors				-0.265 (0.001)		
Civil War						0.206 (0.018)
Napoleonic War				0.176 (0.000)		0.165 (0.063)
Good Parliament					-0.376 (0.003)	
Commercial Revolution						-0.160 (0.033)
Glorious Revolution					-0.299 (0.038)	
Industrial Revolution			-0.318 (0.015)	-0.275 (0.000)		-0.218 (0.002)
Railway Revolution						
Debasement	-0.017 (0.009)					
Rebasement	-0.070 (0.000)				-0.036 (0.000)	
Time	0.001 (0.004)			0.002 (0.000)	0.002 (0.000)	0.002 (0.000)
One year lag	0.624 (0.000)	0.492 (0.000)	0.493 (0.000)	0.350 (0.000)	0.659 (0.000)	0.465 (0.000)
Two year lag	0.162 (0.001)	0.150 (0.000)	0.267 (0.000)	0.238 (0.000)	0.135 (0.003)	0.217 (0.000)
Three year lag		0.196 (0.000)		0.075 (0.091)		
Four year lag	0.084 (0.072)	0.147 (0.006)		0.149 (0.001)		0.125 (0.010)
Five year lag	0.111 (0.008)		0.139 (0.000)	0.085 (0.038)	0.122 (0.000)	0.145 (0.002)
R^2	0.986	0.965	0.909	0.974	0.931	0.978
F	4748.000 (0.000)	2092.000 (0.000)	793.334 (0.000)	1948.000 (0.000)	1091.000 (0.000)	2090.000 (0.000)
No. obs	544	385	481	537	575	477

Table 12: Annual wage trend: final stage results for regression of the change in the log wage with lags[a]

	Wage farm	**Wage craft**	**Wage building**	**Craft-farm premium**	**Craft-building premium**
Constant	-0.023 (0.606)[b]	0.091 (0.002)	0.014 (0.584)	0.935 (0.000)	1.299 (0.000)
Black Death	0.423 (0.000)	0.191 (0.000)	0.252 (0.000)	-0.423 (0.000)	-0.118 (0.056)
Wars of Roses					-0.087 (0.027)
Tudors	-0.214 (0.003)				
Civil War			0.103 (0.069)	0.132 (0.028)	
Napoleonic War	0.261 (0.005)	0.159 (0.001)	0.197 (0.001)		
Good Parliament	0.128 (0.071)			-0.482 (0.000)	-0.249 (0.000)
Commercial Revolution				0.200 (0.000)	0.141 (0.002)
Glorious Revolution	-0.151 (0.003)			0.212 (0.001)	0.175 (0.000)
Industrial Revolution					
Railway Revolution		0.119 (0.001)	0.158 (0.002)	0.269 (0.025)	
Debasement					
Rebasement					
Time	0.003 (0.000)	0.001 (0.000)	0.001 (0.001)		-0.000 (0.000)
Price level lag	-0.146 (0.000)	-0.043 (0.000)	-0.050 (0.001)	-0.303 (0.000)	-0.454 (0.000)
One year lag	-0.406 (0.000)	-0.437 (0.000)	-0.604 (0.000)	-0.400 (0.000)	-0.353 (0.000)
Two year lag	-0.265 (0.000)	-0.201 (0.000)	-0.309 (0.000)	-0.226 (0.000)	-0.165 (0.003)
Three year lag	-0.097 (0.026)	-0.117 (0.006)	-0.191 (0.000)	-0.085 (0.050)	-0.088 (0.071)
Four year lag		-0.072 (0.088)	-0.088 (0.000)		-0.083 (0.025)
Five year lag	-0.094 (0.018)	0.093 (0.014)			
R^2	0.254	0.224	0.328	0.319	0.422

[a] The *t*-statistic used for the Dickey-Fuller test is derived from a regression involving just the lagged price, a time trend and the lagged price changes, excluding the other variables that appear in the table.
[b] *P* values in brackets.

F	17.794 (0.000)	18.422 (0.000)	18.572 (0.000)	26.729 (0.000)	41.874 (0.000)
DF statistic	-2.179	-2.015	-1.149	-2.450	-4.349
No. obs.	585	648	637	580	634

Table 13: Annual wage levels and wage premia: final stage regression results using lagged wages[a]

Variables	Wage farm	Wage craft	Wage building	Craft-farm premium	Craft-building premium
Constant	-0.031 (0.484)	0.111 (0.001)	0.025 (0.344)	0.944 (0.000)	1.564 (0.000)
Black Death	0.424 (0.000)	0.206 (0.000)	0.236 (0.000)	-0.425 (0.000)	-0.137 (0.033)
Wars of Roses		-0.045 (0.092)			-0.102 (0.014)
Tudors	-0.231 (0.001)			0.138 (0.022)	
Civil War			0.098 (0.097)		
Napoleonic War	0.259 (0.005)	0.185 (0.000)	0.195 (0.002)		
Good Parliament	0.141 (0.044)			-0.489 (0.000)	-0.309 (0.000)
Commercial Revolution				0.206 (0.000)	0.164 (0.000)
Glorious Revolution	-0.159 (0.019)			0.215 (0.000)	0.208 (0.000)
Industrial Revolution					
Railway Revolution		0.133 (0.000)	0.154 (0.003)	0.278 (0.016)	
Debasement					
Rebasement					
Time	0.003 (0.000)	0.001 (0.000)	0.001 (0.004)		-0.001 (0.000)
One year lag	0.439 (0.000)	0.487 (0.000)	0.395 (0.000)	0.301 (0.000)	0.170 (0.000)
Two year lag	0.144 (0.002)	0.227 (0.102)	0.301 (0.000)	0.167 (0.000)	0.192 (0.000)
Three year lag	0.182 (0.000)	0.102 (0.013)		0.144 (0.001)	0.093 (0.015)
Four year lag	0.082 (0.057)		0.189 (0.000)	0.082 (0.060)	
Five year lag		0.139 (0.000)	0.070 (0.059)		
R^2	0.990	0.998	0.997	0.783	0.673

[a] *P* values in brackets.

F	5836.000 (0.000)	3775.000 (0.000)	20990.000 (0.000)	207.571 (0.000)	145.387 (0.000)
No. obs	591	650	639	584	645

Figure 1

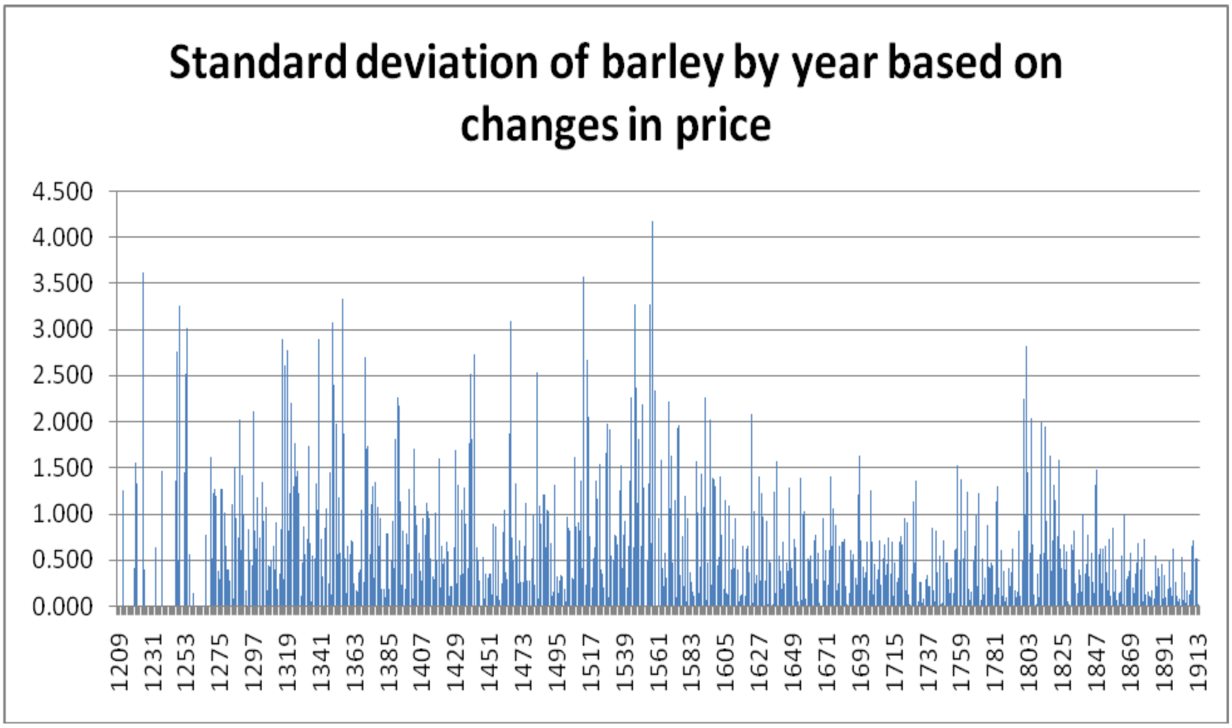
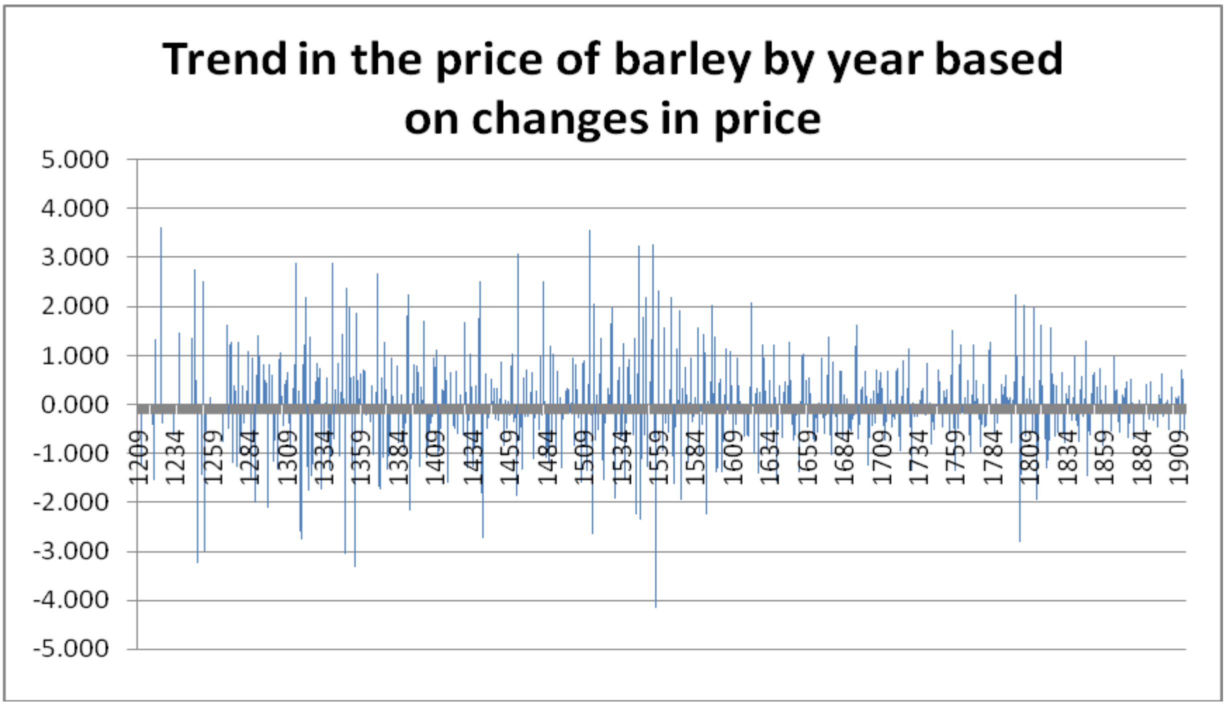

Standard deviation of barley by year based on changes in price
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
1209
1231
1253
1275
1297
1319
1341
1363
1385
1407
1429
1451
1473
1495
1517
1539
1561
1583
1605
1627
1649
1671
1693
1715
1737
1759
1781
1803
1825
1847
1869
1891
1913

Figure 2


Trend in the price of barley by year based on changes in price
5.000
4.000
3.000
2.000
1.000
0.000
-1.000
-2.000
-3.000
-4.000
-5.000
1209
1234
1259
1284
1309
1334
1359
1384
1409
1434
1459
1484
1509
1534
1559
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1609
1634
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1684
1709
1734
1759
1784
1809
1834
1859
1884
1909