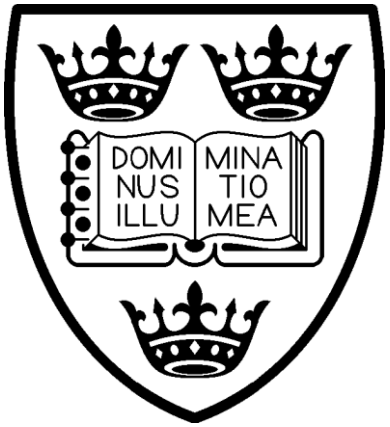

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Abstract

This paper challenges the growing consensus in the literature (Stone, 2005; Dodds, 2007) that medieval English peasants and manorial managers were price responsive in their production decisions. Using prices of and acreages planted with wheat, barley, and oats on 49 manors held by the bishop of Winchester from 1349-70, we estimate price elasticities of supply for each grain in aggregate and on each particular manor. Aggregate price elasticities of supply for wheat and oats were not significantly different than zero, and barley aggregate elasticities of supply were significant but very low. These elasticities are low compared with price elasticities of supply estimated for developing and developed countries in the nineteenth and twentieth centuries. Attempting to explain the variation in the estimated price elasticities for individual manors, market concentration had a significant, positive effect on price elasticities of wheat and oat supply. In the end, the low levels of price responsiveness in the post-Black Death period suggest that commercialisation was not as dominant in the medieval English economy as has been argued. Thus, the institutional and structural changes highlighted by Marxist and Neo-Malthusian historians may need to take a more prominent role in explanations of medieval economic change.

[1] I would like to thank Bob Allen, Bruce Campbell, and Rui Esteves for useful advice on a number of occasions. In addition, I would like to thank seminar participants at Nuffield College, Oxford, Corpus Christi College, Cambridge, and the LSE. The usual disclaimer applies.

Introduction

Beginning in the late 1950s with Nerlove's seminal study of agricultural supply response, development economists became very interested in testing whether farmers adjusted their agricultural output based on prices or other economic indicators.[2] This new empirical technique had the promise of resolving the debate between monetarists and structuralists over the best policies for development. If peasants in developing countries were price responsive, then changes in terms of trade regarding agriculture and price shifts in agricultural commodities could have a large influence on the agricultural output of a country. However, if peasants were not price responsive, then structural changes such as land and income redistribution would be needed in order to raise agricultural output to support growing industrialized cities.[3] Thus, price elasticities of supply have been estimated for a wide range of crops in many countries, including several historical calculations of elasticities in the late nineteenth century.[4] Generally, development economists found positive price elasticities of supply for agriculture, suggesting that even in developing economies, farmers were price responsive. The elasticities for peasant production were lower than the elasticities for industrial farming, but they suggested that the picture of the risk-averse, non-profit maximizing peasant was largely a myth.[5]

Supply response has also been studied by English medieval economic historians, who have used evidence of supply response to argue for an expanded role of commercialization in medieval economic development. Ben Dodds reconstructed peasant production from the tithe receipts of Durham Cathedral Priory and argued that peasants were price responsive in their production decisions because for instance the percentage of wheat out of the total tithe output was correlated with the wheat price.[6] In addition, David Stone has pieced together an extremely detailed picture of the managerial decision-making on the fenland manor of Wisbech Barton, arguing that reeves could be exceptionally good managers and were price responsive in the way they planted their fields. In the third part of his book and in an additional article, Stone extended this argument to a number of manors across Southern England, suggesting that good management and with it, price responsiveness, were widespread in seigniorial agriculture.[7] Thus, they corroborated the story of the development economists that peasants in medieval England generally responded to prices when making production decisions.

Both Stone and Dodds's research is very interesting and fruitful, but it raises concerns for several reasons. First, Stone only looked at a small sample of manors, which were not representative of the country or seigniorial agriculture as a whole. Second, Stone found that all of the manors had elements of price responsiveness, but they were all responsive in different ways. Some reeves were responsive in their planting decisions, for instance at Hambledon, Hinderclay, and Hanford manors, but

[2] Nerlove, *Dynamics*; Askari and Cummings, 'Estimating', 257.

[3] Yotopoulos and Nugent, *Economics of Development*, 135-7.

[4] Askari and Cummings, *Agricultural Supply Response*; Schuh and Brandão, 'The Theory', 660-65.

[5] Rao, 'Agricultural Supply Response', 5-6.

[6] Dodds, *Peasants and Production*, 161.

[7] Stone, *Decision-Making*, 206-12.

others were responsive in the way they managed livestock, for instance pigs on Cuxham manor and sheep on Kinsbourne manor.[8] These results highlight good managerial practices in different aspects of manorial production, but they do not allow historians to understand the important economic question of whether price elasticities of supply for each particular good produced were significantly different than zero in aggregate: i.e. was the price response in grain and livestock production substantial on the majority of manors across the country? Finally, neither Stone nor Dodds tested price responsiveness in a specific theoretical framework with robust econometric techniques. The correlations they cite as proof of price responsiveness are only a first step, which can be complicated by estimating price elasticities of supply for the various crops. This paper will attempt to overcome some of these issues, at least for the seigniorial sector.

Agricultural supply response is of interest to historians because if price elasticities of supply were low or not significantly different than zero in aggregate, then reeves' planting decisions were on average determined by the crop rotations in practice on the manor and other non-market factors, not by prices or input costs. This would call into question reeves' ability to adopt innovative technology or increase productivity in the absence of some institutional or structural change in the economy and would, therefore, weaken the influence of commercialization in the economy. However, if reeves responded to prices or input costs in an attempt to maximize profit, then changes in prices and wages could have a significant influence on the development of agriculture and the medieval economy as a whole.[9]

This paper will measure acreage supply response on 49 manors held by the Bishop of Winchester for the years following the Black Death, 1349-70. I will first describe the data and the variation in acreage sown on the various Winchester manors. I will then present a partial adjustment model of agricultural supply response for acreage planted and estimate the various price elasticities of supply. Finally, I will place these elasticities in the context of price responsiveness in the nineteenth and twentieth centuries, and attempt to determine the factors influencing price responsiveness of reeves on different manors.

The Data: Direct Evidence on Farming from Manorial Accounts

The direct evidence on manorial farming in fourteenth-century England was originally drawn from manorial accounts enrolled in the Winchester Pipe Roll for a majority of the manors held by the Bishop of Winchester. These accounts contain a wealth of information about the seigniorial agricultural economy, including crop yields, acreages sown with various crops, seed rates, grain prices, and piece wages. The lord's property on the each manor, the demesne, was managed by a reeve who was exempted from customary manorial fees and labour obligations in return. Reeves were typically local peasants who had proven their ability to manage their farms well. The manorial accounts were recorded annually at Michaelmas, September 29, after

[8] Stone, 'Medieval Farm Management', 619-23; Stone, *Decision-Making*, 189-212.

[9] Yotopoulos and Nugent, *Economics of Development*, 135-7; Schuh and Brandão, 'The Theory', 655-8.

the harvest, when the lord's steward would audit the reeve to ensure that the reeve was managing the manor properly and not committing fraud. The precision in the documents and the strict review process assure that the figures recorded in the accounts are fairly reliable and may be subjected to econometric scrutiny.

Nearly all of the grain produced on the demesne was saved for sowing the next year, sold at the market, or transferred to the lord with relatively small amounts of grain being transferred to permanent manorial employees, *famuli*. Reeves also continued to farm their own plots while managing the demesne. Therefore, reeves had no subsistence related risk aversion and were the most likely farmers in the medieval period to be price responsive in their production strategies.

However, there were clear incentives and limitations to the reeve's production flexibility. There was some path dependency in the production strategies that would have limited the reeves' ability to adjust the acreage planted on a year-to-year basis. Basic crop rotation and fallowing was necessary to maintain the nutrient content of the soil. In its simplest form, this rotation consisted of three fields: one sown with a winter crop such as wheat, one sown with spring crops such as barley and oats, and one left fallow to regain some of its nutrients. Clearly, reeves could not switch all of their production to wheat in response to climbing wheat prices. Likewise, reeves' flexibility was also limited by their requirement to provide for the consumption of the lord's household. This might mean providing lambs for meat, wheat for bread, or oats as fodder for the lord's horses. These demands, which unfortunately are not observable in a large dataset such as this, could influence the reeve's production strategies.[10] However, there were many incentives for flexibility and responsiveness as well. The massive population decline after the Black Death changed demand structure for the different grains. Peasants started consuming more wheat and beer, which increased demand for wheat and barley at the expense of oats.[11] In addition, prices and the weather varied dramatically in this period, so there were potentially great profits for those who could adjust their production strategies.

The Winchester manors were not wholly representative of all demesnes across England at the time, but they were more representative than has sometimes been argued.[12] They spanned a great distance from Somerset to Surrey, and from Hampshire to Buckinghamshire (Map 1). They included almost all of the post-Black Death cropping and husbandry types described by Campbell.[13] The average acreage in seed ranged from 43 acres on Bitterne manor in southern Hampshire to 489 acres on East Meon manor also in southern Hampshire with a median across all manors of 134 acres.

Many of the manors followed three-course rotations or sowed almost exclusively wheat, barley and oats. This pattern was fairly common throughout Southern England with 53.3 per cent of demesnes in Campbell's demesne dataset falling into these production types.[14] However, the Winchester manors along the

[10] Campbell, *Seigniorial Agriculture*, 10-16, 55-6.

[11] Campbell, *Seigniorial Agriculture*, 238-47.

[12] Stone, *Decision-Making*, 19-20.

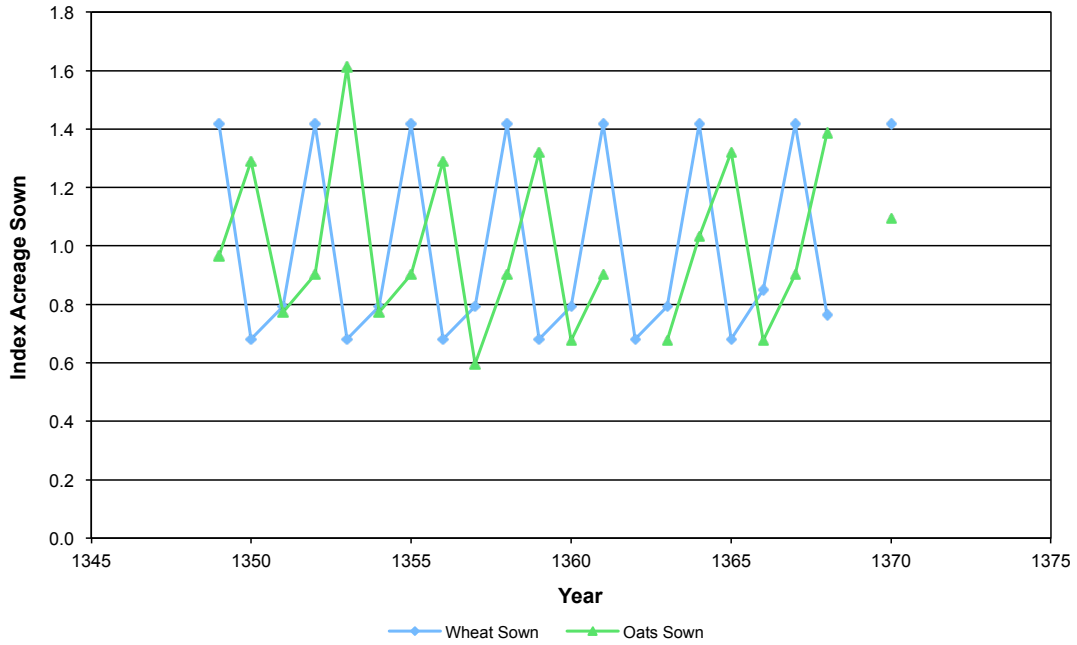
[13] Campbell, *Seigniorial Agriculture*, 275-93.

[14] Campbell, *Seigniorial Agriculture*, 277.

Thames and in the Chilterns and Cotswolds sowed large amounts of mixed grains and had a ready market for their produce in London, making them similar in some ways to the productive and commercialized manors of East Anglia and Kent. Despite this diversity, the composition of cropping and husbandry types does not follow the national pattern. More intensive cropping and mixed-farming types are underrepresented in the sample and the manors are too large to accurately capture the smaller production strategies on manors held by lay lords. Therefore, it is difficult to extend all findings from the Winchester manors to a broader context of Post-Black Death England. However, when the Winchester manors are studied as a whole, they form the most representative sample of seigniorial production that exists anywhere and provide better conclusions than most studies of the manorial economy, which focus on one or two manors.

I did not collect the data used for this dataset from the original documents, instead drawing extensively on the notes of D. L. Farmer held in the archives at the University of Saskatchewan and on Bruce Campbell's crop yield database.[15] The dataset is a panel dataset of 49 individual manors held by the Bishop of Winchester from 1349 to 1370. The panel is strongly balanced but does have some missing data because the manorial accounts were damaged or have not survived. However, the survival or damaging of certain documents would not influence the economic functioning of the manors studied. This paper relies upon two main aspects of the accounts: the acreage planted with wheat, barley, and oats; and the respective prices of these grains.

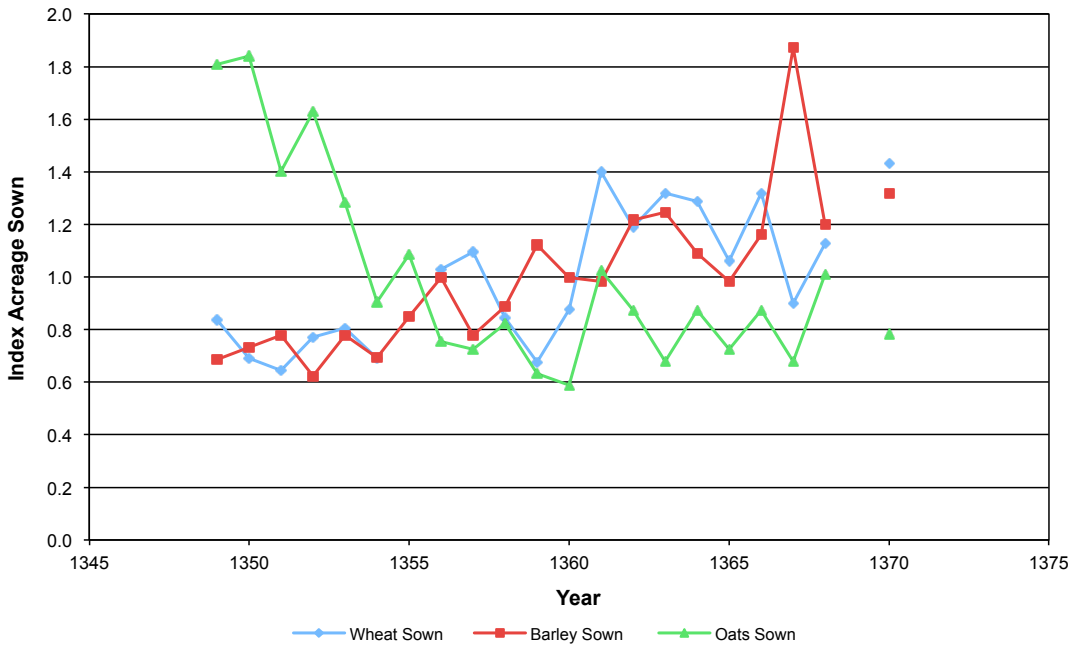
Figure 1: Divergence of acreage sown with wheat and oats from the mean (index = 1) on Taunton Nailsborne manor in Somerset.



[15] University of Saskatchewan Archives, The Papers of David Farmer, Series III, Boxes 11, 12, and 14; Campbell, 'Crop Yields', database. I wish to thank the University of Saskatchewan Archives for making scanned copies of Farmer's papers available.

Farmer recorded the acreage of wheat, barley and oats sown on each of the Winchester manors.[16] In order to compare acreages sown across manors in the regressions, it was necessary to standardize the acreages: the acreage of each crop sown in a given year was divided by the average acreage of that crop sown on the manor over the entire period (1349-70). The means of these indexes of crops sown were equal to unity with the following standard deviations: wheat, 0.281; barley, 0.442; and oats, 0.350. Thus wheat acreage varied 28 per cent around the mean and so on. There is more variation in spring-sown crops than winter-sown crops most likely because barley and oats could be substituted within traditional cropping rotations in the spring-sown field. A larger change in wheat sown, however, could require changing production strategies and crop rotations more generally in order to expand the winter-sown field.

Figure 2: Divergence of acreage sown with wheat, barley and oats from the mean (index = 1) on Wargrave manor in Berkshire.

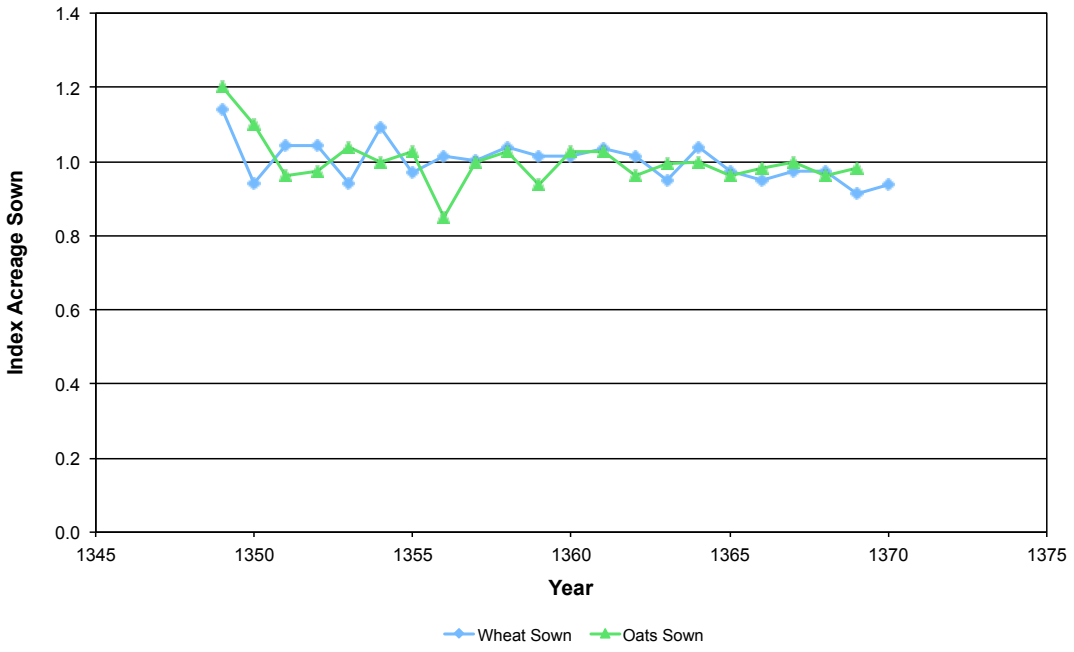


There were three main patterns in planting behaviour on the various manors, which varied based on the regularity of the crop rotation and the variation in the acreage planted. First, there were several manors where the acreage planted varied considerably but the crop rotation was regular. Nailsbourne manor in Somerset was the best example of this type (Figure 1). Acreages planted with wheat and oats ranged between 40 per cent above and below the mean acreage planted in a very regular manner. The demesne must have been divided into three different sized fields with the crops being rotated through the three fields. Second, there were manors with large variations in the acreage planted with different grains that did not follow a regular cropping pattern. Wargrave manor in Berkshire was a good example of this type (Figure 2). The acreage planted with wheat and barley expanded over the 22-year period following the Black Death, but there is no discernible rotation pattern in the cropping. The third type of manors had small variation in the acreage planted over

[16] University of Saskatchewan Archives, The Papers of David Farmer, Series III, Box 10, Folder 1, parts 1-4.

time and no regular cropping pattern. Rimpton manor in Somerset was a good example of this type (Figure 3). Rimpton specialized in wheat and oat production and seems to have had three equally sized fields through which it rotated wheat and oats. Most manors followed the second pattern with no discernible rotation and acreages planted varying perhaps 25 per cent around the mean.

Figure 3: Divergence of acreages sown with wheat and oats from the mean (index = 1) on Rimpton manor in Somerset.



Farmer also recorded many local and regional price series along with a national price series for wheat, barley, and oats. Farmer's weighted annual average prices for wheat were available in his notes for each Winchester manor. To obtain the annual weighted average price for each manor, Farmer divided the total revenue gained from sales of a particular grain in a year by the total quantity of that grain sold. Unfortunately, wheat price data was not available for all years, so manor specific prices were interpolated with Farmer's regional price series. The interpolated prices made up less than 10 per cent of the data. Barley and oat prices were either not available on a manor specific level or had too many missing values to be used at the manor level. Therefore, Farmer's regional price series, the arithmetic mean of the prices on manors in each region, were used in the regressions. These regional series were interpolated using Farmer's national series.[17] As a robustness check, the regional wheat price series was also used in the regressions, but there was no change in the results. Farmer's national wage series was not available in disaggregated form among the scanned copies of his notes, so the national reaping wage series was used in the regressions.[18]

[17] Farmer, 'Prices and Wages', (1991), 501-25; Farmer, 'Prices and Wages', (1988), 787-817; University of Saskatchewan Archives, The Papers of David Farmer, Series III: Box 10, Folder 30; Box 12, Folder 50; Box 14, Folders 1, 2, and 5.

[18] Farmer, 'Prices and Wages', (1991), 501-25.

Partial Adjustment Model of Acreage Supply Response

This paper will test the acreage supply response of reeves managing the Winchester manors in a partial adjustment model framework. The partial adjustment model is made up of two structural equations. First, the equilibrium (desired) acreage planted is taken to be a function of expected prices

$$X_t^* = a + bP_t^e + u_t \tag{1}$$

where X_t^* is the equilibrium acreage planted at time *t* and P_t^e is the expected price in the current year. For the sake of simplicity in estimation, expected prices are taken to be the price in the previous year.

$$P_t^e = P_{t-1}$$

The second structural equation holds that the actual change in acreage planted from one period to the next is proportional to the difference between the equilibrium (desired) acreage planted and the acreage planted in the last period

$$X_t - X_{t-1} = \gamma(X_t^* - X_{t-1}) \tag{2}$$

where X_t is the acreage planted in year *t* and γ is the speed of adjustment from one year to the next. Thus, if γ is equal to unity, then the farmers are adjusting to the equilibrium level every year: i.e. they are actually planting the desired equilibrium acreage. When equation 1 is substituted into equation 2, the following equation is obtained

$$X_t = a\gamma + b\gamma P_{t-1} + (1-\gamma)X_{t-1} + \gamma u_t \tag{3}$$

Thus, the acreage planted is a function of the lagged price and the acreage planted in the previous year.[19]

The log of the acreage sown and the price were used so that price elasticities of supply could easily be calculated. Equation 3 was estimated with aggregate panel and time-series data for each individual manor for acreages sown with wheat, barley, and oats in order to understand both aggregate patterns and the practices of individual reeves.

As Askari and Cummings have argued, it is necessary to represent the price in different ways in order to capture the various incentives that farmers faced.[20] Three price measures were used in the regressions in order to understand more precisely what triggered reeves to shift their production: the price of each grain, the opportunity cost between a grain and its closest substitute, and the labour input costs measured as the price of the grain divided by the reaping wage. As mentioned above, manor specific wheat prices were available for all manors, but regional prices were used for

[19] Yotopoulos and Nugent, *Economics of Development*, 138-40; Nerlove, *Dynamics*, 45-65; Askari and Cummings, *Agricultural Supply Response*, 25-37; Askari and Cummings, 'Estimating', 257-8.

[20] Askari and Cummings, 'Estimating', 259.

barley and oats in the regressions.[21] Reaping wages were highly correlated with ploughing, mowing, and threshing wages, and therefore can be used as a proxy for all labour input costs.[22] The natural log of the various prices was used in the regressions.

The expected price in this model is taken to be the price in the previous year. This simplification is common in agricultural supply response literature and was necessary because including a price expectation other than the price in the previous year makes the model unidentifiable.[23] If the coefficient on the lagged price in equation 3 was significant then short- and long-run elasticities were calculated and compared with elasticities for other parts of the world in more modern times. The short-run elasticity, the response of acreage to price in one year, is the coefficient on the lagged price in equation 3 ($b\gamma$) when both the acreage sown and the prices are logged. The long-run elasticity 'is defined as the elasticity over the time period necessary for complete adaptation', and when acreages sown and prices are logged, it is equal to b in equation 3.

There are three possible interpretations of the short-run price elasticity from the model above. If the short-run elasticity is significant and positive, then reeves planted larger acreages with a particular crop when the price was higher and, therefore, attempted to maximize profit from that particular crop. If the short-run price elasticity of supply is negative, then reeves planted larger acreages with a particular crop when its price was low. Finally, if the short-run price elasticity of supply is not significantly different than zero, then reeves did not respond to prices in their planting decisions.[24]

Before discussing the results of the supply response regressions, it is first necessary to discuss the econometrics employed. In order to estimate price elasticities of supply that would be comparable with the aggregate estimations available for the nineteenth and twentieth centuries, equation 3 was first estimated using the entire panel. Fixed-effects regressions were not possible because there was serial correlation in the idiosyncratic errors for all models, so Generalized Least Squares regressions were employed. Acreages planted were standardized based on the mean acreage planted with each crop over the period so that the indexed value was the percentage change from the mean from year to year.

In order to pinpoint which manors were price responsive and which were not, standard time series OLS regressions were used to estimate equation 3 on each

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[21] Regional prices were also input for wheat prices in the regressions. There was little difference between the regressions using manor level wheat prices and regional wheat prices.

[22] Farmer, 'Prices and Wages', (1991), 501-25.

[23] Nerlove did develop the adaptive expectations model to account for more complexity in expected prices where the expected price was held to be a weighted average of past prices:

$P_t^e = \sum_{\lambda=0}^{t} \beta(1-\beta)^{t-\lambda} P_{\lambda-1}$ However, in order to combine the partial adjustment and adaptive expectations models, either the coefficient of adjustment, γ, in the partial adjustment model or the coefficient of expectation, β, in in the adaptive expectations model must be equal to unity. Otherwise the model is unidentifiable in the absence of further restrictions, which were not possible with medieval data.

[24] Yotopoulos and Nugent, *Economics of Development*, 135-7.

individual manor. Because some of the series were stationary and other were not, first differences of the acreage sown, lagged acreage sown and lagged price variables were used in all regressions. All of the regressions were also checked for serial correlation, and where serial correlation was present, Prais-Winsten regressions were used to correct the parameters and standard errors.[25] These econometric modifications ensure that the relationships estimated by the regressions are unbiased and not based on spurious relationships.

Table 1: Aggregate estimation of price elasticities of wheat supply for three types of prices on the Winchester manors.

ln Index Wheat Sown dep	1	2	3
Model	FGLS	FGLS	FGLS
Heteroskedasticity	Robust	Robust	Robust
Serial Correlation	ps AR(1)	ps AR(1)	ps AR(1)
Years	1349-70	1349-70	1349-70
N	884	808	884
Constant	0.008	0.019**	-0.011***
	(0.32)	(2.12)	(-3.11)
Lag ln Wheat Price (manor)	-0.009		
	(-0.78)		
Lag ln Wheat Barley Price Ratio		-0.066***	
		(-3.61)	
Lag ln Wheat Price / Reaping Wage (nat)			0.007
			(0.75)
Lag ln Index Wheat Sown	0.186***	0.223***	0.187***
	(5.65)	(6.46)	(5.70)
Wald Chi2: All Variables	32.40***	49.92***	33.03***
Coefficient of Adjustment (gamma)	0.814	0.777	0.813
Long-run Price Elasticity	-0.011	-0.085	0.009

Unstandardized Coefficients with z-statistics in parentheses: * denotes significance on the 10% level, ** denotes significance on the 5% level, *** denotes significance on the 1% level

Sources: see text.

[25] The Prais-Winsten regression performs a generalized least-squares regression on the data assuming first-order autoregressive serial correlation of the errors.

Price Elasticities of Supply

The aggregate price elasticities of supply estimated using the entire Winchester panel dataset suggest a pessimistic interpretation of price responsiveness in medieval England. Price elasticities of supply for wheat and oats were either not statistically significant or were negative (Tables 1, 3). Price elasticities for the barley/oat price ratio and the barley price relative to the wage were significant on the 10 and 5 per cent level respectively with short-run elasticities of 0.045 and 0.035 (Table 2). Therefore, the price elasticities of supply for the most important crop, wheat, were zero, and the price elasticities of supply for the commercially important barley were very low even if they were statistically significant. Long-run price elasticities were generally slightly larger than the short-run elasticities and followed the same general pattern across the grains and various prices.

Table 2: Aggregate estimation of price elasticities of barley supply for three types of prices on the Winchester manors.

ln Index Barley Sown dep	1	2	3
Model	FGLS	FGLS	FGLS
Heteroskedasticity	Robust	Robust	Robust
Serial Correlation	ps AR(1)	ps AR(1)	ps AR(1)
Years	1349-70	1349-70	1349-70
N	774	774	774
Constant	-0.041	-0.020	0.018***
	(-1.48)	(-1.42)	(2.58)
Lag ln Barley Price (reg)	0.028		
	(1.60)		
Lag ln Barley Oat Price Ratio		0.045*	
		(1.71)	
Lag ln Barley Price / Reaping Wage (nat)			0.035**
			(2.55)
Lag ln Index Barley Sown	0.321***	0.315***	0.314***
	(11.66)	(11.30)	(11.35)
Wald Chi2: All Variables	143.21***	132.18***	148.10***
Coefficient of Adjustment (gamma)	0.679	0.685	0.686
Long-run Price Elasticity	0.041	0.066	0.051

Unstandardized Coefficients with z-statistics in parentheses: * denotes significance on the 10% level, ** denotes significance on the 5% level, *** denotes significance on the 1% level

Sources: see text.

Table 3: Aggregate estimation of price elasticities of oat supply for three types of prices on the Winchester manors.

ln Index Oats Sown dep	1	2	3
Model	FGLS	FGLS	FGLS
Heteroskedasticity	Robust	Robust	Robust
Serial Correlation	ps AR(1)	ps AR(1)	ps AR(1)
Years	1349-70	1349-70	1349-70
N	857	857	857
Constant	0.007	-0.026**	-0.013
	(0.44)	(-2.33)	(-1.06)
Lag ln Oat Price (reg)	-0.017		
	(-1.16)		
Lag ln Oat Barley Price Ratio		-0.032	
		(-1.46)	
Lag ln Oat Price / Reaping Wage (nat)			-0.002
			(-0.14)
Lag ln Index Oats Sown	0.293***	0.295***	0.302***
	(9.50)	(9.70)	(9.77)
Wald Chi2: All Variables	99.15***	97.69***	99.75***
Coefficient of Adjustment (gamma)	0.707	0.705	0.698
Long-run Price Elasticity	-0.024	-0.045	-0.003

Unstandardized Coefficients with z-statistics in parentheses: * denotes significance on the 10% level, ** denotes significance on the 5% level, *** denotes significance on the 1% level

Sources: see text.

At the disaggregated level, the supply response to changes in wheat prices was generally quite low across the Winchester manors. Only fourteen manors had significant short-run price elasticities of wheat supply in the regressions: five positive elasticities and nine negative elasticities. These price elasticities estimated in time series regressions with first differenced variables are not directly comparable with the aggregate elasticities presented above, but when positive and significant in the regressions, they ranged from 0.148 at Brockhampton in South Hampshire to 0.370 at West Wycombe in Buckinghamshire with a mean of 0.236. Overall, ignoring statistical significance, there were 20 manors with positive average price elasticities across the three price types (41 per cent) and 29 with negative average price elasticities (Table 4).

Table 4: Summary of time series results for supply response on individual manors.

	Wheat	Barley	Oats
Total Manors	49	42	48
Positive, Significant Elasticities	5	9	5
Negative, Significant Elasticities	9	4	12
Insignficant Elasticities	35	29	31
Mean Short-run Positive, Sig. Elasticities	0.236	0.501	0.424
Min Short-run Positive, Sig. Elasticities	0.148	0.213	0.168
Max Short-run Positive, Sig. Elasticities	0.370	1.096	0.863
Positive Elasticities	20	23	14
Negative Elasticities	29	19	34
Percentage Positive Elasticities	40.82%	54.76%	29.17%

Sources: see text.

Positive and significant price elasticities of barley supply were much more prevalent for the Winchester manors than positive price elasticities of wheat supply: nine manors had positive elasticities; four manors had negative elasticities; and twenty-nine manors did not significantly adjust planting strategies based on the price. When positive and significant, the short-run price elasticities of barley supply on the various manors ranged from 0.213 at Twyford in South Hampshire to 1.096 at Ivinghoe in Buckinghamshire with a mean of 0.501 (Table 4). Again setting aside statistical significance, of the 42 Winchester manors where barley was sown, 23 had positive average price elasticities, or 55 per cent.

The response for barley was therefore different than the response for wheat in three key ways: there were more positive and significant price elasticities on individual manors; ignoring statistical significance, there were more manors with positive price elasticities; and the aggregate elasticities were statistically significant, though low. This was especially true for responses to the barley/oat price ratio. These differences are expected because the acreage of barley could be changed more easily without disrupting long-term cropping strategies by decreasing the acreage planted with oats in the spring-sown field. Thus, one would expect more responsiveness between the spring-sown crops than wheat, which was usually sown in its own field.

Barley was also more responsive because the increased demand for barley as a brewing grain following the Black Death made it a highly marketable crop, perhaps providing incentives for price responsiveness in barley planting decisions.[26]

The supply response to oats was much more prevalent than expected. Five manors had positive and significant short-run price elasticities of supply for oats varying from 0.168 to 0.863 with a mean of 0.424. In addition, twelve manors had significant and negative price elasticities of supply for oats. The fact that seventeen manors in total were price responsive in their oat planting is puzzling: oats were both heavy and bulky to transport; they were used predominantly as a fodder crop, especially following the Black Death; and they were rarely marketed.[27] Ignoring statistical significance, there were very few manors that had positive price elasticities: 14 manors had positive average price elasticities (29 per cent) while 34 had negative average price elasticities (Table 4).

This strongly negative price response in oat planting decisions may be explained as a counterpoint to the positive price response in barley planting decisions discussed above. Because the price of wheat strongly influenced the prices of substitute grains and all grain prices were highly correlated, a positive price elasticity for barley in aggregate might necessitate negative price elasticities for oat production. Assuming oat production was constrained within the spring sown fields, then an increase in barley sown would require oats sown to diminish in response. This response was not statistically significant at the aggregate level, but it could help explain the large number of manors with negative price elasticities of oat supply.

In summary, there were reeves on a number of manors that responded to different price variables in determining the acreage sown with wheat, barley, and oats. Positive and significant price elasticities were higher and more prevalent for barley than for wheat or oats because barley was easily substitutable with oats within the spring-sown field and because barley was highly marketable as a brewing grain following the Black Death.[28] Wheat elasticities were understandably lower because wheat was the primary winter-sown grain, which meant that a substantial change in the acreage planted with wheat would require altering existing crop rotations. However, in the aggregate the price elasticities were low in the case of barley or were insignificant and negative in the case of wheat and oats.

Comparison between Medieval and Modern Price Elasticities

After presenting aggregate and manor-level price elasticities of supply for the acreage sown with wheat, barley, and oats, we can now place this responsiveness in its long-term historical context by comparing it with other countries in the nineteenth and twentieth centuries. Comparing supply response across countries and centuries is complicated by a number of issues. First, almost all empirical studies of supply response have used the total acreage planted with a certain crop in a region as the

[26] Campbell, *Seigniorial Agriculture*, 243-5.

[27] Campbell, *Seigniorial Agriculture*, 245-7.

[28] Campbell, *Seigniorial Agriculture*, 243-5.

dependent variable. Thus, they represent an average supply response of many farmers rather than the response of a particular individual on one farm as was estimated in the time series regressions above.[29] Therefore, only the price elasticities of supply estimated as a panel are comparable with the later price elasticities and even these regressions are not completely similar because the panel better accounts for variation on individual manors than the regional aggregate data for later periods. A second issue with comparing price elasticities is deciding which crops should be compared: should the same crops be compared in different countries and across time or should crops be compared by their level of importance in the local economy? Unfortunately, it is too difficult to judge the relative importance of crops in different regions, so medieval supply response will be compared with similar grains in later periods.

Table 5: Comparison of medieval price elasticities of supply with price elasticities of supply calculated for other periods and countries.

Crop	Short-run Price Elasticities	Period	Place	Source
Wheat	insig	Mid 14th c.	Southwestern England	author
	0.09	Late 19th c.	Hungary	(Eddie, 1971)
	0.42	Late 19th c.	Germany	(Eddie, 1971)
	0.0278	Late 19th c.	Missouri, USA	(Fisher/Temin, 1970)
	0.3053	Late 19th c.	Wisconsin, USA	(Fisher/Temin, 1970)
	0.00 - 0.08	Early 20th c.	Punjab	(Krishna, 1963)
Barley	0.045	Mid 14th c.	Southwestern England	author
	0.19	Late 19th c.	Hungary	(Eddie, 1971)
	0.27	Late 19th c.	Germany	(Eddie, 1971)
	0.39	Early 20th c.	Punjab	(Krishna, 1963)
Oats	insig	Mid 14th c.	Southwestern England	author
	0.11	Late 19th c.	Hungary	(Eddie, 1971)
	0.05	Late 19th c.	Germany	(Eddie, 1971)

The short-run price elasticities of wheat supply in the aggregate Winchester panel were either not significantly different than zero or significantly negative. These are far below elasticities found in later periods (Table 5). Fisher and Temin found that the short-run price elasticity of supply for wheat in the United States in the late nineteenth and early twentieth centuries was between 0.0278 in Missouri and 0.3053 in Wisconsin.[30] Krishna found short-run price elasticities of wheat supply in early twentieth century Punjab to be between zero and 0.08 depending on the irrigation method employed, while Eddie found short-run price elasticities of wheat supply to

[29] Rao, 'Agricultural Supply Response', 3.

[30] Fisher and Temin, 'Regional Specialization', 142-43; Askari and Cummings, *Agricultural Supply Response*, 131-6. Higgs has questioned Fisher and Temin's figures, arguing that their price variable did not accurately reflect price expectations: Higgs, 'Regional Specialization', 101-2.

be 0.09 in Hungary and 0.42 in Germany in the late nineteenth century.[31] Short-run price elasticities were higher in Latin America ranging from 0.21 to 0.83 in Argentina before World War II and from 0.37 to 1.30 in Chile after World War II. [32] Therefore, it appears that price elasticities of wheat supply were lower in medieval England than they were in the backward parts of Europe such as Hungary in the late nineteenth century, and the gap increased when compared to the more technologically advanced countries like Germany.

Price elasticities for barley and oats were available for fewer modern countries. The short-run price elasticities of barley supply on the Winchester manors when the elasticity was positive and significant were 0.045 and 0.035 for the barley/oat price ratio and barley price divided by the national wage respectively. Oat elasticities were not significantly different than zero. These elasticities were somewhat lower than elasticities in Hungary, Punjab, and Argentina in later periods. Eddie estimated short-run price elasticities of barley and oat supply to be 0.19 and 0.11 respectively in late-nineteenth-century Hungary and 0.27 and 0.05 respectively in Germany.[33] Krishna observed a short-run price elasticity of 0.39 for barley in Punjab before World War II.[34] Finally, Reca found the short-run price elasticity of oat supply to be 0.08 in Argentina before World War II.[35] Thus, although the barley elasticities were statistically significant and positive, they were still considerably lower than price elasticities of supply in both the modern and less developed parts of the world in the nineteenth and twentieth centuries. Oat elasticities seem to have been fairly low throughout time, but the medieval English elasticities were even lower.

These comparisons with price responsiveness in other periods and countries suggest that reeves were not particularly responsive in medieval England. Although the elasticities compared here did not include the change in yield due to changing input costs, there is no *a priori* reason for the yield response to have been larger in medieval England than in later periods. In fact, it was most likely smaller since medieval reeves had fewer yield increasing technologies and inputs than nineteenth and twentieth century farmers.

Explaining Supply Response to Prices

As seen above, select Winchester manors were responding to changing economic conditions when making their planting decisions, but why reeves on particular manors were responsive and others were not is still puzzling. I have therefore developed a simple model to explain this response

$$PE_i = Y_i^{CoV} + CI_i + F_i + CH_i + Lord_i + M_i + Lon_i \quad (4)$$

[31] Krishna, 'Farm Supply Response', 485; Eddie, 'Farmers' Response', 576; Askari and Cummings, *Agricultural Supply Response*, 392-93. Krishna did find much higher short-run price elasticities for cotton, rice, sugar-cane and maize.

[32] Schuh and Brandão, 'The Theory', 660.

[33] Eddie, 'Farmers' Response', 576; Askari and Cummings, *Agricultural Supply Response*, 394-95.

[34] Krishna, 'Farm Supply Response', 485.

[35] Schuh and Brandão, 'The Theory', 662.

where PE_i is the price elasticity on manor i. Four price elasticities of supply were input into the regressions for each grain, one for each price type described above (price, price relative to substitute grain, and price relative to wage) and another for the mean of the previous three elasticities. Price elasticities of supply were entered into the regression regardless of statistical significance assuming that the elasticity would likely be the same and would become significant if the sample size in the manor specific time series regression were larger. This is a fairly strong assumption, so logistic regressions were also attempted assigning one to manors with positive significant price elasticities and zero to all other manors. These regressions were not robust or particularly helpful in displaying the relationships, so I have excluded them from the paper.

Y_i^{CoV} is the coefficient of variation of the grain yield. Askari and Cummings found that when yield coefficients of variation were larger, it was more difficult for farmers to make useful predictions about the future, and they were less likely to be price responsive.[36] CI_i is the average percentage of arable land sown with the grain over the period 1349-70 and served as a measure of the importance of a crop on the manor. F_i is the number of fields planted on the manor, testing whether having more fields allowed more flexibility in crop rotation. CH_i is the number of cows and horses per acre on a manor. This variable represents two issues affecting price elasticities depending on the grain. For wheat and barley, it represents the availability of plough teams. Manors with more plough teams per acre could potentially increase their production more easily because they could handle the increased ploughing and sowing requirements that would come at one point in the year when the winter or spring crops were sown. The number of cows and horses per acre is important to oat elasticities because after the Black Death oats were commonly used as fodder for livestock. Thus, manors with high stocking rates would have higher internal consumption requirements for their oat production.[37]

$Lord_i$ is the distance to the closest manor house, palace, or castle held by the bishop of Winchester. It was included as a measure of the lord's influence in the production strategies and the manor's requirements to provide for the lord's household.[38] M_i is the number of markets in a 16 km radius of the manor and measures the influence of market density on price responsiveness.[39] There is some potential for endogeneity with this variable if markets developed near manors that were more price responsive. However, market saturation was incredibly high in medieval England, and there would have been significant arbitrage profits from servicing manors that were not price responsive as well as those that were price responsive. Finally, Lon_i is a dummy variable where manors within London's trading

[36] Askari and Cummings, *Agricultural Supply Response*, 394-95.

[37] Farmer recorded annual stocking densities on the various manors from 1362-64, including the number of cows and horses combined. Unfortunately, it was not possible to separate cows and horses.

[38] Map, Wolvesey Castle, Winchester.

[39] Keene and Letters, *Markets and Fairs*. A large number of market density measures were tried such as manors within a 10, 16, and 25 km radius of the manor. In addition, the approximate size of the market was proxied by the amount of tax levied in the 1334 Lay Subsidy. The maximum lay subsidy tax in a 16 km radius was used to understand the effect of being near a large market. These values did not lead to significantly different relationships.

zone were given a one and all other manors were given a zero. This variable attempts to measure the influence of the London market on price responsiveness.[40] Only these seven important variables were included in the regressions because the sample sizes were too small to support a great number of variables.

Equation 4 was estimated for the price elasticity of each price type and each crop separately using OLS methods. These regressions are tentative estimations of the relationships at best because of the low sample sizes used to predict the price elasticities on each manor, but they provide a first look at the kinds of factors that might have been driving price responsiveness in southern England after the Black Death.

Table 6: Regressions explaining the variation in estimated price elasticities of wheat supply on various Winchester manors.

Price Elasticity of Acreage Planted Dep	1	2	3	4
Model	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust
Grain Type	Wheat	Wheat	Wheat	Wheat
Price Type	Grain	Relative Grain	Grain Wage	Mean Elasticity
N	48	48	48	48
Constant	0.290	0.369*	0.364*	0.341*
	(1.49)	(1.81)	(1.82)	(1.96)
Coefficient of Variation of Wheat Yield	-0.702	-0.899**	-0.591	-0.731*
	(-1.65)	(-2.06)	(-1.52)	(-1.97)
Percentage of Arable Sown with Wheat	-0.657**	-0.611*	-0.779**	-0.682**
	(-2.28)	(-1.92)	(-2.55)	(-2.56)
Number of Fields	-0.002	-0.004	-0.001	-0.003
	(-0.37)	(-0.65)	(-0.33)	(-0.57)
Cows and Horses per Acre	0.006	0.068	0.025	0.033
	(0.07)	(0.96)	(0.31)	(0.48)
Distance to Manor House	0.001	0.000	-0.000	0.000
	(0.49)	(0.21)	(-0.09)	(0.25)
Markets in 16km Radius	0.008**	0.007*	0.006*	0.007**
	(2.17)	(1.68)	(1.74)	(2.36)
Access to London Market	-0.012	0.105	-0.016	0.026
	(-0.18)	(1.04)	(-0.24)	(0.42)
R-square	0.23	0.34	0.26	0.34
F-statistic	3.45	5.00	1.87	3.97

Unstandardized Coefficients with t-statistics in parentheses: * denotes significance on the 10% level, ** denotes significance on the 5% level, *** denotes significance on the 1% level

Sources: see text.

[40] Campbell, *et al.*, *Medieval Capital*.

For price elasticities of wheat supply, the coefficient of variation of wheat yields had a significant negative effect on the price elasticities (Table 6). If unpredictable environmental conditions led yields to be more variable, then reeves maintained traditional cropping strategies and were less likely to be positively price responsive. In addition, manors that sowed a relatively high percentage of the arable with wheat were less likely to be price responsive. This result is somewhat puzzling. Askari and Cummings found that modern farmers sowing cash crops taking up a large percentage of the arable sown were more likely to be price responsive, but here we see the opposite.[41] The number of fields, the stocking density of cows and horses, and the distance to the nearest manor house, castle, or palace were insignificant in the regressions. The number of markets in a 16 km radius had a positive and significant influence on the price elasticity of wheat on each manor. Thus, manors surrounded by

Table 7: Regressions explaining the variation in estimated price elasticities of barley supply on various Winchester manors.

Price Elasticity of Acreage Planted Dep	1	2	3	4
Model	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust
Grain Type	Barley	Barley	Barley	Barley
Price Type	Grain	Relative Grain	Grain Wage	Mean Elasticity
N	41	41	41	41
Constant	-0.388	0.053	0.297	-0.013
	(-0.71)	(0.13)	(0.79)	(-0.05)
Coefficient of Variation of Barley Yield	0.075	0.789	0.117	0.327
	(0.11)	(0.92)	(0.18)	(0.58)
Percentage of Arable Sown with Barley	1.395	-0.304	-0.009	0.360
	(1.63)	(-0.55)	(-0.02)	(0.92)
Number of Fields	0.014	-0.028	0.006	-0.003
	(1.34)	(-1.18)	(0.55)	(-0.27)
Cows and Horses per Acre	-0.142	0.180	-0.173*	-0.045
	(-1.22)	(1.29)	(-1.82)	(-0.64)
Distance to Manor House	-0.001	0.006	-0.002	0.001
	(-0.38)	(0.95)	(-0.62)	(0.32)
Markets in 16km Radius	0.001	-0.005	-0.018	-0.007
	(0.04)	(-0.34)	(-1.47)	(-0.90)
Access to London Market	-0.005	0.034	-0.132	-0.034
	(-0.03)	(0.15)	(-1.08)	(-0.36)
R-square	0.22	0.23	0.28	0.12
F-statistic	3.66	0.92	3.17	1.26

Unstandardized Coefficients with t-statistics in parentheses: * denotes significance on the 10% level, ** denotes significance on the 5% level, *** denotes significance on the 1% level

Sources: see text.

[41] Askari and Cummings, *Agricultural Supply Response*, 352-5, 371-3.

more markets were more likely to be price responsive. Access to the London market had no effect on price elasticities. The magnitude of the effect of each of the significant variables was roughly similar as the standardised beta coefficients were all roughly similar. The percentage of arable sown with wheat had the largest effect followed by the coefficient of variation on the wheat yield and then the market variable. Again, these regressions are tentative because of the small sample size in estimating the individual manor price elasticities of supply and because the R-squares are low varying between 0.23 and 0.34.

When estimating equation four for the price elasticities of barley supply, none of the coefficients were consistently statistically significant (Table 7). This is puzzling because barley was the most price responsive of the three grains in aggregate and also had the most manors with positive price elasticities. In any case, the variables included in equation four do not significantly explain the variation in price elasticities of barley supply on the Winchester manors.

Table 8: Regressions explaining the variation in estimated price elasticities of oat supply on various Winchester manors.

Price Elasticity of Acreage Planted Dep	1	2	3	4
Model	OLS	OLS	OLS	OLS
Heteroskedasticity	Robust	Robust	Robust	Robust
Grain Type	Oats	Oats	Oats	Oats
Price Type	Grain	Relative Grain	Grain Wage	Mean Elasticity
N	47	45	47	47
Constant	-0.558	-0.024	-0.616	-0.392
	(-1.67)	(-0.07)	(-1.59)	(-1.24)
Coefficient of Variation of Oat Yield	2.132*	0.351	2.874*	1.762
	(1.85)	(0.59)	(1.91)	(1.66)
Percentage of Arable Sown with Oats	-0.713	-1.302*	-0.938	-1.005
	(-1.18)	(-1.82)	(-1.42)	(-1.64)
Number of Fields	-0.000	0.010	-0.003	0.003
	(-0.00)	(0.71)	(-0.16)	(0.20)
Cows and Horses per Acre	-0.032	-0.189	-0.084	-0.100
	(-0.21)	(-1.12)	(-0.50)	(-0.67)
Distance to Manor House	-0.006*	-0.007*	-0.005	-0.006*
	(-1.77)	(-1.87)	(-1.23)	(-1.84)
Markets in 16km Radius	0.007	0.022***	0.005	0.011*
	(1.21)	(2.84)	(0.62)	(1.84)
Access to London Market	0.347*	0.202	0.270	0.274
	(1.72)	(0.84)	(1.16)	(1.35)
R-square	0.47	0.24	0.51	0.43
F-statistic	1.93	2.65	1.33	1.82

Unstandardized Coefficients with t-statistics in parentheses: * denotes significance on the 10% level, ** denotes significance on the 5% level, *** denotes significance on the 1% level

Sources: see text.

Equation four had more power in predicting the variation in price elasticities of oat yields (Table 8). Three variables had consistently significant effects. First, the coefficient of variation of the oat yield also had an unexpected positive and significant influence on the price elasticity of oat supply. Thus, manors where oat yields were more variable had higher price elasticities. This result is opposite to the results found by Askari and Cummings for modern peasant agriculture and is difficult to explain. Second, the distance to a manor house, castle or palace had a somewhat significant negative effect on price elasticities of oat supply. This result is also unexpected and difficult to explain because one would expect manors that were farther from the lord would provide less direct produce for his household's (or horses') consumption and would therefore be freer to be price responsive. The number of markets in a 16 km radius had a positive effect on the price elasticity of oat supply, suggesting that market saturation could also influence price elasticities of oats despite the fact that oats were marketed less frequently than barley and oats. However, many of the coefficients for these variables were only significant at the 10 per cent level and were only significant in two or three of the regressions.

Strict cropping rotations could have also impeded the price responsiveness of reeves. As shown above, some Winchester manors, namely Nailsbourne, followed very strict rotations of crops between different fields and never varied their pattern from year to year (Figure 1). However, it is not clear that this production inflexibility was linked to any one cropping pattern. Using the cropping type classifications defined by Campbell, it is possible to test whether price elasticities for the various crops were higher on manors employing four different cropping patterns.[42] There were no significant and consistent effects of the different cropping systems on price elasticities of barley and oat supply, but there were some significant effects for price elasticities of wheat supply. Price elasticities of wheat supply were significantly lower on manors practicing intensive cultivation with legumes (cropping type 1) than elasticities on manors practicing three-course rotations of wheat and oats (cropping type 5). However, elasticities were significantly higher on manors where mixed grains were a more prominent part of production (cropping type 3). The result for cropping type 1 manors, however, is not particularly interesting because only one manor in the sample practiced this form of agriculture. The results for cropping type 3 manors were also dubious because the coefficient was only significant in half of the price elasticity regressions. It would not be surprising though if cropping type 3 manors had higher price elasticities because they tended to be more market oriented in their production of mixed grains that could be sold for making bread or for brewing.[43] Thus, although there are some small and not particularly robust differences in price elasticities of supply for wheat across the four main cropping types employed after the Black Death, overall, these differences were minor and do not explain overall differences in the price elasticities of supply.

There could have also been regional variation in the structure of demand that influenced reeves price responsiveness on the various manors. Farmer grouped the Winchester manors into seven regional groups when he was constructing price series

[42] Campbell, *Seigniorial Agriculture*, 275-93.

[43] Campbell, *Seigniorial Agriculture*, 288-9.

for England: South Hampshire, North Downs (northern Hampshire), Wiltshire, Somerset, Upper Thames Valley, Chilterns, and Cotwolds (Map 2).[44] However, these regional dummies were not particularly useful in explaining price responsiveness. None of the regional dummies were significant in explaining differences in price elasticities of wheat supply. For price elasticities of barley supply, Somerset had lower elasticities than the reference group, the North Down manors in Hampshire. Only one Somerset manor in the sample planted barley, however, so this result is not particularly enlightening. Price elasticities of oat supply were higher than the North Down reference manors in the Thames valley, Chiltern and Cotswold region and in the Somerset region, though the coefficients were only significant at the 10 per cent level. Therefore, while there were some weak effects of varying regions on the price elasticities, regional differences in the structure of demand did not convincingly influence price elasticities of supply.

In conclusion, it is difficult to explain why some manors had higher price elasticities of supply than others. The coefficient of variation of yields on each manor explained some of the difference for wheat, but the relationship was insignificant for barley and oats, complicating the interpretation. Again in the case of wheat, manors had lower price elasticities when a larger percentage of the arable was sown with the crop. This is opposite to Askari and Cummings's findings that farmers who planted a larger share of their land with a crop were usually more price responsive, though this was normally in the context of cash crops that took up the substantial majority of the arable land.[45] The average acreage of wheat sown on the Winchester manors never took up more than 50 per cent of the manor with an average of 37 per cent. Wheat, therefore, may not have had the same characteristics of prominent cash crops in modern times. The concentration of markets around each manor also had a positive effect on the price elasticity of supply, but this effect was not significant in explaining variations in price elasticities of barley supply. Access to the London market was also not an important factor in explaining price elasticities of supply. The difficulty in explaining the spatial variation in price elasticities is puzzling and perhaps corroborates Stone's finding that some reeves were good managers and others were not.[46] This somewhat random effect may significantly influence price responsiveness and muddle the explanations provided here.

Conclusion

Stone's qualitative findings of price responsiveness and good management practices on select manors throughout southern England in the late Middle Ages are corroborated by the minority of manors held by the bishop of Winchester that were significantly price responsive in their planting decisions. In fact, as he suggests different manors were price responsive in different ways.[47] In the end, however,

[44] The Thames Valley, Chilterns, and Cotswolds groups were combined together because of low sample sizes in each. The manors in these regions were fairly similar and therefore their grouping together is justified. Farmer, 'Price and Wages', (1991), 498-9.

[45] Askari and Cummings, *Agricultural Supply Response*, 352-5, 371-3.

[46] Stone, *Decision-Making*, 205-12.

[47] Stone, *Decision-Making*, 205-12.

aggregate price elasticities of supply were very low if they were significantly different than zero. Supply response measured by the acreage sown is a lower bound for total output supply response because it does not account for price responsiveness in the allocation of labour and capital resources that would affect yields. Still, even including a small level of price responsiveness in yields, the overall price elasticity of total supply for wheat, barley and oats would be quite small, especially considering that weather variation was most important in determining yields. These claims must be weakened slightly because the Winchester sample was not completely representative of England as a whole. If manors from the more developed eastern regions such as East Anglia and Kent were included in the sample, supply response might be marginally higher. However, by using a sample of manors with a wide geographic range, this study produces more realistic figures for the country as a whole than studies that focus on East Anglia.

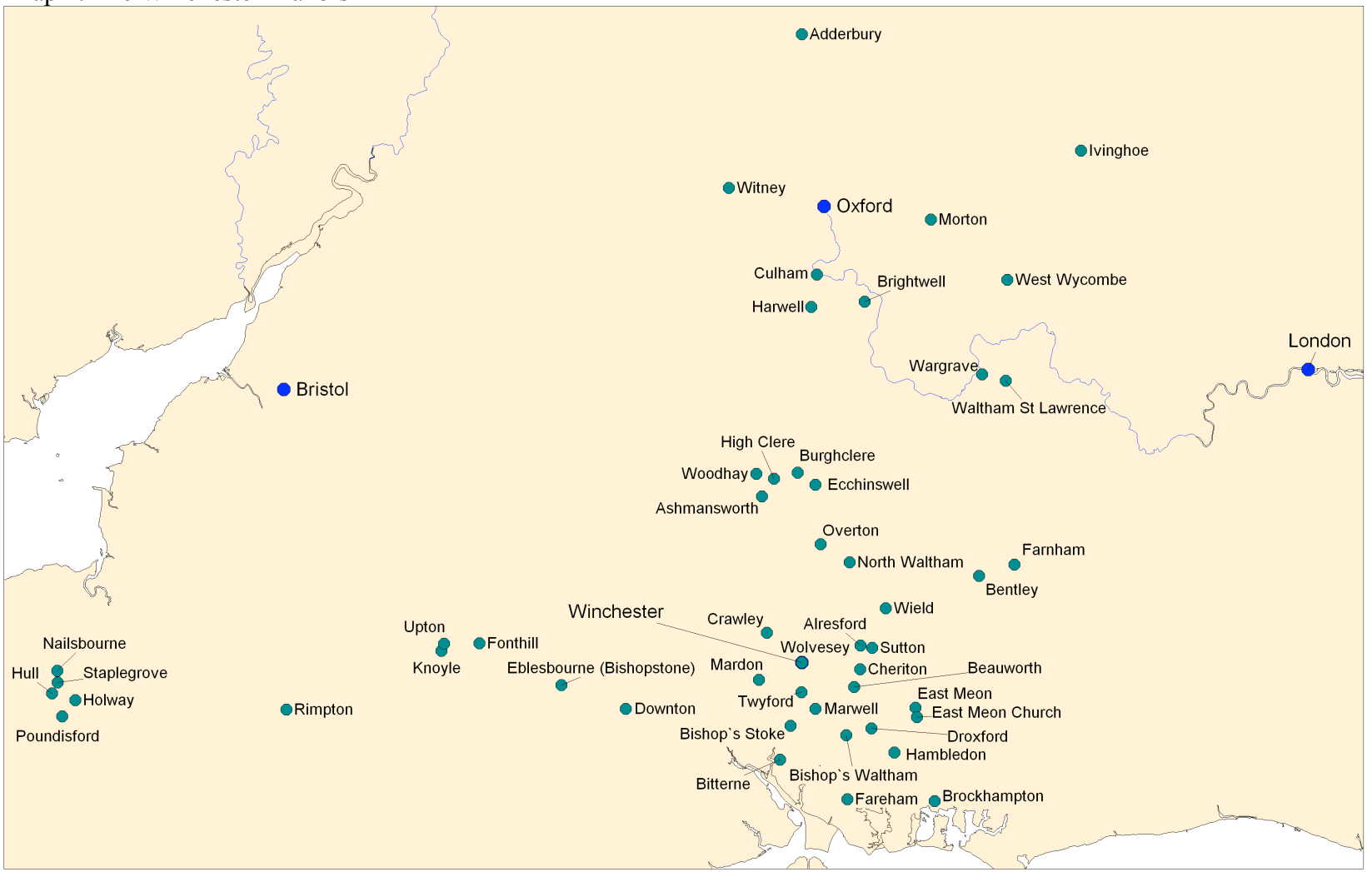
It is impossible to tell from the present study whether the reeves who were price responsive after the Black Death were the remnants of a sophisticated, commercialized agricultural sector before the Black Death, the innovators leading the rural economy to increased price responsiveness as demesnes were leased in the fifteenth century, or the minority of the agricultural sector that had always been price responsive. However, given the tentative conclusions about the factors determining the price elasticities across the Winchester manors, it seems unlikely that reeves would have become more price responsive over the fourteenth and fifteenth centuries. There was at best no expansion in markets and urban demand across the fourteenth and fifteenth centuries and at worst a decline.[48] Thus, increases in market concentration could not have stimulated further responsiveness in later periods. It is possible that climate became less variable making it easier to predict yields year to year, but this variability had a different influence on wheat and oat planting decisions.

Thus, changes in prices during the post-Black Death period were unlikely to drive changes in grain output or the efficiency of production on manors. This may suggest, then, that structural changes in the economy were more important in promoting economic development after the Black Death than commercialization. Therefore, the institutional and structural changes in the economy highlighted by Marxist and Neo-Malthusian historians such as the disappearance of villeinage, the leasing of manors, and the growth of the wage labour market, may need to take a more prominent role in explanations of economic change.

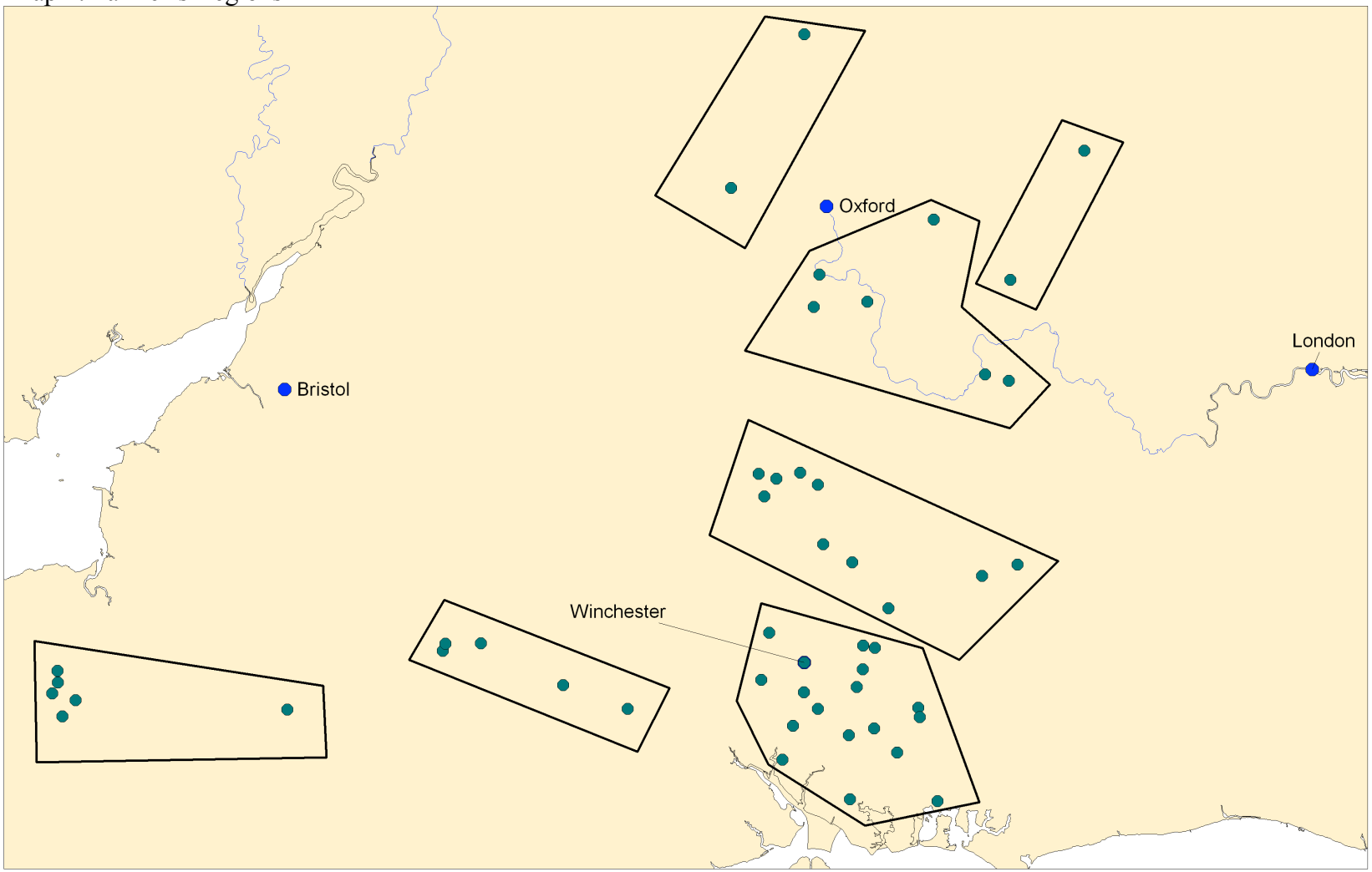
In the end, this paper challenges the extent to which the commercial revolution of the twelfth and thirteenth centuries had created an economy in which Smithian economic forces dominated. Despite the undeniable increase in urbanization and the monetization of the economy, the least risk-averse agricultural producers in the medieval economy, reeves managing seigniorial demesnes, in aggregate did not respond to price changes when making planting decisions.

[48] Britnell, *Commercialisation*, 155-64; Schofield, *Peasant*, 133; Rigby, 'Urban Population', 409-11.

Map 1: The Winchester Manors



Map 2: Farmer's Regions



Appendix II: References

Manuscript and Archival Sources

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