DETERMINANTS OF THE RATE OF PARLIAMENTARY ENCLOSURE

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The modern discussion was initiated by Ashton who stressed the hitherto neglected role of the rate of interest; he contrasted "... a long period of relative inactivity from 1781 to 1795 ..[when although].. the average price of cereals was higher than in the 'sixties and 'seventies... rates of interest were such as to make enclosure highly expensive and for many impossible" with the situation during the wars when "...the famine prices of grain, following the disastrous harvest of 1795, led to a spate of enclosure bills in 1796-7. It is true that government stock stood at a low figure, but these were years of high inflation...."(4) It is worth noting that this argument is in fact more subtle than is sometimes appreciated being presented in terms of the real not the money rate of interest and in multicausal terms. However, the final emphasis is clear "....above all, their activities were determined by the degree to which funds were available for investment."(5)

The reaction to this view has been generally unfavourable with most writers preferring to give prominence to the role of agricultural prices, especially wheat prices. Thus we find for example Deane, "The price of corn was the crucial factor which determined the readiness of the landlord to consolidate",(6) maintaining the old orthodox view of Ernle, "Throughout the eighteenth century the number of Enclosure Acts fluctuated considerably with the advance or decline in the price of wheat."(7) The most complete statement is provided by Chambers and Mingay, "...it should be noticed that the

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(4) T. S. Ashton, An Economic History of England:the 18th Century, (London: Methuen, 1955) pp. 40-1.

(5) Ibid., p. 42

(6) P. Deane, The First Industrial Revolution, (Cambridge: C.U.P., 1965)p. 41.

(7) Lord Ernle English Farming Past and Present, (6th edition, London: Heinemann-Cass, 1961).

relationship between the rate of interest and enclosure breaks down in the period of the Napoleonic Wars when interest rates rose but enclosure, instead of declining, increased enormously. This suggests that the level of agricultural prices was perhaps a more significant influence on enclosure than the rate of interest, and there is indeed a fairly close alignment between prices and enclosure throughout the whole of the period of parliamentary enclosure, upswings in prices being followed after a short interval by upswings in enclosure." (8) They also provide reasons specifically for rejecting the rate of interest hypothesis: "[Ashton's argument] rests on two assumptions : that investment in enclosure was closely linked with landowners' ability to borrow and that the return on investment in enclosure was comparable to the returns on funds .... But it seems probable .... that a large proportion of enclosure...was financed not by borrowing but out of current estate income...the returns [on enclosures] being much higher than those on...virtually any of the range of investments open...." (9) It should be noted that this argument is presented entirely in money terms and stresses the influence of agricultural prices on liquidity.

Recently McCloskey has attempted to re-establish Ashton's position. He makes several important points, notably :

(i) "Self-financing...has an opportunity cost, and this cost is related to the current rate of interest...[but]...it is not the money rate of interest which measures the real opportunity cost of an investment, but the rate of interest corrected for the expected rate of inflation in the general level of prices." (10)

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(8) Chambers and Mingay, "Agricultural Revolution", pp. 83-4.

(9) Ibid., pp. 82-3.

(10) D. N. McCloskey, "The Enclosure of Open Fields: Preface to a Study of Its Impact on the Efficiency of English Agriculture in the Eighteenth Century", Journal of Economic History XXXII (1972), p.26.

(ii) "The rise in price of wheat during the Napoleonic Wars, which is sometimes considered sufficient by itself to explain the spurt of enclosures, is less impressive when compared with the rise in other prices."(11)

(iii) "Prices are one component in the demand for enclosure, the increase in physical output another."(12) McClaskey's argument, which is phrased in terms of real variables and perfect capital markets, is therefore in direct opposition to that of Chambers and Mingay.

It seems that so far there has been no attempt to make any quantitative appraisal of the merits of these competing hypotheses. This paper represents a preliminary attempt to perform an empirical assessment. In doing so it utilises approaches based firstly on a sectoral investment function and secondly on an elementary diffusion hypothesis.

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(11) Ibid., p.31.

(12) Ibid., p. 32.

II.

Perhaps the simplest procedure is to think of the process of parliamentary enclosure in terms of modern economic theories on investment decisions[13] and ask what factors were important in determining the flow of expenditure on enclosure in the whole country in each year. The "sectoral investment function" approach indeed seems to be implicitly envisaged in the literature reviewed in Section I. The disagreements over the importance of a particular variable can then be considered in terms of whether there is a significant relationship between it and expenditure on enclosures, the magnitude of the elasticities involved and the amount of variation in the series, with other influences which are thought potentially important a priori held constant.[14]

Starting from the assumption of profit maximisation both the neo-Keynesian and the neo-classical theories of investment predict that an increase in product price will tend to raise and an increase in interest rate to reduce the optimal stock of capital in a sector ceteris paribus all variables in real terms.[15] This leaves unsolved the question of how the stock adjusts from the

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(13) For convenient summaries of theories and evidence, see M. K. Evans, Macroeconomic Activity (New York:Harper and Row, 1969) Chs. 4-5 and P. N. Junankar, Investment:Theories and Evidence, (London:MacMillan, 1972).

(14) It is important to be clear as to what is in dispute. Regrettably the literature is at times vague about this.For example in Chambers and Mingay's criticism of Ashton (see above p. 3) they do not seem to take account of the ceteris paribus conditions he implied and it is not unambiguous as to whether they wish to deny the existence of any significant relationship between enclosure and the rate of interest or simply to assert that prices were much more powerful because of greater movements and/or elasticities.

(15) If the enterprise is a price taker of the market rate of interest (r^*) profit maximisation implies acquiring assets up to the point where the rate of return on the marginal asset equals the interest rate. Since the price rise will raise expected yields (a_m) and a rise in r^* will raise the required rate of return then given $\partial^2 y/\partial k^2 < 0$ the predictions follow.

We have supply price of asset $p = v(a_m, r^*) = \int_0^T a_m(t)e^{-r^*t}\,dt$ with

$\partial v/\partial a_m > 0$, $\partial v/\partial r^* < 0$.

actual to the optimal, i.e., the implications for the flow of investment over time. Both theories suggest that this will depend on the costs of adjustment. Thus the Keynesian version argues that this will mean the equating of the marginal efficiency of investment to the rate of interest.(16) This implies an inverse relationship between investment and the rate of interest with expected yields held constant and that an increase in expected yields will increase investment at any given rate of interest. Empirical work has tended to be based on modified flexible accelerator versions of this theory such as(17)

$$I_t = \alpha_1(1 - \lambda)Y_t - (1 - \lambda - \delta)K_{t-1} - \beta_1 r_{t-1} \qquad (1)$$

This type of investment function seems to fit in well with McCloskey's arguments in particular,(18) and equation (1) could indeed be a way of formalising them. However, there remain one or two points which require further elaboration.

An argument for the importance of the rate of interest based on profit maximisation grounds is not unreasonable given that it is widely agreed that English agriculture was ready and willing to respond to market opportunities at this time. Furthermore enclosure is a very long-lived project normally which we would expect to increase the significance of the interest rate. However, there are some difficulties with the interest rate argument.

(a) The theory suggests that in a perfect capital market the <u>real</u> rate of interest represents the opportunity cost of internal finance which influences the investment decision. The real rate of interest, however, is an <u>ex-ante</u>

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(16) Marginal efficiency of investment is the rate of return on capital taking into account rises in the supply price of the asset as investment per time period rises.

(17) $0 < \lambda < 1$ and δ isthe rate of depreciation; the important question of lag structure is left until later.

(18) See above p.3,4.

concept and is therefore in practice very difficult to measure. Modern studies have tended to find rather low elasticities of investment with respect to the rate of interest.(19)

(b) On the other hand in an imperfect capital market it may be supposed that there are major advantages in internal finance and obstacles in the way of external finance. If this situation prevailed then the Chambers and Mingay liquidity argument would seem a very live possibility as an explanation for delays in adjustment to the optimal capital stock(20) despite the apparent profitability of the investment. This provides a partial justification for stressing the role of agricultural price rises through their favourable cash flow effects and for de-emphasising the role of interest rates in stimulating enclosures. However we would normally expect cash flow to be related to profits and hence output and costs as well as prices.

This problem is also encountered if it is argued that a rise in agricultural prices, notably corn prices, promoted enclosure through profitability considerations. Certainly the initial impact of a rise in corn prices relative to other prices would be to raise the marginal efficiency of investment in enclosure ceteris paribus, but we would not expect a once for all permanent change in price to generate a permanent sustained rise in the flow of investment in enclosure, although, provided that it raised the real value of output, it would generally raise the desired stock of enclosed land.

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(19) See M. K. Evans, Macroeconomic Activity, Ch. 5.

(20) If agricultural entrepreneurs were always facing the external finance problem, e.g. in terms of being on the rising section of a marginal cost of funds schedule, then the implication of the imperfect capital market would be not only to change the time path of investment but the optimal capital stock itself. My thanks are due to P. J. Law for this point.

In the long run there are more difficulties[21] with a simplistic prices hypothesis.

(a) If as an approximation we regard the amount of land as given, then as enclosure proceeded we would expect the marginal efficiency of investment in enclosure to fall as more and more inferior land was involved and the ceiling[22] of enclosable land was approached (cf. "normal industrial investment").

(b) If we regard enclosure as for practical purposes irreversible we may also expect the impact of prices to depend at least partly on the previous peak price.

It is therefore unlikely a priori that investment in enclosure in the long-run was a function of agricultural prices or changes in agricultural prices alone. However, in the short-run such a relationship may well hold, especially since the demand for corn, and other products, was almost certainly price inelastic[23] so that for the sector as a whole the direction of change

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(21) The relationship of parliamentary enclosure to product prices is further complicated by the fact that enclosure may be an adjunct for innovation or merely an extension of the cultivated area. Whilst the latter would presumably be encouraged by price rises, there is a school of thought which urges that innovation in agriculture was much stimulated by price falls, e.g. D. Grigg, The Agricultural Revolution in South Lincolnshire, (Cambridge:C.U.P. 1966). If this was so the predicted direction of change of investment in enclosure with respect to price changes would be ambiguous.

(22) For present purposes the "ceiling" can be thought of in physical terms. However the idea will be modified to a "satiation stock" when the diffusion model is considered; see below p. 21.

(23) There is no quantitative evidence for this proposition although the notion is almost universal in the literature. For a dissenting view see M. W. Flinn, "Agricultural Productivity and Economic Growth in England: A Comment", Journal of Economic History XXVI (1966), pp. 93-98.

in price and sales value would be the same.

This discussion leads us with some misgivings to an expression such as

$$E_t = k + \alpha_2 w_1 t-1 - \beta_2 rt-1 \qquad (2)$$

where E is expenditure on parliamentary enclosure, w_1 is the real price of wheat and r_1 is the real rate of interest. This we could perhaps regard as the basic formulation offered by Ashton.

Chambers and Mingay's hypothesis is somewhat different. They argue throughout in money terms, whereas the investment theory approach is in real terms. Their argument can of course be fitted into the theory discussed above by the assumption of money illusion, which might well be thought plausible for the period under consideration. This would generate an equation such as

$$E_t = z + \alpha_3 w_{2t-1} - \beta_3 r_{2t-1} \qquad (3)$$

where w_2 is the money price of wheat and r_2 is the money rate of interest.

The lag structure of any investment function can also be expected to be very important in view of the nature of parliamentary enclosure and the experience of empirical work[24] in addition to the theory outlined above. The very existence of costs of adjustment implies the importance of lags in the completion of the response to some economic event impinging on the desired capital stock. The parliamentary enclosure procedure was undoubtedly also subject to other sorts of lags. We might expect these to be

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(24) See M. K. Evans, Macroeconomic Activity, Chs. 4 & 5.

(a) 'decision lags' resulting from delays in perception of profitable opportunities through poor information or uncertainty as to whether changed economic circumstances, e.g. a new level of corn prices, were "permanent" or "transitory".

(b) 'implementation lags' arising from the passage of the bill through parliament and the carrying out of an act through the enclosure award.

However we have no a priori information about the nature of the lag structure except that distributed lags would seem more plausible than a rigid lag. Two very simple ad hoc possibilities can be considered and are made use of later in this paper. Firstly, that enclosure activity was a function of some sort of weighted average of values of the independent variables. Secondly, we could assume that actual investment adjusted in proportion to the difference between the desired level of investment and the actual level in the previous period.

$$E_t - E_{t-1} = \gamma(E_t^* - E_{t-1}) \qquad (0 < \gamma < 1) \qquad (4)$$

The implications of this form for equations (2) and (3) are obvious. We obtain[25]

$$E_t = \gamma k + \gamma\alpha_2 w_{1t-1} - \gamma\beta_2 r_{1t-1} + (1-\gamma)E_{t-1} \qquad (2a)$$

$$E_t = \gamma z + \gamma\alpha_3 w_{2t-1} - \gamma\beta_3 r_{2t-1} + (1-\gamma)E_{t-1} \qquad (3a)$$

This discussion leaves us in considerable doubt as to the suitablity of the investment function models relying simply on corn prices and interest rates outlined in Section I.

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(25) Equation (2a) is obtained by letting $E_t^* = k+\alpha_2 w_{1t-1} - \beta_2 r_{2t-1}$. Combining this with equation (4) rewritten in the form $E_t = (1-\gamma)E_{t-1} + \gamma E_t^*$ we obtain equation(2a). This formulation is similar to that used by P. N. Junankar, "The Relationship between Investment and Spare Capacity in the U.K. 1957-66", Economica XXXVII (1970), pp. 277-292.

III.

The availability and quality of the data required to estimate the preceding investment functions require some brief comments. The most important handicap of all is the non-existence of any time series on agricultural output before 1866. This precludes the possibility of testing directly McCloskey's hypothesis.

(a) Expenditure on Parliamentary Enclosure.

This is represented by a proxy variable, the annual number of parliamentary enclosure bills.(26) There are a number of reasons for using this series.

(i) It is not possible with the information currently available to build up an adequate aggregate time series of the costs of parliamentary enclosure. Some information is available on individual counties(27) but even so decadal averages would be the best we could deal in and there are serious doubts as to the comprehensiveness of the estimates(28). Furthermore the figures we require ideally would need to be quality adjusted.(29)

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(26) Parliamentary Papers 1836 VIII pt.II, 3rd Report from the Select Committee on the State of Agriculture, p. 501.

(27) See for example W. E. Tate, "The Cost of Parliamentary Enclosure in England (with special reference to the County of Oxford)", Economic History Review, 2nd Ser. V (1952/3), pp. 258-265, J. M. Martin, "The Cost of Parliamentary Enclosure in Warwickshire," University of Birmingham Historical Journal IX (1964), pp. 144-162, and M. E. Turner, "The Cost of Parliamentary Enclosure in Buckinghamshire", Agricultural History Review XXI (1973), pp. 35-46.

(28) See Turner, ibid.

(29) It seems likely that more difficult enclosures were left till last, see Tate "Cost of Parliamentary Enclosure" and McCloskey "Enclosure of Open Fields".

(ii) There seems to be a very close relationship between the number of acts in a year and the acreage enclosed based on the averages declared for those acts which did report the acreage involved. This is particularly so before 1801 the year of the first General Enclosure Act.(30)

(iii) The use of information based on bills rather than acts or awards simplifies the problem of lags. In terms of modern investment theories bills can be thought of as analagous to "appropriations".

(iv) In any case the use of bills does enable us to test directly the hypotheses of Ashton and Chambers and Mingay who based their contributions on the evidence of this series.

(b) The Rate of Interest.

In order to test the hypotheses advanced earlier we need series of both the real and the money rates of interest. For the latter we have followed Ashton's advice and used the yield on Consols which avoids the difficulties imposed by the Usury Laws.(31)

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(30) This hypothesis was tested using the data provided in G. E. Slater, English Peasantry and the Enclosure of Common Fields (London 1907, reprinted New York:Kelley, 1968). The equations obtained where y is the number of acts and x the acreage enclosed were

1756-1801	y =	1.967	+ 0.0005x	R^2 =	.963
		(2.438)	(33.876)	DW =	2.222
1802-1815	y =	8.367	+ 0.0005x	R^2 =	.900
		(3.339)	(10.832)	DW =	2.389

(31) This series is presented in B. R. Mitchell and P. Deane, Abstract of British Historical Statistics (Cambridge:C.U.P. 1962), p. 455. They comment that "....no better indicator of the long-term rate of interest exists". (ibid., p.437)

Any attempt to measure the real rate of interest is bound to be hazardous. The real rate is defined as the money rate minus the expected rate of change of the price level, which is itself strictly non-observable. The method adopted here for circumventing this difficulty is to assume that expectations of the future were based on recent experience. Two alternative assumptions were then used, that the expected rate of price changes was equal to the unweighted average of the last three years' rates of inflation, that it equalled the unweighted average of the last seven years' inflation. Only results involving the latter are reported here; in all cases use of this variable gave better results in terms of the conventional criteria. There are obviously a very large number of alternative methods !

Also the measurement of the rate of inflation causes problems. All the cost of living indices for the eighteenth and early nineteenth centuries can be severely criticised. In this paper the Schumpeter-Gilboy consumer goods index[32] has been chosen; this is perhaps the most widely used index for the period. Given the use of seven year averages it is in any case unlikely that use of any other available index would make much difference to the results.

(c) The Price of Wheat.

The results obtained make use of the price of wheat, the price of which has been most emphasised in the literature. It is used here partly because it was a very important part of agricultural output and also because it is a crop for which it is possible to obtain a long time series with some pretensions to being a national price. From 1771 the series used is the average British price from the London Gazette as reported in Barnes.[33]

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(32) See Mitchell and Deane, ibid., pp. 468-9.

(33) D. G. Barnes, A History of the English Corn Laws 1660-1846, (New York: (1930) . Reprinted New York:Kelley (1961)), p. 298.

Before then the average of prices in Eton and Oxford was used, this being reported in the same source.(34) Deflation of the money price to obtain the real price of wheat was done by using the Schumpeter-Gilboy price index for consumer goods other than cereals.(35) There is no alternative as the movement of other series is much affected by changes in the price of wheat itself.

Some of the main variables used in the regression analysis are plotted in Figure 1.

IV.

Table One reports the results of the estimation of equations (2) and (3) together with (2a) and (3a) which include the lagged dependent variable. These results make use of three year unweighted averages of the independent variables in an attempt to capture the notion of the 'decision lag'. This formulation performed better than those based on a rigid one year lag in the independent variables.(36) The period covered by the analysis is 1756-1815 which is the main period of parliamentary enclosure up to the end of the French Wars. The actual starting point was governed by the fact that the rate of interest series starts in 1756.

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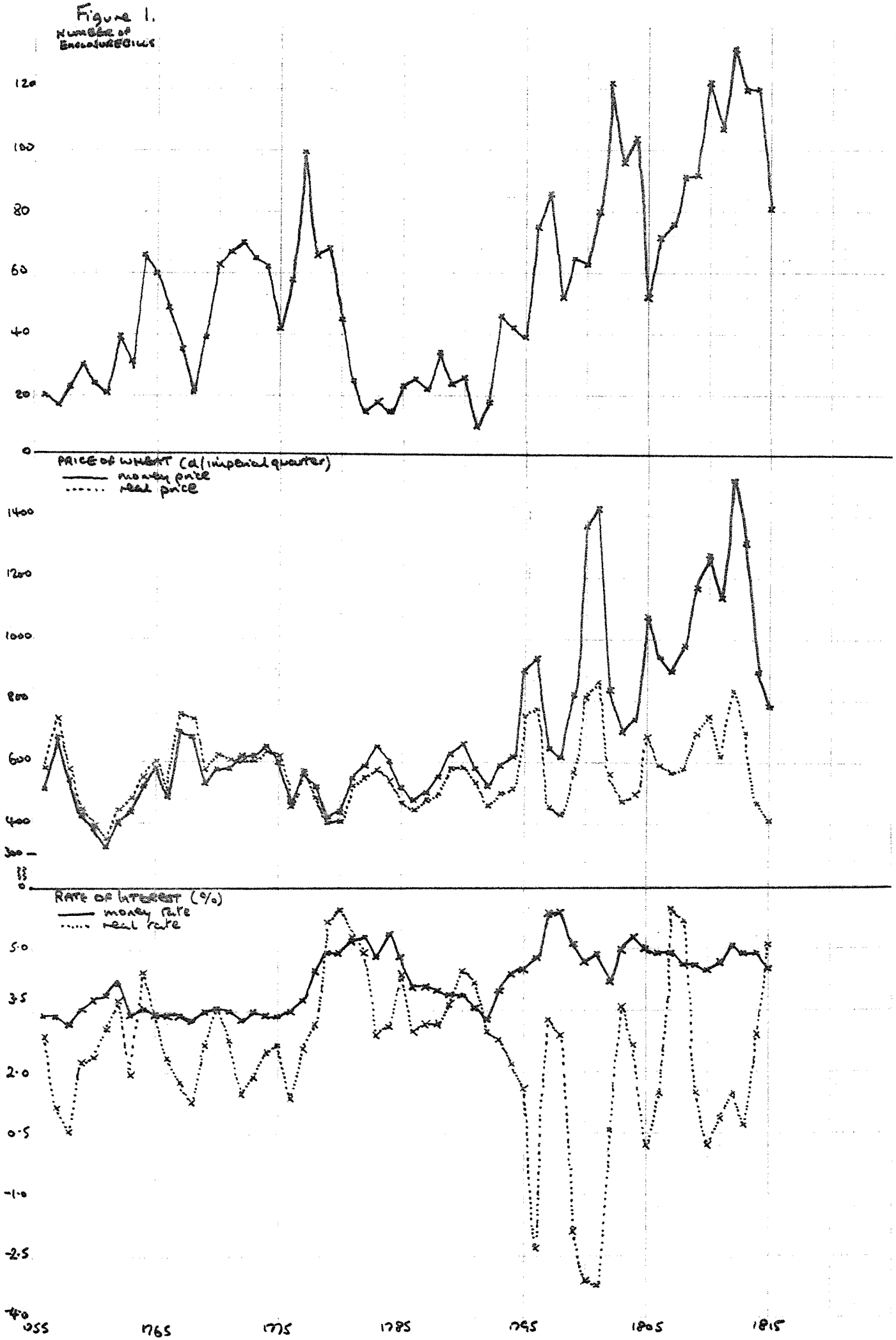
(34) This extension of the series for the years before 1771 is somewhat doubtful but it may not be totally unreasonable since several authors have argued that even at this time the degree of autonomy of local markets for wheat may have been severely limited. See especially E. W. Gilboy, Wages in Eighteenth Century England (Cambridge Mass; Harvard U.P. 1934) and C.W.J. Granger, and C.M.Elliott "A Fresh Look at Wheat Prices and Markets in the Eighteenth Century", Economic History Review, 2nd ser. XX (1967), pp. 257-265. The series are in Barnes, "Corn Laws", p. 298 and were taken from Customs Tariffs of the United Kingdom from 1800 to 1897 (c.-8706), pp. 253-255.

(35) See Mitchell and Deane, Abstract... pp. 468-9

(36) r_{lt-1} is one year's money rate of interest deflated by the average of seven years inflation rates, see above p.13. Several other approaches to lags were tried none of which worked better and some of which ran into great collinearity problems.

Figure 1.


Number of Enclosure Acts
120
100
80
60
40
20
0
PRICE OF WHEAT (d/imperial quarter)
money price
real price
1400
1200
1000
800
600
400
200
0
RATE OF INTEREST (%)
money rate
real rate
5.0
3.5
2.0
0.5
-1.0
-2.5
-4.0
1755
1765
1775
1785
1795
1805
1815

The results for the whole period for both equations (2) and (3) show the wheat price variable but not the rate of interest variable as significant at the 5% level[37]; both have the expected sign. The money variables equation produces the better fit as measured by $\bar{R}^2$, which is in any case low for the real variables case. In both cases autocorrelation is a serious problem. Examination of the residuals suggested the possibility of a structural break concurrent with the beginning of the wars with France. When the results for the subperiods 1767-92 and 1793-1815 were compared an F test indicated there was a significant difference between the two periods.[38]

Indeed there is a remarkable lack of similarity between the subperiods. For the French Wars period in each case the wheat price variable performs very well and the interest rate one very badly, autocorrelation is not a problem and the fit is quite good. Again the money variable version does better. In the earlier period, however, neither variable in the real variables equation is significant, whilst in the money variables case the rate of interest is significant with the correct sign but the wheat price has the wrong sign although the coefficient is not significant. Auto-correlation raises serious difficulties and in both cases the $\bar{R}^2$ is very low. It is unlikely that multicollinearity is responsible for the lack of significance of any coefficient.

The formulation using the lagged dependent variable at first sight looks promising. These equations generally have a much higher $\bar{R}^2$, except in 1793-1815, and the Durbin-Watson statistic is generally close to 2 but there remain many doubts. Although the sign on E_{t-1} is between 0 and 1 as predicted, (except in one case), in the light of the theoretical justification for its introduction into (2a) and (3a) it is rather unfortunate to observe the

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(37) The conventional 5% level is used throughout in discussing significance.

(38) The reason for the choice of 1767-92 is discussed below, p.18 . Similar results were obtained for 1756-92, and of course comparison of 1756-66 and 1767-92 runs into small samples problems.

erratic impact on the size of the other coefficients. Furthermore the use of the lagged dependent variable means that the Durbin-Watson statistic is a weak test for autocorrelation[39] so that its apparent removal may be illusory. Finally the high degree of association between E_t and E_{t-1} is worrying and could be indicative of the importance of 'autonomous' components in the investment. The position with regard to the significance of variables is little changed; the loss of significance of w_{1t-1} for the whole period may be a result of collinearity.

Elasticities can be crudely calculated from the results for equations (2) and (3) by the use of formulae of the type $\hat{b}_1\bar{r}_1/\bar{E}$ where the barred variables are sample period means.[40] These estimates are reported in Table One.

These attempts to use an investment function approach do not provide unequivocal support for either the Chambers and Mingay or the Ashton hypotheses, although the money variables equations generally work better. The relative importance of wheat prices and interest rates seems to be different between periods both in terms of significance and elasticity and neither variable is significant in both subperiods in any of the variations tried. Periodisation thus seems to be important. However, the results in general are not very good and it may be premature to accept this conclusion.

The unsatisfactory nature of these results is perhaps not surprising when the theoretical discussion of Section II is considered in the historical context. It was pointed out there that in general the correspondence between the level of agricultural prices and the profitability of enclosure would be

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(39) See the discussion in K. F. Wallis, Introductory Econometrics, (London: Gray-Mills, 1972), pp. 89-95.

(40) This method is quite widely used, see for example M.K.Evans, Macroeconomic Activity, Ch. 5.

TABLE ONE

	Constant	w_{1t-1}	w_{2t-1}	r_{1t-1}	r_{2t-1}	E_{t-1}	$\bar{R}^2$	DW
1756-1815	-43.725 (-1.609)	0.194 (4.514)		-3.612 (-1.909)			.399	.623
	1.354 (0.070)	0.046 (1.327)		-3.493 (-2.707)		0.683 (7.943)	.720	2.133
	12.855 (0.799)		0.113 (9.727)		-7.968 (-1.871)		.642	0.905
	10.659 (0.759)		0.062 (3.968)		-5.425 (-1.444)	0.473 (4.258)	.728	1.851
Elasticities		1.97	1.42	-0.18	-0.61			
1767- 92	24.876 (4.511)	0.067 (0.837)		-6.665 (-1.545)			.179	0.629
	-8.466 (-0.228)	0.059 (1.112)		-3.829 (-1.317)		0.684 (5.504)	.639	2.091
	179.585 (2.983)		-0.069 (-0.886)		-24.735 (-3.975)		.348	0.682
	19.336 (0.306)		0.049 (0.709)		-8.359 (-1.288)	0.652 (3.859)	.594	1.969
Elasticities		0.92	-0.97	-0.54	-2.46			
1793-1815	-72.641 (-2.373)	0.256 (5.302)		-0.310 (-0.184)			.547	1.467
	-50.217 (-1.390)	0.191 (2.595)		-0.890 (-0.510)		0.221 (1.148)	.554	1.892
	-7.075 (-0.245)		0.100 (7.713)		-0.402 (-0.064)		.729	1.831
			0.120 (5.283)		0.579 (0.091)	-0.195 (-1.079)	.731	1.473
Elasticities		1.79	1.08	-0.01	-0.02			

Notes to Table One All symbols and sources are described in the text. It should be noted that w_1, w_2 and r_2 are all 3 year averages (unweighted) of the variable concerned and r_1 is the version of the real rate of interest based on the last 7 years price changes. The dependent variable is the no. of enclosure bills in time t.

far from perfect. The equations tested here have many variables, which might be expected to be important, missing e.g., output, non-arable prices, costs. Further it was argued that a sustained higher level of agricultural prices would be expected to lead to a permanent rise in the desired stock of enclosed land rather than a sustained increase in the flow of enclosures. It was also suggested that the impact of a rise in agricultural prices on the flow of enclosures would partly depend on the level of the prvious peak price, e.g. a fall from a peak price followed by a subsequent recovery might leave agricultural entrepreneurs still feeling that the stock of enclosed land was high enough or even too high during this recovery of prices.

The level of wheat prices in real and money terms was higher in 1767 than any subsequent year down to 1795; this is the reason for the choice of that date for the start of the first subperiod of Table One. During this period not only was the pric e of corn below the 1767 peak but there were good reasons for believing that the peak would not be regained. The new Corn Law of 1773[41], repealed in 1791, reduced protection and it was anticipated that it would imply that the price of wheat would settle in the range of 44-48s. per quarter, well below the 1767 average price of 58/10½d.[42] Moreover, thirteen of the years between 1772 and 1791 saw net imports of wheat, which had previously only occurred at times of crisis prices, 1728-9, 1757-8, 1767-8, at considerably lower prices.[43] Although output was no doubt increasing slowly during the period it would not be surprising if for much of it agriculturalists felt that they were already at or above the desired stock of enclosed land. Barnes argues that "...when the demand for food increased and the price of agricultural products began to rise, the landed interest felt that the act of 1773 prevented them from reaping the benefit to which they were entitled."[44]

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(41) 13 Geo.III, c.43. (42) This is the price in the series adopted in this paper.

(43) The appropriate series are printed in Barnes, "Corn Laws",pp.298-300; the thirteen years concerned were 1772-5, 1777, 1781-4, 1787-8, 1790-1.

(44) Ibid., p. 60

The wartime period differed notably. New peak wheat prices were recorded in real and money terms in 1795, 1796, 1801 and 1802 and in money terms in 1812; the price of wheat was above the 1767 level in money terms every year but 1797-8. The Corn Law of 1773 had been repealed and price rises now occurred in a situation where the economy had probably not adjusted up to the new desired stock implied by the very recent new peak prices. The short-run association between prices and enclosures envisaged in Section II seems to have occurred. The difference in results between the two sub-periods in terms of goodness of fit, autocorrelation and significance of the wheat price terms is perhaps not surprising and could be quite consistent with wheat prices playing essentially the same role throughout.

The rate of interest variable performed better in the first sub-period. This may reflect the possibility that in the wartime period with expections buoyant agriculturalists perceptions of the marginal efficiency of capital were little influenced by the interest rate. Alternatively it could be claimed that a different formulation of the real rate of interest would be more accurate and give better results.

V.

Elsewhere in the literature stress has been placed on factors affecting the pace of enclosure which have received relatively little prominence in the sectoral investment function approach. One view has been that the process can only be adequately understood at the local level in very detailed terms. For example, Hunt in his study of Leicestershire emphasised "the varying response from parish to parish to the changing economic conditions in the second half of the eighteenth century"[45] consequent

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(45) H. G. Hunt, "The Chronology of Parliamentary Enclosure in Leicestershire", Economic History Review 2nd.Ser. IX (1957/8), p.266.

on a number of factors such as the distribution of landownership, the type of soil, the proximity of communications and the existence or not of nearby successful parliamentary enclosures.

Another important point which has frequently been made is that many of the enclosures which occurred early in the period of parliamentary enclure were concerned with the conversion of land to pasture. Mingay suggests that "the greater returns available from pasture farming on land not naturally well suited to arable enouraged owners to concentrate on the enclosure of such parishes before the rise in grain prices in the later eighteenth century",(46) an argument which finds wide support in local studies.(47)

This proposition can be linked to a thesis by Jones. Put crudely, this thesis is that the last half of the seventeenth and the eighteenth centuries saw the spread of innovations well suited to arable farming on light soil areas and faced with these developments one response for heavy soil areas was to specialise in grazing activities.(48) We can regard this as an adjustment to a new balance of comparative advantage within agriculture which would make a substantial amount of enclosure for pasture profitable at any of the relative prices prevailing in the pre-1793 period.

These facets of parliamentary enclosure do not accord very well with

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(46) G. E. Mingay, Enclosure and the Small Farmer in the Age of the Industrial Revolution, (London:Macmillan, 1968).

(47) See, for example, Hunt, "Enclosure in Leicestershire", and J. D. Chambers, Nottinghamshire in the Eighteenth Century, (London 1932, reprinted London: Cass 1966).

(48) This thesis has been advanced and elaborated on by Jones in a number of places; see, for example, E. L. Jones, "Agriculture and Economic Growth in England, 1660-1750: Agricultural Change", Journal of Economic History XXV (1965), pp. 1-18.

the "induced investment" hypotheses considered so far. An alternative is to view the movement in terms of a diffusion process. The fitting of diffusion curves has become quite common in economics[49] and there are a number of reasons for believing that it may be appropriate for parliamentary enclosure.

The diffusion process approach postulates that it takes time for the use of a new producer good to reach an equilibrium level (the 'satiation stock'). We can conceptually imagine a "natural endogenous growth" to an equilibrium level which would take place with economic conditions held constant. If we could assume that supply conditions are (approximately) perfectly elastic then this "natural growth" can be interpreted in terms of a rate of acceptance determined by demand conditions. The rate of acceptance will be influenced by a learning process in a world of imperfect information; this underlying process is perhaps best regarded as a stochastic one. It may also be expected that the ajdustment rate will be faster the greater is the profitability stimulus. It is generally assumed that the "natural growth rate" will depend on the growth already achieved and the proximity of the satiation stock; the greater the existing stock of the good the greater will be the awareness of its existence and potential, the nearer the ceiling the fewer the prospective users that are left.

It seems plausible to suppose that these arguments may have applied to parliamentary enclosure which we can regard as a new process which became available in the eighteenth century, although enclosure itself was of course not new. Enclosure by Act of Parliament gradually became a standardised

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(49) See, for example, G. C. Chow, "Technological Change and the Demand for computers", American Economic Review LVII (1967), pp. 1117-1130 and Z. Griliches, "Hybrid Corn: An Exploration in the Economics of Technological Change", Econometrica XXV (1957), pp. 501-522.

process which made possible enclosures which had been difficult or impossible before. In the light of the motives for enclosure for pasture discussed above there seems to be good reason to believe the stock of enclosed land in say 1750 was below the satiation stock whilst the awareness process concept would in fact seem to be fairly consistent with the arguments of Hunt[50] and others who discuss details at the local level and the importance of diffusion processes in English agriculture at this time has long been emphasised.[51]

However, even if the flow of enclosures does partly represent an endogenous diffusion process it is nevertheless the case that economic conditions did not remain unchanged during the period of parliamentary enclosure. This implies that we might expect "the observed growth path... to consist of a number of segments of several growth curves whose parameters would depend in some way on economic factors."[52] This has two important corollaries.

(a) There will be problems in selecting the appropriate diffusion curve; there are no clear a priori guidelines and direct observation is clearly inadequate.

(b) It is desirable to separate out the "natural growth path" by making allowance explicitly for changes in economic conditions.

In this paper results are presented which make use of the Gompertz curve[53]

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(50) See above p. 20, and Hunt, "Enclosure in Leicestershire".

(51) For example the famous observation that "the pace of advance of new methods was not more than a mile a year from their place of origin", quoted in Deane Industrial REvolution, p. 39.

(52) A. D. Bain, The Growth of Television Ownership in the United Kingdom Since the War, (Cambridge:C.U.P. 1964), p.2.

(53) Regressions were also run using the logistic curve; this did not perform so well. For a brief description of the properties of the Gompertz curve, see Chow,"Demand for Computers," p. 1119.

The equation whose solution is the Gompertz curve is

$$\frac{dy}{dt} = \mu y(\log y^* - \log y) \qquad (5)$$

where y is the existing stock of parliamentary enclosed land, y^* is the satiation stock, α is the adjustment coefficient and the log terms represent natural logarithms. This formulation implies that both the existing stock of enclosed land and the difference between the satiation stock and the existing stock have a positive influence on the flow of enclosures (i.e. the rate of change of the stock).

Equation (5) can be rewritten as

$$\frac{d\log y}{dt} = \mu(\log y^* - \log y) \qquad (6)$$

or as a convenient approximation

$$\Delta \log y_t = \mu(\log y^* - \log y_{t-1}) \qquad (7)$$

The influence of economic conditions can be taken into account by letting the satiation stock be a function of economic variables. In discussing theories of investment in Section II it was made clear that in general it is easier to talk about the relation of product prices and the rate of interest to the desired stock of capital than to the flow of investment. We can now accomodate the role of these influences in a theoretically more satisfactory form by assuming(54)

$$\log y_t^* = \phi_0 + \phi_1, \log w_{1t-1} - \phi_2 \log r_{1t-1} \quad (i=1,2) \qquad (8)$$

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(54) This formulation assumes constant elasticities of course. This makes estimation considerably simpler.

which implies using (7)

$$\Delta \log y_t = \mu\phi_0 + \mu\phi_1 \log w_{it-1} - \mu\phi_2 \log r_{it-1} - \mu \log y_{t-1} \qquad (9)$$

In estimating this relationship we can attempt to test the influence of the rate of interest and wheat prices on parliamentary enclosure by interpreting their importance in terms of impact on the desired stock of enclosed land whilst taking into account a diffusion process. This approach should avoid some of the apparent difficulties encountered in the investment function results and also perhaps take into account in an admittedly summarised fashion some of the considerations omitted there. The data used is as described in Section III with the addition that the stock of parliamentary enclosed land at any time t is represented by total of enclosure bills which had been presented by that time. The results are presented in Table Two.

TABLE TWO

	Constant	Log w_{1t-1}	Log w_{2t-1}	Log r_{1t-1}	Log r_{2t-1}	Log y_{t-1}	X Dummy	$\bar{R}^2$	DW
1756-1815	0.391 (1.614)	0.032 (0.807)		-0.021 (-2.691)		-0.073 (-13.198)		.783	1.128
	0.065 (0.679)		0.094 (5.162)		0.047 (1.314)	-0.097 (-12.961)		.821	1.332
	0.313 (1.564)	0.047 (1.452)		-0.010 (-1.424)		-0.074 (-16.279)	-0.043 (-4.923)	.852	1.547
	0.300 (2.734)		0.057 (2.921)		-0.001 (-0.040)	-0.084 (-10.949)	-0.034 (-3.525)	.855	1.590

Notes: The dependent variable is $\Delta \log y_t$. For description of symbols and sources, see text. For equations involving Log r_{1t-1} four observations are omitted as in those years r_{1t-1} was negative.

The equations of type (9) do well in terms of $\bar{R}^2$; an interesting difference is that in the real variables case the rate of interest is significant but not the wheat prices whereas the situation is reversed in the money variables case where the interest rate has the wrong sign. In both cases the Durbin-Watson statistic is on the low side. A return to the arguments of Section IV provides a possible reason. There it was suggested that during the period 1767-92 agricultural entrepreneurs may well have felt that the desired stock of enclosed land was lowered. In order to test this hypothesis a dummy variable was added to equation (9) with the values 1 for the years 1767-92 and 0 elsewhere, with the predicted sign on XDummy negative.

With this addition the results are more satisfactory. In each case XDummy is significant with the expected sign, the interest rate variable has the expected sign but is insignificant and the Durbin-Watson statistic has improved considerably although it is still the uncertain range. The main difference is that wheat prices in money terms are significant but not in real terms. These estimates imply that the elasticity of the stock of parliamentarily enclosed land with respect to either money or real wheat prices was about 2/3 whilst the interest rate elasticities are very close to zero.

These results seem better than those obtained from the investment function approach. The picture which they suggest is of a "natural growth rate" based on a learning process in a situation where enclosure (probably mainly for pasture) was profitable at prevailing prices followed by a period when the original ceiling was already near and the equilibrium level was subjected to rises in money wheat prices which tended to raise it and perhaps adverse trading legislation which temporarily depressed it. This version would have moved away somewhat from the models apparently envisaged

by Ashton or Chambers and Mingay and is perhaps closer to the description of Gonner "...the improvements in breeding and feeding combine to associate enclosure from 1750 to 1780 with frequent conversions to pasture. This tendency decreases after 1780, partly because much of the land most suited to such treatment had been turned to grass, but partly also because in the last two decades a new inclosure wave displays itself. Improved methods made it possible to cultivate more highly soil of a poorer nature, while the demand for grain made such cultivation possible.(55) Nevertheless, the results are probably closer in spirit to Chambers and Mingay than Ashton given the performance of the money wheat price variable compared with that of the interest rate variables.

The sign and significance of the dummy variable is consistent with 1767-92 being a period when the satiation stock was reduced perhaps due to a fall in profit expectations. This would imply decreases in the flow of enclosures as the (now much nearer) ceiling was approached. If this was so then it may be that arguments relating the fall in investment in enclosure to the rise in interest rates in the pre-French Wars period have been based on an empirical relationship which is misleading. It may also imply that Chambers and Mingay's description of entrepreneurs ex-ante perceptions of the relative profitability of investment is mistaken;(56) this inference could also be drawn from the investment function results.

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(55) Gonner, "Common Land", p.141. Details of the regional distribution of acts are perhaps most readily accessible in G. E. Slater, The English Peasantry.

(56) See above, p.

VI.

The results obtained from the use of the diffusion model are encouraging. They suggest that, despite the undeniable complexities of the parliamentary enclosure movement, it is possible to analyse the process at a macro level. The approach is perhaps capable of extension at the disaggregated level where such facets of enclosure as different "rates of acceptance" could be examined. These results are therefore to be regarded as preliminary and should in any case be treated with great caution given the data problems discussed in Section III, especially the measurement of the real rate of interest, and the non-availability of series on the volume of output or the costs of enclosure. As they stand the results provide more support for the importance of wheat prices than interest rates. However, a more important point to emerge perhaps is the importance of specifying precisely theoretical relationships to be tested rather than basing arguments on straightforward comparison of time series.