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Does Capital Market Structure affect Farm Investment?
A comparison using French and British farm level panel data

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Introduction

A substantial body of recent empirical research now supports the view that, contrary to the Modigliani-Miller theorem internally generated and external funds are not perfect substitutes for financing investment. Much of this evidence comes from micro-econometric studies of investment (Fazzari, Hubbard and Petersen, 1988; Whited, 1992; Schaller, 1993; Faroque and Ton-That, 1995; Bond and Meghir, 1995) which show that overall firm level investment exhibits 'excess sensitivity' to financial variables.

One theoretically consistent explanation of rejections of Modigliani-Miller is that they arise from the presence impact of credit restrictions due to the informational asymmetries in the capital market (Stiglitz and Weiss, 1981). If such restrictions are the cause, capital market structure should affect both access to credit and investment behaviour. Generally, evidence suggests that institutional differences can have significant impacts on economic behaviour so the potential impacts of such capital structure differences may be significant (Card and Freeman, 1993). Particularly in the context of EU agricultural policy, such effects are important if they imply that access to credit differs substantially across member states.

In this paper observed differences in the structure of agricultural capital markets in France and the UK are used to generate separate predictions as to how credit restrictions - if present - would arise. More specifically, it is argued that in France if credit restrictions occur they will generally impact on new borrowings, while in the UK any restrictions are likely to act through a limit on total debt. These differences form the basis for the estimation of a number of farm level investment equations from which the impact of the differences in capital market structure in the two countries can be judged. Hence, the paper provides a framework for testing whether capital market structure affects farm investment and, by implication, provides further evidence as to whether rejections of the Modigliani-Miller theorem are in fact consistent with the credit market imperfections interpretation.

The differences in the potential form of restrictions on credit occur because of the distinct nature of agricultural capital markets in the two countries. In France, as in many in continental European countries a farmer co-operative bank, the *Crédit Agricole*, provides the vast majority (over 90%) of funds to agriculture (Lefèvre 1995). In contrast, UK agricultural lending is dominated by the non-specialist commercial banks. As a result of these structural differences, the available credit terms and conditions vary significantly across the countries. Principally, while in France finance for long term investment is typically only available in the form of long-term loans (Lefèvre 1997), in the UK - in part as a result of competition between the commercial banks (Camm, 1985) - overdraft financing (which is generally cheaper and more flexible) is available for both short and long term financing requirements (Midland Bank, 1982; Hill and Seagrave 1987). Hence, any restrictions on credit in France will only be felt when the farmer applies for new borrowings, while in the UK the farm's agreed overdraft limit will represent a restriction on the farm's total debt.

The structure of the paper is as follows. In the next section the standard dynamic model of the farm firm under uncertainty is presented and its empirical implications explained. This section also describes how the two types of potential credit restriction - on total debt and new borrowing can be incorporated into the model and their implications. Section 3 describes the empirical specification of the model and the approach to testing. Section 4 discusses the panel data constructed using information from the French and English-Welsh farm business surveys, the GMM estimation methods used and reports the estimation results. Section 5 concludes.

Dynamic models of investment

Perfect Capital Markets

Before introducing the implications of various types of restrictions on borrowing, the 'benchmark' model of investment under uncertainty under perfect capital markets will be considered. It is assumed that each farm/firm wishes to maximise the expected value of the farm subject to various technological constraints. The basic optimisation problem for the farm can then be formulated as the following dynamic programme (Bond and Meghir, 1995).

$$V_t(K_{t-1}, d_{t-1}) = \max_{R_t, b_t, a_t} \left\{ R_t + \theta_t E_t [V_{t+1}(K_t, d_t)] \right\} \quad [1]$$

s.t.

$$R_t = \pi_t(K_t, L_t, I_t, A_t) - r_{t-1}d_{t-1} + b_t - a_t$$

$$K_t = (1 - \delta)K_{t-1} + I_t$$

$$d_t = d_{t-1} + b_t - a_t$$

where E_t - represents expectation at time t , θ_t - exogenous discount factor, R_t - revenue from the farm/private drawings, $\pi_t(\cdot)$ - net revenue function, K_t - capital stock beginning of period, L_t - vector of current inputs, I_t - investment, A_t - vector of fixed factors, r_t - interest rate, d_{t-1} - existing debt beginning of period, b_t - new borrowing, a_t - repayments, δ - the depreciation rate.

Strictly, the inclusion of the financial variables, debt, new borrowings and repayment are unnecessary as the Miller-Modigliani theorem implies that investment decisions are independent of financial structure. This result derives from the empirical Euler equation for investment obtained from this model by combining the first-order conditions for investment with the expression obtained for $\partial V_t / \partial K_t$ (using the envelope theorem) (Bond and Meghir, 1995)

$$-(1 - \delta) \frac{\partial \pi_{t+1}}{\partial I_{t+1}} = -(1 + r_t) \frac{\partial \pi_t}{\partial I_t} - (1 + r_t) \frac{\partial \pi_t}{\partial K_t} + v_{t+1} \quad [2]$$

where $E_t v_{t+1} = 0$, i.e. assuming rational expectations. Thus equation [2] implies the standard result that under perfect capital markets investment is independent of the farm's financial decisions and structure. This model (Perfect Capital Market Model) is the most straightforward to implement empirically as a parametrised version of equation [2] may be estimated and tested by considering the significance of financial explanatory variables.

Restrictions on Borrowing : Total Debt Constraint

As argued in the introduction, if credit restrictions are important in UK agriculture they are likely to take the form of limits on total debt, i.e. overdrafts limits. In the current framework, this type of constraint can be captured most simply model by simply adding the following constraint to problem [1].

$$d_t \leq \bar{d}_t \quad [3]$$

where \bar{d}_t represents an exogenous maximum debt level set by the bank. Clearly, in practice the actual maximum will be dependent upon various farm and farmer characteristics. However, what is assumed is that the farmer does not know the exact process by which the maximum debt level is set. Constraints of this type are the standard approach to the incorporating credit restrictions caused by informational asymmetries in capital markets (Whited, 1992).

For consistency, once the perfect capital market assumption is relaxed, it is not possible to assume that farm revenue/private drawings are totally unrestricted¹. Thus, the following constraint is also required

$$R_t \geq \bar{R}_t \quad [4]$$

That is, farm revenue/private drawings must not fall below some exogenously set level determined by the farm household. The exact level will depend upon the other sources of income and extent of non-agricultural assets held by the farm household.

The Miller-Modigliani theorem breaks down in the presence of the constraints such as [3] and [4]. Solving for the Euler equation in this case, i.e. problem [1] plus constraints [3] and [4] gives the following expression.

$$-(1-\delta) \frac{\partial \pi_{t+1}}{\partial I_{t+1}} = -(1+r_t + \lambda_t) \frac{\partial \pi_t}{\partial I_t} - (1+r_t + \lambda_t) \frac{\partial \pi_t}{\partial K_t} + v_{t+1} \quad [5]$$

¹ Otherwise implicitly the farm has access to an infinitely large fund of own non-agricultural funds and the total debt constraint would never be binding.

where λ_t is the Lagrangian multiplier on the total debt constraint [2] and as before $E_t v_{t+1} = 0$. As λ_t is a function of (amongst others) the financial variables, it is the presence of this unobserved variable in this expression which links the financial and production decisions and complicates the empirical implementation of this model variant (Total Debt Constraint Model). As is well known, the effect of the presence of this variable is to increase the farm's effective rate of discount when the debt constraint is binding.

Testing for this type of constraint typically involves an *a priori* split of the sample into two groups, namely those farms considered to be *unconstrained* and those who may be *constrained* by the total debt constraint (Whited, 1992). As in the former group, the value of Lagrangian multiplier λ_t should be zero, the investment behaviour of this sample should be identical to the model without financial constraints, i.e. no financial variables should have any explanatory power. In contrast in the potentially *constrained* sample, the presence of the multiplier λ_t implies that any estimating equation based on [2] will be misspecified and that in particular, financial variables might be expected to have explanatory power. The obvious difficulty with this approach is the problem of identifying currently unconstrained farms *a priori*. The approach taken below classifies farms on the basis of farm size and level of available collateral. Theoretically, both these variables are potentially important in determining the degree of access to credit (Carter, 1988; Eswaran and Kotwal, 1989), while practice in the UK and elsewhere also suggests that access to the most flexible and cheapest loan types, such as overdrafts, is likely to be restricted for small farms or for those whose collateral is limited. (Hill and Seagrave, 1987; LEI/Rabobank, 1990; Miller *et al*, 1993)

Restrictions on Borrowing : Constraint on New Borrowing

In French case, it is argued that because most borrowings for new investment is in the form of long-term loans credit restrictions - if present - they will only impact upon the farmer when applications for new borrowings are made. This can be captured by replacing the overall debt constraint [3] introduced in the last section by the following restrictions on new borrowing and repayments.

$$0 \leq b_t \leq \bar{b}_t \tag{6}$$

$$a_t \geq \bar{a}_t \tag{7}$$

where \bar{a}_t and \bar{b}_t represent the minimum debt repayment and maximum new borrowing exogenously set by the lender in each period. As for the maximum debt constraint, the maximum new borrowing limit will depend upon various farm characteristics (including existing debt levels). However, as above, it is assumed that the farmer is unaware how such farmer specific information is used in the setting of the limit. In terms of loan repayment, the model abstracts from accounting explicitly for the term structure of the outstanding loans. Instead, the

simple minimum repayment level set by the bank is used to capture the fact that long-term loans must be repaid according to an agreed timetable².

One possible and useful way to consider the impact of the limit on new borrowing is to interpret it as having an effect similar to an explicit transaction cost on new borrowings. This equivalence can be shown as an application of the Lagrangian theorem of duality (Bazarra, Sherali and Shetty, 1993). That is, the model in this case consists of problem [1] plus constraints [4], [5] and [6]. Let η_t be the Lagrangian multiplier associated with the new borrowing constraint [5]. Then, from the Dual theorem, it follows that - for given η_t - the solution in period t is equivalent to maximizing the following objective subject to constraints [4] and [6]

$$\max_{b_t, a_t} \left\{ \pi_t(K_t, L_t, I_t, A_t) - r_{t-1}d_{t-1} + b_t(1-\eta_t) - a_t + \theta_t E_t[V_{t+1}(K_t, d_t)] \right\} \quad [8]$$

That is, for those constrained the effect of the credit restrictions is 'as if' they faced a transactions cost on all new borrowing. This similarity with a transactions cost model of investment can also be seen when the Euler equation for those who undertake new borrowings in consecutive periods is considered .

$$-(1-\delta) \frac{\partial \pi_{t+1}}{\partial I_{t+1}} = - \left(\frac{1+r_t-\eta_{t+1}}{1-\eta_t} \right) \frac{\partial \pi_t}{\partial I_t} - \left(\frac{1+r_t-\eta_{t+1}}{1-\eta_t} \right) \frac{\partial \pi_t}{\partial K_t} + v_{0t+1} \quad [9]$$

where now $E_t[v_{t+1}/b_{t+1} > 0] = 0$

Here, the Lagrangian values η_t and η_{t+1} act as equivalent to individual time varying transactions costs on new borrowing (Benjamin and Phimister, 1997). Further, in contrast to the effect of the Lagrangian multiplier λ_t in the Total Debt Constraint Model, here the overall effect on the effective rate of discount is ambiguous.

As for the Total Debt Constraint Model, this model (New Borrowing Constraint Model) can be empirically tested if those who are not constrained by the credit restrictions can be identified as this group should exhibit investment behaviour consistent with the Perfect Capital Market Model Euler equation [2]. However, here the *unconstrained* sample consists of those who are unconstrained in *two* consecutive periods, i.e. i.e. $b_t < \bar{b}_t, b_{t+1} < \bar{b}_{t+1}$. On first sight determining this sample seems an even more onerous task than determining the unconstrained sample for the Total Debt Constraint Model. However, it can be argued that observing new borrowing on a farm provides a signal that in fact this farm is not constrained in that period (Andersson, 1997). At the very least, those with new borrowings have not by definition had their loan applications

² Imposing a structure on the loans and loan repayments is possible but adds unnecessary complexity to the model.

rejected and therefore must satisfy some if not all the criteria deemed necessary by the lender. Applying this working hypothesis, the implications of equation [9] are observationally equivalent to a transactions costs model of investment (Benjamin and Phimister, 1997), namely, that the 'unconstrained' group is simply those who are observed to contract new borrowings in two consecutive periods.

Empirical Implementation

Parameterisation

It is clear from the discussion above that the specification of the Euler equation [2] for the model with no financial constraints is a key component in the testing of all model variants, i.e. for all three cases the theory implies that this equation is valid in *at least part* of the sample. To obtain the econometric specification of this equation the approach follows that of Bond and Meghir (1995). Firstly, the net revenue function is defined as

$$\pi_t = p_t F(K_t, L_t, A_t) - p_t G(I_t, K_t) - w_t L_t - p_t^I I_t \quad [10]$$

where p_t is output price, $F(K_t, L_t, A_t)$ is a constant returns to scale Cobb Douglas production function ($F(K_t, L_t, A_t) = dK_t^{\gamma_1} L_t^{\gamma_2} A_t^{1-\gamma_1-\gamma_2}$), the function $G(I_t, K_t) = bK_t(I_t/K_t - c)^2$ is the (linearly homogenous) adjustment cost function, w_t is the vector of prices for the variable inputs and p_t^I is the price of investment goods. Let $Y = F - G$ be the value of net (observable) output. As a result of the assumptions concerning the production and adjustment cost functions, it follows that the net output function $Y(K_t, L_t, A_t)$ is also linearly homogenous. Then, equation [2] can be written as

$$\left(\frac{I}{K}\right)_{it+1} = c(1 - \phi_{t+1}) + c(1 + \phi_{t+1})\left(\frac{I}{K}\right)_t - \phi_{t+1}\left(\frac{I}{K}\right)_t^2 - \frac{\gamma_1}{b}\phi_{t+1}\left(\frac{Y}{K}\right)_t + \frac{\phi_{t+1}}{b}Q_t + u_{t+1} \quad [11]$$

where $\phi_{t+1} = (p_t/p_{t+1})(1+r_t/1-\delta)$, $Q_t = \frac{1}{p_t}\left(\frac{r_t p_t^I + (p_t^I - p_{t+1}^I) + \delta p_{t+1}^I}{1+r_t}\right)$, and u_{t+1} is a composite error term. The term Q_t is equivalent to the user cost of capital with the numerator equal to the interest cost plus capital loss plus depreciation cost of investment. Instead of attempting to estimate Q_t directly the time varying effects from both this variable and the parameters on I/K , $(I/K)^2$ and Y/K are assumed to be captured by time specific and individual farm effects (Bond and Meghir, 1995). Hence, the basic estimating equation is

$$\left(\frac{I}{K}\right)_{i,t+1} = \beta_1 \left(\frac{I}{K}\right)_{i,t} + \beta_2 \left(\frac{I}{K}\right)_{i,t}^2 + \beta_3 \left(\frac{Y}{K}\right)_{i,t} + \rho_i + \sigma_{t+1} + v_{it+1} \quad [12]$$

where ρ_i refer to the farm specific effect , σ_{t+1} is the time-specific effect. Further, it can be shown that, for both cases, the parameters values are restricted such that $\beta_1 > 0$, $\beta_2 < -1$ and $\beta_3 < 0$.

Estimation Methods and Testing Approaches

For all three models two specifications are estimated (based on equation [12]) using the sub-sample of farms which the particular model predicts should not be credit rationed. The first specification is simply equation [12] itself, while the second one consists of equation [12] plus two financial explanatory variables (included to test for investment sensitivity to financial variables). The estimation of models based upon equation [12] is complicated by the fact that the lagged values of the dependent variable are correlated with the farm effect. Thus, the standard fixed effects estimator - obtained by applying OLS after transforming all values into deviations from the appropriate mean value- is inconsistent because the transformation induces a correlation between the lagged dependent variable and the error (Hsiao, 1986). Following Arellano and Bond (1991), this problem may be overcome by taking first differences of equation [12] to remove the fixed effects and then estimating the parameters by Generalised Method of Moments (GMM) where the instrument set contains the independent variables plus the dependent variable lagged two or more periods. Furthermore in each equation estimated we add dummies to include year effects i.e. the effects that are specific to each time period but are the same for farms.

The predictions of the theoretical models in conjunction with the estimation method employed provide two distinct strands to testing the three models. Firstly, the exact predictions of the three models can be tested for, namely, whether in the hypothesised *unconstrained* sub-sample the financial variables are statistically insignificant and the coefficients on I/K , $(I/K)^2$ and Y/K are as predicted. Given the strength of a number of the auxiliary assumptions, e.g. rational expectations, using these predictions is extremely demanding on the data. It is therefore useful to also use a complementary approach which will provide (weaker) evidence on the competing models. This second approach arises from the fact that in GMM the test of the over-identifying restrictions³ is 'as close as one can come ... to a portmanteau specification test' (Davison and Mackinnon, 1993, p.616). Hence, one can also test whether the two specifications (equation [12] and equation [12] plus financial variables) are rejected overall in the various sub-samples.

³ This tests whether the sample moments, corresponding to the restrictions imposed by the GMM orthogonality conditions, are sufficiently close to zero. Under the maintained hypothesis of validity of instruments it is a general test of the specification of the model.

Thus, if credit market restrictions in the two countries are present in the two forms claimed, one would expect both specifications (but at least equation equation [12]) to be rejected in the whole sample, while neither should be rejected by the UK data for the *unconstrained* sample implied by the Total Debt Constraint Model, nor by the French data for the *unconstrained* sample implied by the New Borrowing Constraint Model. Thus, the exact parameter restrictions implied by the theory can be considered as providing a strong test of the impact of the different capital structures in the two countries, while the pattern of rejections/non-rejections of the specifications for three models provides a weaker test of these differences. Table 1 summarises the predictions generated by the two approaches.

Table 1 Competing models and empirical specification

Model	Empirical Specification	If credit restrictions present	
		Specification Test	Parameter Restrictions
<i>Perfect Capital Market Model</i>	Equation [12] and equation [12] plus financial variables estimated for whole sample	Rejected both samples	Financial variables significant Coefficient signs not consistent with predictions
<i>Total Debt Constraint Model</i>	Equation [12] and equation [12] plus financial variables estimated for <i>a priori</i> unconstrained group defined relative to farm size and debt/asset ratio	French sample rejection? UK sample non-rejection	For UK unconstrained only Financial variables not significant, Coefficient signs consistent with predictions
<i>New Borrowing Constraint Model</i>	Equation [12] and equation [12] plus financial variables estimated for those with new borrowings in consecutive periods	French sample non-rejection UK sample rejection ?	For France unconstrained only. Financial variables not significant, Coefficient signs consistent with predictions

Results

Data

The two balanced panels are derived from the English-Welsh and French farm business surveys for the years 1987-1992 respectively. Table 2 summarises a number of selected variables for the sample farms in the two countries over the period including the variables used in the econometric analysis. One major advantage of these datasets is that - in principle at least - their use by the European Commission has led to the development of consistent definitions across countries. Due to the lack of available data from the British survey on capital excluding land before 1989, farm capital and investment represent the values for machinery and equipment only deflated by the machinery and equipment price index (EU Commission 1996). Of the other variables, farm output represents gross enterprise output and income is occupiers income value. These values plus the debt values are all deflated by the appropriate national farm output price index, (EU Commission 1996).

Table 2: Means of Selected Variables**A. England and Wales**

number of farms per year N=758

	1987	1988	1989	1990	1991	1992
Investment /Capital (I/K)	0.175	0.182	0.167	0.141	0.137	0.15
(Investment/Capital) ² (I/K) ²	0.057	0.060	0.053	0.042	0.041	0.049
Farm Output/Capital (Y/K)	3.553	3.799	3.681	3.632	4.200	5.133
Income/Capital (C/K)	0.671	0.736	0.559	0.283	0.512	1.050
Total Debt/Capital (DT/K)	1.998	1.999	2.013	2.288	2.614	2.873
(Short Term Debt/Capital)	1.257	1.235	1.253	1.334	1.555	1.692
(Long Term Debt /Capital)	0.741	0.758	0.759	0.954	1.059	1.182
New Borrowing Dummy 1 (D)	23	23	22	11	18	-
New Borrowing Dummy 2 (D)	216	218	210	162	139	-
New Borrowing Dummy 4 (D)	294	297	295	244	223	-

New Borrowing Dummy 1 long term loans only in consecutive years

New Borrowing Dummy 2 long term loans + short term loans increase of over 10% in consecutive years

New Borrowing Dummy 4 long term loans + any short term loans increase in consecutive years

B. France

number of farms per year N=1471

	1987	1988	1989	1990	1991	1992
Investment /Capital (I/K)	0.192	0.204	0.203	0.215	0.186	0.167
(Investment/Capital) ² (I/K) ²	0.085	0.094	0.094	0.312	0.089	0.076
Farm Output/Capital (Y/K)	4.39	4.739	5.261	6.004	7.977	7.614
Income/Capital (C/K)	1.51	1.603	2.401	2.381	2.79	2.525
Total Debt/Capital (DT/K)	2.36	2.302	2.410	2.406	2.834	2.114
(Short Term Debt/Total)	0.099	0.092	0.093	0.106	0.117	0.098
(Long Term Debt /Total)	2.16	2.210	2.308	2.300	2.721	2.016
New Borrowing Dummy D=0 ⁽¹⁾	421	304	272	266	227	-

(1) New Borrowing Dummy defined here for long term loans only. This dummy variable equals zero when the farm has new borrowings in consecutive periods (in period t+1 and in period t) and one otherwise. For instance, 421 french farms have new long term borrowings in 1987 and in 1988.

A number of differences between the British and French samples are evident from Table 2. Firstly, the expected difference in structure of borrowings across the two countries is clearly seen with short term loans accounting for around 60% of all borrowing in the UK but only 10% in the French case. It is notable that the investment/capital, income/capital and output/capital ratios are higher in the French sample than in UK one. *A priori* it is difficult to determine whether these

arise from differences in data definitions or in the prevalent economic conditions in the two countries during this period. Certainly, the trends in the British sample values are broadly consistent with the UK aggregate figures reflecting the extent of the recession in UK agriculture during this period (Harrison and Tranter, 1994).

Euler equation estimates

For all specifications ⁴, below the coefficients the value of standard errors are reported which are asymptotically robust to heteroscedasticity. Furthermore, as discussed above for each estimation the Sargan test for over-identifying restrictions is also presented. Under the null of a valid model the Sargan statistic has a χ^2 distribution (with the degrees of freedom equal to the number of over-identifying restrictions).

Table 3. Acceptability of the Perfect Capital Market Model : All farms

Dependent variable $I/K_{i,t+1}$ T=1988-1992 ⁽¹⁾	France (N=1471)		UK (N=758)	
	I	II	III	IV
$(I/K)_{i,t}$	0.036 (0.017)	0.038 (0.015)	-0.129 (0.029)	-0.163 (0.030)
$(I/K)^2_{i,t}$	-0.038 (0.789*10 ⁻²)	-0.032 (0.460*10 ⁻²)	0.055 (0.049)	0.127 (0.052)
$(Y/K)_{i,t}$	0.551*10 ⁻² (0.831*10 ⁻³)	-0.305*10 ⁻² (0.100*10 ⁻²)	0.023 (0.701*10 ⁻²)	0.924*10 ⁻² (0.681*10 ⁻²)
$(res/K)_{i,t}$		0.612*10 ⁻² (0.630*10 ⁻³)		0.018 (0.660*10 ⁻²)
$(borr/K)_{i,t}$		0.817*10 ⁻² (0.157*10 ⁻²)		0.884*10 ⁻² (0.316*10 ⁻²)
dummy88 ⁽²⁾	-0.041 (0.018)	-0.037 (0.0186)	-0.034 (0.016)	-0.028 (0.016)
dummy89	-0.039 (0.020)	-0.0295 (0.019)	-0.062 (0.018)	-0.062 (0.018)
dummy90	-0.047 (0.018)	-0.0345 (0.018)	-0.019 (0.016)	-0.020 (0.016)
dummy91	-0.0395 (0.020)	-0.0292 (0.019)	-0.514*10 ⁻² (0.021)	-0.015 (0.017)
Sargan (degrees of freedom)	45.96 (31)	58.68 (49)	57.29 (31)	83.41 (49)
p value	0.041	0.162	0.003	0.002

(1) For specifications I and III, the instruments used are lagged values of (I/K) , $(I/K)^2$, (Y/K) dated $t-1$, $t-2$, $t-3$, $t-4$ (where available). For specification I and IV, the instruments are the same as in specifications I and III plus the lagged values of (res/K) , $(borr/K)$ dated $t-1$, $t-2$, $t-3$, $t-4$ (where available).

(2) Year dummies (noted dumm-) were included in the specification

In Table 3, the acceptability of the Perfect Capital Market Model is tested by estimating equation [12] and [12] plus two financial based variables, i.e. the ratios farm income: capital (res/K) and total borrowing capital ($borr/K$), using the whole sample for both France and the UK. In summary, if this model is acceptable the equation [12] estimations, i.e. Columns I and III should provide an adequate explanation of the investment capital ratios in both samples and - in

⁴ The dataset covers the period 1987-1992 for each country. As we need lags, the effective sample for the estimation is 1988-1992.

addition - the coefficients on I/K , $(I/K)^2$ and Y/K should be positive, less than negative one and negative respectively. In both cases the overall specifications are rejected (Sargan test p-values $< 5\%$ and $< 1\%$ respectively), and while the coefficients on I/K and $(I/K)^2$ are of the expected sign for the French case, none of the UK coefficients are consistent with their predicted values or signs. Further, when the equation [12] plus financial variables specification is estimated (columns II and IV), in both the French and UK cases these variables are significant at the 5% level.

The results from column II and IV estimations also indicate some further differences between the French and UK samples. In the former case, the overall specification is (just) not rejected at 10% significance level (Sargan p-value = 0.162), while the coefficients on I/K and Y/K are consistent with equation [12] and that for $(I/K)^2$ is (at least) negative indicating that controlling for the impact of financial variables does marginally increase the consistency between the results and the theoretical predictions. In contrast, in UK sample, including the financial variables does not lead to an either to an acceptable overall specification overall, nor are signs of any of coefficients on the individuals variables consistent with the predictions. In summary, therefore the results of Table 3 indicate the rejection of the Perfect Capital Model.

Table 4 reports the results of the estimations consistent with the Total Debt Constraint Model.

Table 4 Total debt constraint model
a priori unconstrained sample : Farms > 40 ESU and < median debt/asset ratio

Dependent variable $I/K_{i,t+1}$ T=1988-1992 ⁽¹⁾	France (N=252)		UK (N=249)	
	I	II	III	IV
$(I/K)_{i,t}$	-0.020213 (0.1009)	-0.023154 .083983	0.037 (0.075)	0.058 (0.068)
$(I/K)^2_{i,t}$	-0.1077 (0.114)	-0.181230 (0.093262)	-0.288 (0.135)	-0.405 (0.126)
$(Y/K)_{i,t}$	$0.1624 \cdot 10^{-3}$ ($0.4372 \cdot 10^{-3}$)	0.0255 ($0.7085 \cdot 10^{-2}$)	0.047 ($0.592 \cdot 10^{-2}$)	0.042 ($0.850 \cdot 10^{-2}$)
$(res/K)_{i,t}$		-0.026 ($0.545 \cdot 10^{-2}$)		0.042 (0.016)
$(borr/K)_{i,t}$		-0.0178 (0.010)		-0.032 (0.014)
dummy88 ⁽²⁾	-0.0109 (0.0428)	0.01101 (0.039)	$-0.126 \cdot 10^{-2}$ (0.023)	-0.018 (0.022)
dummy89	-0.0177 (0.114)	$-0.4123 \cdot 10^{-2}$ (0.041)	-0.047 (0.018)	-0.038 (0.019)
dummy90	$0.1624 \cdot 10^{-2}$ ($0.437 \cdot 10^{-3}$)	-0.0806 (0.036)	-0.021 (0.025)	$-0.900 \cdot 10^{-2}$ (0.023)
dummy91	0.03028 (0.035)	-0.0662 (0.033)	$-0.585 \cdot 10^{-2}$ (0.025)	$0.130 \cdot 10^{-2}$ (0.026)
Sargan (degrees of freedom) p value	49.46 (31) 0.019	63.78 (49) 0.076	33.07 (31) 0.366	46.79 (49) 0.563

(1) For specifications I and III, the instruments used are lagged values of (I/K) , $(I/K)^2$, (Y/K) dated $t-1$, $t-2$, $t-3$, $t-4$ (where available). For specification I and IV, the instruments are the same as in specifications I and III plus the lagged values of (res/K) , $(borr/K)^2$ dated $t-1$, $t-2$, $t-3$, $t-4$ where available.

(2) Year dummies (noted dumm-) were included in the specification

As discussed above in this case, testing for the presence of a total constraint on debt involves an *a priori* split of the sample into two groups, namely those farms considered to be *unconstrained* and those who may be *constrained* by the total debt constraint. Here farms are classified unconstrained on the based upon farm size and level of available collateral (debt/asset ratio). In particular, for the estimations reported in Table 4, the sub-samples considered likely to be 'unconstrained' are those farms over 40 economic size units (ESU) (defined by the EU as 'Large') and whose debt-asset ratio lies below the relevant nations median value.^{5 6} Although arbitrary, these thresholds do provide a sub-sample of farms which are more likely to be unconstrained by a restriction on total debt than the remainder of the sample.

For the French sample, both the specifications (equation [12] and equation [12] plus financial variables) are rejected at the 5% and 10% significance level respectively. Comparing the column I and II estimations across Tables 3 and 4, it is apparent that restricting the estimation to this potentially 'unconstrained' sub-sample in the French case does not improve the consistency of the results with the theory in the column 1 specification and actually leads to a deterioration in the column II specification when the financial variables are included. Hence in the French case, one can the rejection of the perfect capital market assumption and the observed excess sensitivity of investment to financial variables cannot be interpreted as consistent with the existence of simple limits on total debt.

In contrast, the results for the UK provide some support for the hypothesis that the rejection of the perfect capital market assumption in this case can be explained by limits on total debt. Here, unlike the Table 3 results the Sargan test implies that neither of the overall specifications can be rejected and although the column IV results indicate that financial variables are still significant determinants of investment for this group, the sign of the coefficients on I/K and $(I/K)^2$ have become negative. Further supporting that these results are consistent with the Total Debt Constraint Model was provided from the results (not reported) of estimating the two specifications on the remainder of the sub-sample. For example, for the sample of the farms greater than 40 ESU in size but with debt asset ratio above the median both specifications were rejected overall, while for farms less than 40 ESU but with debt asset ratio less than median although the overall specification was not rejected none of the estimated coefficients had the predicted sign.

⁵ Experimentation indicated that in isolation nether of these variables defined a sub-sample where the specifications were not rejected.

⁶ UK median =0.13 France median =0.23

Table 5 New borrowing constraint model

Dependent variable $I/K_{i,t+1}$ T=1988-1992 ⁽¹⁾	France (N=1471)		UK (N=758)	
	I*	II*	III** (0%)	IV*** (10%)
$(I/K)_{i,t}$	-0.915·10 ⁻² (0.078)	0.0900 (0.076)	-0.041 (0.075)	0.456 (0.159)
$(I/K)^2_{i,t}$	-0.0352 (0.748·10 ⁻²)	-0.044 (0.81·10 ⁻²)	0.179 (0.163)	-0.166 (0.273)
$(Y/K)_{i,t}$	0.024 (0.838·10 ⁻²)	-0.017 (0.011)	0.020 (0.759·10 ⁻²)	0.018 (0.839·10 ⁻²)
$(res/K)_{i,t}$		0.046 (0.021)	0.086 (0.016)	0.052 (0.026)
$(borr/K)_{i,t}$		0.025 (0.012)	0.027 (0.599·10 ⁻²)	0.016 (0.559·10 ⁻²)
$d_{i,t}(I/K)_{i,t}$	-0.1732 (0.1362)	-0.179 (0.133)	0.048 (0.175)	-0.685 (0.232)
$d_{i,t}(I/K)^2_{i,t}$	0.2966 (0.1316)	0.134 (0.105)	-0.623 (0.363)	-0.099 (0.455)
$d_{i,t}(Y/K)_{i,t}$	-0.035 (0.993·10 ⁻²)	0.016 (0.011)	-0.531·10 ⁻² (0.411·10 ⁻²)	-0.235·10 ⁻² (0.474·10 ⁻²)
$d_{i,t}(res/K)_{i,t}$	0.025 (0.966·10 ⁻²)	-0.0414 (0.021)	-0.096 (0.026)	-0.049 (0.034)
$d_{i,t}(borr/K)_{i,t}$	0.292·10 ⁻² (0.532·10 ⁻²)	-0.023 (0.012)	-0.211·10 ⁻² (0.531·10 ⁻²)	-0.129·10 ⁻² (0.530·10 ⁻²)
dummy88	-0.0294 (0.019)	-0.0321 (0.0187)	-0.046 (0.017)	-0.045 (0.018)
dummy89	-0.034 (0.021)	-0.0122 (0.0198)	-0.061 (0.018)	-0.064 (0.019)
dummy90	-0.022 (0.019)	-0.0323 (0.0183)	-0.023 (0.017)	-0.034 (0.018)
dummy91	-0.027293 (0.020)	-0.0228 (0.0186)	-0.667·10 ⁻² (0.019)	0.014 (0.019)
Sargan (degrees of freedom)	27.30 (26)	46.83 (44)	59.30 (44)	55.59 (44)
p value	0.3937	0.357	0.062	0.113

* Dummy $d_{i,t} = 0$ if long term loans increase in consecutive years

** Dummy $d_{i,t} = 0$ if (long term loans + short term loans) increase in consecutive years

*** Dummy $d_{i,t} = 0$ if long term loans increase or short term loans increase by more than 10% in consecutive years

(1) For specifications I and III, the instruments used are lagged values of (I/K) , $(I/K)^2$, (Y/K) dated $t-1$, $t-2$, $t-3$, $t-4$ (where available). For specification I and IV, the instruments are the same as in specifications I and III plus the lagged values of $(res/K)_{i,t-1}$, $(borr/K)$ dated $t-1$, $t-2$, $t-3$, $t-4$ (where available).

(2) year dummies (noted dumm-) were included in the specification

The final set of empirical results in Table 5 report the results of the estimations consistent with the New Borrowing Constraint Model. As discussed above - as for transaction costs on new borrowing - the investment behaviour of those who borrow in consecutive periods (and are not constrained) should be consistent with equation [12]. The empirical specification of this case is more complicated than the Total Debt Constraint Model because in this case the error in the empirical Euler equation [9] is conditional on both positive new borrowing in t and $t+1$, i.e. here $E_t[v_{t+1}/b_{t+1} > 0] = 0$. Therefore this equation cannot be applied in isolation as the error will not have a zero mean and hence, formally the cases where on positive new borrowing in t but not in $t+1$ must be also be incorporated. To allow for this all the specifications reported include a dummy which is zero when farm i had new borrowings in consecutive periods and one otherwise. This dummy is interacted with the independent variables to provide a formulation

which allows the parameters of the model to differ across farms in the two sub-samples, i.e. those with new borrowings in consecutive periods and the remainder. Further, as the dummy variable is endogenous in the model all the interaction terms are also instrumented (Bond and Meghir, 1995). The exact definition of the dummy varies across the two national samples. For France, the dummy is simply defined as whether a farm had new long term borrowings in two consecutive periods, while in the UK two alternative definitions are used to reflect the use of overdraft funds for long-term investments.⁷ In column III, the dummy is simply whether the total amount of borrowing increased, while in column IV this is whether either long term borrowing increased in consecutive periods and total short-term lending increased by 10%⁸ or more in consecutive periods. As the exact short run borrowing position of any farm will tend to naturally fluctuate year to year, this latter definition was used to test whether excluding such small fluctuations was important.

The results from Table 5 for the French sample provide some evidence that this rejection of the Perfect Capital Market Model may well arise from the presence of borrowing restrictions on new borrowings. Consider the results for specification which includes financial variables, i.e. column II. Empirically this specification is superior to both the whole sample estimation in Table 3 and the sub-sample estimation in Table 4. Firstly, the overall specification is not rejected (p-value=0.393). In addition, the classification of the sample into those with new borrowings in consecutive periods and the remainder is supported by these results with the equality of the two coefficients on the financial variables is rejected at 5% and the restricted model (table 3 column II) rejected overall at 5% significance level (LM test, Davison and Mackinnon, 1993, p.618). However, to be entirely consistent with the theoretical model of new borrowing constraints, the coefficients on I/K , $(I/K)^2$ and Y/K for the group with consecutive borrowings (dummy=0) should follow the predictions of equations [12]. Further if the working hypothesis is satisfied, namely, that these farms are not borrowing constrained, the financial variables should be also insignificant for this group. However, the column II results show that while the coefficients on I/K , $(I/K)^2$ and Y/K are of the predicted signs, only the value on $(I/K)^2$ is significant at the 5% level (and this is not as predicted less than negative one) while both financial variables are significant.

Finally, in contrast but consistent with the conjecture that UK credit restrictions do not impact on new borrowings, the results for the UK sample show that allowing the parameters of the two specifications to vary for those farms with consecutive new borrowings does not lead to empirically acceptable specifications with both specifications either rejected or barely not rejected at the 10% significance level.

⁷ Information in the UK was restricted to the net borrowing. In contrast to France Table 2 confirms the small number of farms (around 20 per period) where long-term borrowings increased in consecutive periods.

⁸ The results were found to be insensitive to the threshold chosen over a range of 5%-20%.

Summary and Conclusions

This paper has explored whether differences in the structure of agricultural capital markets in France and the UK have impacts on farm investment caused by differing methods by which credit is restricted. In particular, it was argued that in France if credit restrictions occur they will generally impact on new borrowings, while in the UK any restrictions are likely to act through a limit on total debt. The theoretical and empirical implications of such differences were explored by adapting the dynamic theory of the firm under uncertainty to account for these two types of credit restrictions. The resulting empirical investment equations were then estimated by GMM using two panel datasets derived from the French and English and Welsh Farm Business Surveys.

In terms of the empirically acceptable specifications, the econometric results provide some support for the contention that credit rationing is important in the two countries and takes the different forms hypothesised, i.e. restrictions on new borrowings in France but on total debt in the UK. In both countries, the empirical model consistent with perfect capital markets is comprehensively rejected, with only one overall empirical specification not rejected and excess sensitivity to financial variables observed throughout. In contrast, the empirical model consistent with a restriction on total debt provided an empirically satisfactory specification for the UK but was rejected for France, while the empirical model consistent with restrictions on new borrowing generated an acceptable empirical specification for France but was rejected for the UK.

The results do not however, provide such clear-cut conclusions with respect to the more detailed predictions of the theoretical models with - for the empirically acceptable specifications - a number of estimated coefficients not as predicted and in all cases the persistent observation of excess sensitivity of farm investment to financial variables. Nevertheless, the results provide some evidence to support the general interpretation that empirical rejections of the perfect capital market assumption arise from the presence of credit restrictions. More specifically, the evidence suggests that credit restrictions are different and hence do affect investment behaviour in the two countries. One implication of this which merits further investigation, is whether as a consequence the UK agricultural credit system has a larger in-built bias against small farmers than that present in the French agricultural capital market.

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