Does loan type affect investment ? A comparison using French and British farm level panel data

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Abstract

This paper tests whether observed differences in the structure of lending in UK and French agricultural capital markets give rise to differences in observed farm investment behaviour. To test for these effects a dynamic model of the farm firm incorporating both transactions costs on borrowing and restrictions on credit is estimate empirical Euler investment equations using panel datasets for France and the UK. The results indicate the importance of borrowing transactions costs in both national samples, but suggest that credit restrictions only play an important role in the UK. These confirm that small differences in financing can affect investment patterns.

Keywords: agricultural investment, transactions costs, credit restrictions.

JEL Classification:

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A substantial body of recent empirical research 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 behaviour (Fazzari, Hubbard and Petersen, 1988; Whited, 1992; Schaller, 1993; Faroque and Ton-That, 1995; Bond and Meghir, 1994) which show that overall firm level investment exhibits 'excess sensitivity' to financial variables in general and internal cash flow in particular. Theoretically, this excess sensitivity of investment is attributed to the presence of asymmetric information in capital markets (Hubbard, 1998; Stiglitz and Weiss, 1983).

One important but relatively neglected implication of this research is that capital market structure can impact upon investment. As general evidence suggests that institutional differences can have significant impacts on economic behaviour (Card and Freeman, 1993), then clearly the major differences in financial systems which exist across countries might well be expected to have significant impacts on investment (Mayer, 1997; Thakor, 1996; Allen and Gale, 1995). However, relative to single country studies (e.g. Hoshi, Kashyap and Scharfstein, 1991), the multi-dimensional nature of the types of observed differences across countries, e.g. sources of investment sources, patterns of ownership, financial regulations, make it difficult to isolate specific institutional effects. For example, while Bond *et al,* (1997) report results consistent with the hypothesis that the market orientation of financial system in the UK means that internal finance is more important in the UK than elsewhere in continental Europe, they caution against this interpretation because no direct test of this was possible. Ideally therefore, to test for how asymmetric information and institutional structure combine to affect investment across countries, specific alternative hypotheses about possible information effects need to be distinguished while controlling for other institutional differences.

This paper aims to test whether observed differences in UK and French agricultural capital markets structure have implications for the relative importance of the channels through which asymmetric information impacts on investment. More specifically, it considers the different lending structures in the two countries and how this affects the relative impact and importance of credit restrictions and borrowing transactions costs on investment behaviour. While empirical studies of investment have most typically characterised asymmetric information via types of credit restrictions (e.g. Whited, 1992; Hubbard *et al* , 1995), it may also induce transactions costs of various types (Bond and Meghir, 1994). In the agricultural context, borrowing transactions costs are potentially important as applicant for loans seek to satisfy lenders of their financial status, e.g. costs of preparation of accounts, financial plans etc. As detailed below, *a priori* it may be expected that the differences in the financing structure between the UK and France will alter the relative importance of these two types of credit market imperfection in terms of their investment effect. To test for this, a dynamic model of the farm firm incorporating both transactions costs on borrowing and restrictions on debt is used to generate empirical estimating equations for farm investment. These equations are then applied to farm level panel datasets for France and the UK constructed for the period 1987-1992.

As argued by Hubbard and Kashyap (1992), agriculture is a particularly good case study for testing hypotheses in this literature. For example, the assumption that firms consist of individual entrepreneurs who negotiate with outsiders for financing is tenable for agricultural firms, while monitoring difficulties mean agricultural investments are particularly prone to information problems. In the current context, the domination of the agricultural industry in both countries by individual entrepreneurs controls for the ownership structure effect which Mayer (1997) argues is important. Further, within the EU the collection of farm level data which uses consistent accounting procedures (EU Commission, 1989) minimises the impact of data differences which are evident when general investment data is used (Bond *et al.* 1997). Finally, the observed differences in agricultural capital markets and in the structure of lending discussed above provide specific hypotheses about the mechanisms through which asymmetric information may impact on investment.

The current differences in the structure of the UK and French agricultural capital markets arise principally from the extent to which historically farmers collectively financed themselves. In France, as in many continental European countries a farmer co-operative bank, the *Crédit Agricole*, provides the vast majority (over 90%) of funds to agriculture (Lefèvre 1997). 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 is available for both short and long term financing requirements (Midland Bank, 1982; Hill and Seagrave 1987).

Overdraft finance can be viewed as a discretionary loan commitment contract (Soffe, 1987; Melnik and Plaut, 1986)[2] and it has been shown, in theory, that this type of loan contract has specific effects on investment behaviour (Thakor, 1996) distinct from those implied by long-term loans (Houston and Venkataraman, 1996). In practice, the differing availability of the loan types is also likely to affect both access to credit and the costs associated with borrowing. In the UK overdraft financing is, on average, cheaper and more flexible than long term loans. However, observation suggests that restrictions on access to this type of credit may be particularly severe for certain groups, e.g. small farms, and farms with limited collateral (Hill and Seagrave, 1987). Hence, while certain groups of farmers may benefit from the availability of overdraft finance for long-term investment, the greater degree of monitoring associated with long-term loans may mean greater equality in access to credit in France. In contrast, whereas the existence of a simple overdraft limit allows farmers to re-invest without recourse to the lender, the need to continually re-apply for new borrowing for new long-term loans may suggest that transactions costs associated with borrowing are likely to be more important in the French market.

The structure of the rest of the paper is as follows. In the next section the dynamic model of the farm firm under uncertainty allowing for both types of capital market imperfections

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[2] In principle overdrafts are on ten days call (Camm, 1985). Boot *et al* (1993) argue that such discretionary financial contracts have a sound theoretical explanation.

is presented. 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.

1. Dynamic model of investment

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:

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

$$R_t = \pi_t(K_t, L_t, I_t, A_t) - r_{t-1}d_{t-1} + (1-\alpha)b_t - a_t \quad [2a]$$

$$K_t = (1-\delta)K_{t-1} + I_t \quad [2b]$$

$$d_t = d_{t-1} + b_t - a_t \quad [2c]$$

$$R_t \geq \overline{R}_t \quad [2d]$$

$$d_t \leq \overline{d}_t \quad [2e]$$

$$b_t, a_t \geq 0 \quad [2f]$$

where $V_t(.)$ is the farm's value at the start of the period t, d_{t-1} is the existing beginning-period debt, R_t represents private drawings, θ_t is the exogenous discount factor, E_t represents expectation at time t, K_t is beginning-period capital stock, b_t is new borrowing, $\pi_t(.)$ defines net revenue function, L_t the vector of current inputs, I_t investment, A_t vector of fixed factors, r_t is interest rate, a_t is repayments, δ the depreciation rate, αb_t fixed transactions cost on new borrowing, $\overline{R}_t$ minimum farm revenue/private drawings, $\overline{d}_t$ exogenous maximum debt.

The first set of constraints [2a] define private drawings in each period as net revenue minus interest payments on debt plus new borrowings minus repayment on existing debt minus costs associated with new borrowing. The production possibilities facing the farm are incorporated with the inclusion of the net revenue functions $\pi_\tau(K_t, L_\tau, I_\tau, A_\tau)$, while the new borrowing transactions costs are assumed to simply increase linearly with the level of new borrowing. At least in terms of the explicit transactions costs, this is consistent with the French situation where the main agricultural lender, the Credit Agricole, charges a commission proportional to the amount of new borrowing (Lefèbre, 1997).

The second set of constraints [2b] define current capital stock K_t as the depreciated value of the previous period's stock plus new investment (additions to the capital stock are instantaneous), while the next period's debt level d_t (defined by constraints [2c]) is the debt level at the beginning of the current period plus new borrowing minus repayments on existing debt. The first set of inequality constraints [2d] define the (exogenous) minimum permissible levels for private drawings for each period $\overline{R}_t$. The exact level of these will depend upon the other sources of income and extent of non-agricultural assets held by the farm household. The second set of inequality constraints [2e] define the limits on total credit available to the farm where $\overline{d}_t$ represents an exogenous maximum debt level set by the bank. In practice this maximum debt level will depend upon farm and farmer characteristics but it is simply assumed here that the farmer is unaware of the process by which the maximum debt level is set. The introduction of such a constraint is the standard approach to incorporate credit restrictions caused by informational asymmetries in capital markets (Whited, 1992; Hubbard, 1998).

For solution purposes define μ_t as the Lagrangian multiplier associated with the minimum farm drawings constraints [2d] λ_t the Lagrangian multiplier for the total debt constraint [2e], and η_t and φ_t be the Lagrangian multipliers associated with the new borrowing and repayment non-negativity constraints respectively [2f]. Then it is possible to derive (from the first order conditions and the envelope theorem) the following Euler equation for investment (see appendix 1):

$$-\theta_t(1-\delta)E_t\left[(1+\mu_{t+1})\frac{\partial\pi_{t+1}}{\partial I_{t+1}}\right]=-(1+\mu_t)\frac{\partial\pi_t}{\partial I_t}-(1+\mu_t)\frac{\partial\pi_t}{\partial K_t} \quad [3]$$

while the following condition holds between the values of the Lagrangian variables .

$$(1+\mu_t)(1-\alpha)+\eta_t-\lambda_t=\theta_t E_t\left[(1+\mu_{t+1})(1+r_t-\alpha)+\eta_{t+1}\right] \quad [4]$$

While these equations are assumed to hold *ex ante* equivalent equations, under rational expectations a combination of these equations are also assumed to hold *ex post* with the addition of a suitably defined error term (or forecast error) (Hayashi, 1985). This allows these two equations to be used to generate empirical Euler equations for investment which - as discussed below - may be directly estimated.

2. Empirical Implementation

2.1 Capital Market Structure and Empirical Implications

The general theoretical model presented encompasses four alternative possible capital market structures, namely, (a) the existence of a perfect capital market ($\bar{d}_t \rightarrow +\infty, \alpha=0$), (b) the presence of debt constraints only ($\bar{d}_t$ finite, $\alpha=0$), (c) the presence of transactions costs in borrowing only ($\bar{d}_t \rightarrow +\infty, \alpha>0$), and finally (d) the presence of both debt constraints and transactions costs ($\bar{d}_t$ finite, $\alpha>0$). In order to disentangle the importance of each of the two types of credit market imperfections, the empirical implications all four possible capital market structures will be considered and tested.

For case (a) when perfect capital markets are assumed, the empirical Euler equation collapses to the standard case for the firm (Bond and Meghir, 1994),

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

where v_{t+1} is a white noise expectational error uncorrelated with any information known at time *t*. Hence, if this assumption is acceptable the investment behaviour of all farms should be independent of the farm's financial decisions and structure.

In case (b), i.e. debt constraints present alone, the presence of the unobserved variable λ_t in equation [4] links the financial and investment decisions complicating empirical implementation. However, if an *unconstrained* sample, i.e. where $d_t < \bar{d}$, can be found, then equation [5] is still relevant, since for this sample the value of Lagrangian multiplier λ_t is zero. Therefore investment behaviour (for this group) should still appear to be independent of financial decisions. In contrast, in the remainder of the sample, i.e. the potentially *constrained* farms, the presence of the multiplier λ_t implies that any estimating equation based on [5] will be misspecified. One obvious difficulty with this is the problem of identifying currently unconstrained farms *a priori* (see Hubbard (1998) for a more detailed discussion). The approach taken below classifies farms on the basis of farm size and level of available collateral (prior to the estimation period) as both variables are important theoretically and practically in determining the degree of access to credit (Carter, 1988; Eswaran and Kotwal, 1989; Hill and Seagrave, 1987; LEI/Rabobank, 1990; Miller *et al.*, 1993).

Case (c) assumes that the only capital market imperfection present is the existence of transactions costs on new borrowings. Again the presence of the unobservable Lagrangian multiplier η_t in equation [3] means that no single empirical Euler equation for investment is applicable in general. However, if the farm undertakes new borrowings in consecutive periods a single empirical Euler equation is produced. This follows from the first order conditions which imply that if $b_t > 0$, $b_{t+1} > 0$ then the following empirical Euler equation is valid[3] (see appendix 1):

$$-(1-\delta)\frac{\partial \pi_{t+1}}{\partial I_{t+1}} = -\left(\frac{1+r_t-\alpha}{1-\alpha}\right)\frac{\partial \pi_t}{\partial I_t} - \left(\frac{1+r_t-\alpha}{1-\alpha}\right)\frac{\partial \pi_t}{\partial K_t} + v_{0t+1} \qquad [6]$$

where $E_t\left[v_{t+1}/b_{t+1} > 0\right] \neq 0$. This equation implies that in the presence of restrictions on debt and transactions costs on new borrowing, only farms which contracted new borrowings in two

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[3] This result is analogous to that derived by Bond and Meghir (1994) in an investment model with share issues costs.

consecutive periods will appear to behave 'as if' investment behaviour is independent of the farm's financial decisions and structure.

Under case (d) which allows both for credit restrictions and transactions costs in borrowing the relevant empirical Euler equation is essentially a combination of cases (b) and (d), that is it can be shown that equation [6] will be valid only for those farms which are currently unconstrained and have contracted new borrowings in two consecutive periods, i.e. $d_t < \bar{d}$, $b_t > 0$ and $b_{t+1} > 0$.

In summary, all four possible capital market structures imply that a Euler equation which explains $\partial\pi_{t+1} / \partial I_{t+1}$, as a linear function of $\partial\pi_t / \partial I_t$ and $\partial\pi_t / \partial K_t$ only should be valid for at least a sub-sample of the data, i.e. it should hold under case (a) (no capital market imperfections) for the whole sample, for case (b) (credit restrictions only) only for the those farms who are currently unconstrained, for (c) (transactions costs only) for those who have new borrowings in consecutive periods, and (d) credit restrictions and transactions costs) for those who are currently unconstrained and who have new borrowings in consecutive periods.

2.2 Parameterisation

Two particular issues must be resolved before the models consistent with the four possible views of the nature of capital market imperfections can be implemented in the data. Clearly, to operationalize the empirical Euler equations, the net revenue functions must be parameterised. Further, the financial variables to include in the basic empirical specification in order to test for overall investment sensitivity must be determined.

Firstly for the parameterisation of net revenue, define the net revenue function as

$$\pi_t = p_t F(K_t, L_t, A_t) - p_t G(I_t, K_t) - w_t L_t - p_t^I I_t \qquad [7]$$

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. Using these parameterisations, equation [5] can be rewritten, after rearrangement as:

$$\left(\frac{I}{K}\right)_{it+1} = c(1-\phi_{t+1}) + c(1+\phi_{t+1})\left(\frac{I}{K}\right)_t - \phi_{t+1}\left(\frac{I}{K}\right)_t^2 - \frac{\gamma_1}{b}\phi_{t+1}\left(\frac{Y}{K}\right)_t + \frac{\phi_{t+1}}{b}Q_t + u_{t+1} \quad [8]$$

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.[4] Following (Bond and Meghir (1994) instead of attempting to estimate Q_t directly the time varying affects from this parameter are assumed to be captured by time specific and individual farm effects while it is also assumed that the values ϕ_{t+1} are constant across time. From [8] it follows (for the given parameterisations and auxiliary assumptions) that the empirical Euler equations [5] and [6] imply that the investment capital ratio in one period should be explained by its lagged value, its lagged value squared and the lagged value of the output capital ratio.

While the parameterisation of the net revenue function provides a specification which closely approximates the structure of the empirical Euler equations [5] and [6], the inclusion of the chosen financial variables is essentially *ad hoc.* Firstly, the ratio of occupier income to capital stock (res/K) is included to capture the sensitivity of investment to the availability of internal funds, i.e. this captures the 'cash flow' effect, while the ratio of total borrowing to capital (borr/K) is included to capture interest rate risk premium. Therefore the basic estimating equation has the following form;

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[4] The transactions cost cases simply follow cases (a) and (b) with $1+r_t' = (1+r_t-\alpha)/(1-\alpha)$ replacing $1+r_t$.

$$\left(\frac{I}{K}\right)_{i,t+1}=\beta_1\left(\frac{I}{K}\right)_{i,t}+\beta_2\left(\frac{I}{K}\right)^2_{i,t}+\beta_3\left(\frac{Y}{K}\right)_{i,t}+\beta_4\left(\frac{\mathrm{Res}}{K}\right)_{i,t}+\beta_5\left(\frac{Borr}{K}\right)_{i,t}+\rho_i+\sigma_{t+1}+v_{it+1}$$

[9]

where ρ_i refer to the farm specific effect, σ_{t+1} is the time-specific effect. As summarised in Table 1, all four competing capital market structures may be tested using equation [9] as they each imply this equation - plus the parameter restrictions $\beta_1>0$, $\beta_2<-1$, $\beta_3<0$, $\beta_4=0$ and $\beta_5=0$ - should be valid for a different sub-sample of the data.

(Table 1)

3. Results

3.1 Data

The two balanced panels are obtained 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 both countries over the period including the variables used in the econometric analysis. One major advantage of these datasets is that their use by the European Commission has led to the development of consistent definitions across countries EC Commission, 1989). 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). Among the other variables farm output represents gross enterprise output and income is occupiers income value[5]. These values plus the debt values are all deflated by the appropriate national farm output price index, (EU Commission 1996).

(Table 2)

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

[5] Occupier income represents farm net value added plus investment grants minus wages, rent and interest paid.

France. It is notable that the investment/capital, income/capital and output/capital ratios are higher in the French sample than in UK one. 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).

3.1 Euler equation estimates

The estimation of equation [9] 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 [9] to remove the fixed effects and then estimating the parameters by Generalised Method of Moments (GMM). As long as the error term in levels is serially uncorrelated then the error term in first differences will be MA(1) and a valid instrument set can be constructed from the independent variables plus the dependent variable lagged two or more periods. If the error term in levels is MA(1) then instruments dated t-3 must be used. In addition, (conditional on instrument validity) GMM also provides an additional criterion with which to judge the adequacy of the empirical results as the Sargan test of the over-identifying restrictions is 'as close as one can come ... to a portmanteau specification test' (Davison and Mackinnon, 1993, p.616).

Hence, for all specifications below the actual values for the tests of first order (m1) and second order (m2) serial correlation in the differenced residuals are reported (asymptotically standard normal under the null of no serial correlation) plus the p values for the Sargan test (asymptotically distributed χ^2 with the degrees of freedom equal to the number of over-identifying restrictions). Finally, for all the estimated coefficients the reported values of standard errors are asymptotically robust to heteroscedasticity.

(Table 3)

In Table 3, the acceptability of the Perfect Capital Market assumption is tested by estimating equation [10] using the whole sample for both France and the UK. If this model is acceptable these estimations should provide an adequate explanation of the investment/capital ratios consistent with the theoretical predictions, i.e. the coefficients on I/K, $(I/K)^2$ and Y/K should be positive, less than negative one and negative respectively and the financial variables should have no explanatory power. While the overall specification in the French sample is not rejected at 10% significance level (Sargan p-value = 0.162), and the coefficients of I/K and Y/K are consistent with equation [9], both the financial variables are significant at the 5% level. In the UK sample, the overall specification (Sargan test p-value < 1%) is rejected, both financial variables are significant and none of the other coefficients are consistent with expectations. These results are consistent with the evidence form the corporate sector, namely, that investment in sensitive to financial variables and therefore the assumption of Perfect Capital Markets is not tenable. Further, comparing estimated coefficients on (res/K) in the two samples provides some evidence that overall there is a greater sensitivity to the availability of internal funds in the UK than in France.

(Table 4)

Table 4 reports the results of the estimations consistent with the assumption that the only capital market imperfections present are restrictions on total debt. For these estimations, 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.[6] Although arbitrary, given the typical criteria used by agricultural lenders to screen loan applicants, e.g. collateral requirements, profitability etc. (Miller *et al.* 1993, Ellinger, Barry and Mazzocco, 1990; LEI/Rabobank, 1990), if such credit restrictions are important these thresholds do provide a sub-sample of farms which are less likely to face restrictions on credit than the remainder of the sample.[7]

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[6] UK median =0.13 France median =0.23

[7] Table A1 (Appendix 2) gives the corresponding results for those not in the *a priori* unconstrained sample, i.e. ≤ 40 ESU and debt/asset ratio ≥ median.

For the French sample, the Sargan test results imply the rejection (at the 1% and 10% level) of the estimating equation [9] in the two sub-samples considered. The estimates obtained for the sample of large farms (>40esu) are also the estimates obtained are generally less consistent with the theoretical predictions than the French results presented in Table 3. However, although the overall specification is formally rejected, the estimates obtained for the sample of farms with lower than median debt-asset ratios are apparently consistent with the presence of debt constraints based on collateral restrictions. Firstly, the coefficients on I/K, $(I/K)^2$ and Y/K are as predicted and while the effect of borrowing level is still significant, there is no evidence of a internal funds effect on investment for this sample. However, the presence of second order serial correlation when *t*-2 instruments were used restricts this estimation to the period 1989-1992 implying the presence of first-order serial correlated errors in the levels equation [9]. As noted by Bond and Meghir (1994), MA(1) errors in [9] may arise from a variety of sources, of mis-specification, e.g. decision lags, time aggregation, but formally provides evidence against the acceptability of the model in this sub-sample. Further evidence against is provided by the results for farms with debt asset ratios greater than or equal to the median value (appendix 2 Table A1, column 2) which are at least as consistent with the theoretical predications as the column 2 results from Table 4. For the UK the results are similar in that the specification is rejected in both sub-samples, and although the results for the sample with debt/asset ratios less than the median exhibit no sensitivity to the two financial variables this result is also observed for the remainder of the sample (Appendix 2, Table A1, column 4). Again conclusion must be that the sensitivity to the financial variables observed in Table 3 and particularly to the internal finance variable (res/K) are not simply explained by credit restrictions.

(Table 5)

Table 5 reports the estimation results consistent with assumption that the only capital market imperfections present are transactions costs on new borrowing, i.e. consistent with equation [6]. The empirical specification in this case is more complicated than the previous cases due to the presence of the non-zero mean error v_{ot+1} caused by the fact that the error here is conditional on positive new borrowing *t+1*, 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 explanatory 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 (where the theoretical predictions should hold) and the remainder. Further, as the dummy variable is endogenous in the model all the interaction terms are instrumented (Bond and Meghir, 1994).

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. In column II, the dummy is simply whether the total amount of borrowing increased, while in column III it is whether either long term borrowing increased in consecutive periods and total short-term lending increased by 10% 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. That is, if the process of increasing one's overdraft limit by a relatively substantial amount also incurs transactions costs, e.g. associated with the verification of the farmer's financial status, then one might expect that the investment behaviour consistent with new borrowing transaction costs would be more likely to be evident for this case.

The results from Table 5 for the French sample provide evidence that the rejection of the Perfect Capital Market Assumption in the French sample may - in part - arise from the presence of transactions costs on new borrowings. Empirically the specification reported for the French sample in Table 5 is superior to the whole sample estimation in Table 3 (and the Table 4 results). 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 rejected at 5% and the restricted model (table 3 column I) rejected overall at 5% significance level (LM test). However, the French 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. Further, the estimated coefficient on $d_{i,t}(res/K)$ indicates a greater investment sensitivity to the availability of internal finance for those farms with borrowings in consecutive periods than the remainder of the sample, inconsistent with the hypothesis that investment sensitivity should be greater for those excluded or who self-select out of capital market transactions.

Somewhat surprisingly, the results for the UK also show the empirical validity of the specification based around borrowing transactions costs with neither dummy specification rejected at 10% by the Sargan test. Furthermore, in contrast to the Table 3 results, for both cases the estimated coefficient on I/K is positive, the coefficient on $(I/K)^2$ is negative (although not less than negative one) and Y/K negative and/or insignificant. In terms of the effect of the financial variables, in column II, a internal finance effect on investment is still present (although there appears no borrowing effect) while in column III the reverse is the case. Comparing the sensitivity of investment to internal funds, the column I and II results are consistent with Table 3 indicating a greater sensitivity in the UK sample, while this is not the case when the French results are compared with the Column III UK results. The estimated coefficients on the dummy interaction terms indicate strong support for the sample-selection rule based on changes in borrowing with significant differences in the lagged investment capital ratio effect and the borrowing capital ratio effect.

(Table 6)

Finally, Table 6 reports the results of estimating the specification used in Table 5 but now for the sub-samples which are likely to contain 'unconstrained' farms, i.e. those over 40 economic size units and whose debt-asset ratio lies below the relevant national median value. Therefore these results are consistent with the presence of both restrictions on debt and transactions costs on borrowing.[8] For the French sample, the results are similar to those given

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[8] See Table A2 (Appendix 2) for the corresponding results for those not in the *a priori* unconstrained sample, i.e. $\leq$ 40 ESU and debt/asset ratio $\geq$ median.

in Table 4 with the specification formally rejected for both sub-samples at the 10% and 5% levels respectively. As before, the estimates obtained for the sample of large farms (>40esu) are also less consistent with the theoretical predictions than the French results presented in either Table 3 or Table 5, while those obtained for the sample of farms with lower than median debt-asset ratios are apparently consistent with theory. However, the results for the remainder of the sample (Appendix 2, Table A2, Column 2) again make it difficult to attribute this improvement in the results to the presence of credit restrictions based on collateral with, for example, the internal finance effect larger in the Table 4 results than for the remainder of the French sample (who should be more likely to be credit constrained . In contrast, the UK results do suggest that controlling for both transactions costs and potential credit restrictions leads to results which imply greater consistency with theoretical predictions. In the sample of larger farms both dummy definitions (columns 3 and 5) generate results where the lagged investment capital ratio effects and output capital ratio effect are as predicted, although they still exhibit (strong) sensitivity to internal funds (which, consistent with the French results, is significantly greater than for those without consecutive borrowing increases). For both dummy definitions the sample of farms with debt asset ratios lower than the median exhibit no observed investment sensitivity to either the financial variables. However, given the other estimated coefficients and the results for the reminder of the sample (Appendix 2, Table A2, columns 3 and 6), the evidence that this arises from the presence of credit restrictions is only plausible for the results based on the second dummy definition, i.e. 10% increases borrowing in consecutive years (Column 6).

4. Summary and conclusions

Much recent empirical research supports the view that, due to the presence of asymmetric information in capital markets, internally generated and external funds are not perfect substitutes for financing investment. Although this research naturally implies that cross-country differences in capital market structure should affect investment, the causes of such effects are difficult to measure due to the multi-dimensional nature of observed institutional differences across countries. Using specific differences in the lending structure in UK and French agricultural capital markets, this paper has tested whether this has observable effects on the way in which the presence of asymmetric information in these markets affects investment. Specifically, it has explored how such differences affect the relative impact and importance of credit restrictions and borrowing transactions costs on investment behaviour by estimating a dynamic model of the farm firm (incorporating both these types of market imperfections) using farm level panel datasets for France and the UK constructed for the period 1987-1992.

Somewhat surprisingly, the results show that borrowing transactions costs are important in both UK and French samples. However, once these costs are controlled for, there is also evidence in the UK case only that credit restrictions are present and affecting investment behaviour. Given the dominance of overdraft finance as external funding in the UK, this is consistent with *a priori* expectations, that credit constraints would be relatively more important here than in the French context where long-term loans predominate. This may also explain why - where investment was found to be affected by the level of internal funds - the sensitivity of investment to the internal funds was generally greater in the UK sample than that for France.

However, a number of puzzles remain. In the French results, the continued sensitivity of French farm investment to financial variables - even when both transactions costs and restrictions on credit are controlled for - remains unexplained. If transactions costs are playing the role suggested in the French case, this result may be explained by the maintained hypotheses concerning these costs, i.e. that they are constant across time and individuals. Further, the fact that the role of credit restrictions is rejected is somewhat surprising. Again this may be due to a different mechanism as long-term repayments requirements and overall credit limits may interact giving an investment effect which differs that arising from the single credit limit considered here.

The results have implications for the agricultural sector specifically but also more widely. For EU agricultural policy the results emphasise the need to recognise that financial structure impacts on investment behaviour in general, but also that differences in the structure of agricultural capital markets across member states is likely to influence response to policy changes. Generally, the results help to show that - even when ownership structure is controlled for - relatively small differences in the source of external funding do have discernible effects on observed investment behaviour. More specifically, the evidence presented here supports the theoretical prediction that there are loan commitment investment effects relative to other types of loan.

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Table 1 Empirical specifications overview

Assumed Capital Market Structure	Empirical predictions (Equation [9] validity with $\beta_1>0$, $\beta_2<-1$, $\beta_3<0$, $\beta_4=0$ and $\beta_5=0$)
Perfect Capital Market	For whole sample
Debt Constraints only	For unconstrained group (defined *a priori* relative to farm size and debt/asset ratio).
Transactions Costs on new Borrowing only	For those with new borrowings in consecutive periods.
Debt Constraints and Transactions Costs on new Borrowing	For those with new borrowings in consecutive periods and who are unconstrained (defined *a priori* relative to farm size and debt/asset ratio).

Table 2: Means of Selected Variables

	1987	1988	1989	1990	1991	1992
England and Wales N=811 (farms per year)						
Investment /Capital *(I/K)*	0.179	0.183	0.167	0.141	0.137	0.157
(Investment/Capital)^2 $(I/K)^2$	0.061	0.061	0.052	0.047	0.044	0.050
Farm Output/Capital *(Y/K)*	3.669	3.748	3.653	3.590	4.149	5.051
Occupiers Income/Capital *(C/K)*	0.687	0.708	0.550	0.265	0.493	1.028
Total Debt/Capital *(DT/K)*	2.151	2.005	2.017	2.275	2.592	2.830
(Short Term Debt/Capital)	1.265	1.229	1.251	1.333	1.551	1.675
(Long Term Debt /Capital)	0.886	0.776	0.765	0.942	1.040	1.154
New Borrowing Dummy 1*(D)* (1)	26	23	25	13	19	-
New Borrowing Dummy 2 *(D)* (2)	321	315	314	257	234	-
New Borrowing Dummy 4 *(D)* (3)	239	230	224	172	146	-
France N=1471(farms per year)						
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
Occupiers 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 $D=0^{(4)}$	421	304	272	266	227	-

(1) New Borrowing Dummy 1: long-term loans only in consecutive years
(2) New Borrowing Dummy 2 :long-term loans + short term loans increase of over 10% in consecutive years
(3) New Borrowing Dummy 4 :long-term loans + any short term loans increase in consecutive years

(4) New Borrowing Dummy 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.

Table 3. Perfect Capital Market Assumption

Dependent variable $I/K_{i,t}$ T=1988-1992 (1)	France (N=1471)	UK (N=811)
$(I/K)_{i,t-1}$	0.038	-0.049
	(0.015)	(0.021)
$(I/K)^2_{i,t-1}$	-0.032	-0.174
	(0.460*10^{-2})	(0.037)
$(Y/K)_{i,t-1}$	-0.305*10^{-2}	0.017
	(0.100*10^{-2})	(0.311*10^{-2})
$(res/K)_{i,t-1}$	0.612*10^{-2}	0.021
	(0.630*10^{-3})	(0.729*10^{-2})
$(borr/K)_{i,t-1}$	0.817*10^{-2}	-0.493*10^{-2}
	(0.157*10^{-2})	(0.262*10^{-2})
dummy88 (2)	-0.037	-0.055
	(0.0186)	(0.016)
dummy89	-0.0295	-0.046
	(0.019)	(0.016)
dummy90	-0.0345	-0.272*10^{-2}
	(0.018)	(0.016)
dummy91	-0.0292	-0.019
	(0.019)	(0.016)
m1	-1.88	-8.55
m2	-1.02	-1.28
Sargan test	58.68	87.98
(degrees of freedom)	(49)	(49)
p value	0.162	0.001

(1) The instruments used are lagged values of (I/K), $(I/K)^2$, (Y/K) (res/K), $(borr/K)$ dated *t-2, t-3, t-4, t-5* (where available).

(2) Year dummies (denoted dummy-) were included in the specification.

Table 4 Debt Contraints only

(A *priori* unconstrained sample : Farms > 40 ESU and < median debt/asset ratio)

Dependent variable $I/K_{i,t}$ T=1989-1992 [(1)]	France		UK	
	>40esu (N=590)	D/A< median (N=736) [(2)]	>40esu (N=557)	D/A< median (N=404)
$(I/K)_{i,t-1}$	-0.068 (0.026)	0.618 (0.402)	-0.112 (0.012)	-0.156 (0.041)
$(I/K)^2_{i,t-1}$	-0.028 (0.364*10^{-2})	-0.720 (0.455)	-0.113 (0.015)	0.157 (0.059)
$(Y/K)_{i,t-1}$	-0.215*10^{-2} (0.113*10^{-2})	-0.010 (0.854*10^{-2})	0.041 (0.948*10^{-2})	0.065 (0.752*10^{-2})
$(res/K)_{i,t-1}$	0.402*10^{-2} (0.537*10^{-3})	0.016 (0.014)	0.027 (0.011)	-0.444*10^{-2} (0.866*10^{-2})
$(borr/K)_{i,t-1}$	0.731*10^{-3} (0.165*10^{-2})	0.0109 (0.512*10^{-2})	-0.036 (0.817*10^{-2})	-0.480*10^{-2} (0.740*10^{-2})
dummy88 [(3)]	0.024 (0.026)	-	-0.046 (0.017)	-0.065 (0.021)
dummy89	-0.033 (0.028)	-0.040 (0.027)	-0.059 (0.016)	-0.065 (0.023)
dummy90	-0.037 (0.030)	-0.028 (0.029)	-0.594*10^{-2} (0.018)	-0.644*10^{-2} (0.020)
dummy91	-0.874*10^{-2} (0.026)	0.016 (0.033)	-0.016 (0.018)	-0.029 (0.020)
m1	-0.99	-16.03	-5.85	-11.65
m2	-1.02	1.70	-1.26	0.20
Sargan (degrees of freedom) p value	89.48 (49) 0.000	39.21 (28) 0.077	76.29 (49) 0.008	64.82 (49) 0.064

(1) Instruments used are lagged values of (I/K), $(I/K)^2$, (Y/K) (res/K), $(borr/K)^2$ dated *t-2, t-3, t-4, t-5* (where available).

(2) The instruments dated t-2 are found to be invalid for this specification, hence instruments dated t-3 are used and for the estimation period 1989-1992.

(3) Year dummies (denoted dummy-) were included in the specification

Table 5. Transactions Costs on New Borrowing only

Dependent variable $I/K_{i,t}$ T=1988-1992 (1)	**France*** (N=1471)	**UK** ** (N=811,0%)	**UK** *** (N=811,10%)
$(I/K)_{i,t-1}$	0.0900 (0.076)	0.576 (0.105)	0.925 (0.127)
$(I/K)^2_{i,t-1}$	-0.044 (0.81·10^{-2})	-0.208 (0.117)	-0.287 (0.115)
$(Y/K)_{i,t-1}$	-0.017 (0.011)	-0.652*10^{-2} (0.012)	0.012 (0.872*10^{-2})
$(res/K)_{i,t-1}$	0.046 (0.021)	0.055 (0.031)	-0.026 (0.020)
$(borr/K)_{i,t-1}$	0.025 (0.012)	0.471*10^{-2} (0.945*10^{-2})	0.0824 (0.618*10^{-2})
$d_{i,t}(I/K)_{i,t-1}$	-0.179 (0.133)	-0.978 (0.138)	-1.323 (0.155)
$d_{i,t}(I/K)^2_{i,t-1}$	0.134 (0.105)	0.036 (0.140)	0.102 (0.121)
$d_{i,t}(Y/K)_{i,t-1}$	0.016 (0.011)	0.864*10^{-2} (0.011)	0.016 (0.636*10^{-2})
$d_{it}(res/K)_{i,t-1}$	-0.0414 (0.021)	-0.039 (0.035)	-0.037 (0.022)
$d_{it}(borr/K)_{i,t-1}$	-0.023 (0.012)	0.019 (0.968*10^{-2})	0.017 (0.645*10^{-2})
dummy88	-0.0321 (0.0187)	-0.051 (0.020)	-0.056 (0.021)
dummy89	-0.0122 (0.0198)	-0.048 (0.020)	-0.064 (0.020)
dummy90	-0.0323 (0.0183)	-0.156*10^{-2} (0.021)	-0.505*10^{-2} (0.021)
dummy91	-0.0228 (0.0186)	-0.495*10^{-2} (0.018)	-0.936*10^{-2} (0.018)
m1	-1.66	-10.48	-9.18
m2	-1.07	0.333	-0.29
Sargan (degrees of freedom)	46.83 (44)	54.70 (44)	53.16 (44)
p value	0.357	0.129	0.162

* 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) Instruments used are lagged values of (I/K), $(I/K)^2$, (Y/K) (res/K), $(borr/K)^2$ dated *t-2, t-3, t-4, t-5* (where available).

(2) year dummies (denoted dummy-) were included in the specification

Table 6. Debt Contraints + Transactions Cost on New Borrowing

Dependent variable $I/K_{i,t}$ T=1988-1992 (1)	France*		UK** (0%)		UK*** (10%)	
	>40esu (N=590)	d/a< median (N=736)	>40esu (N=557)	d/a< median (N=379)	>40esu (N=557)	d/a< median (N=404)
$(I/K)_{i,t-1}$	-0.112 (0.083)	1.895 (0.418)	1.050 (0.180)	0.253 (0.188)	1.541 (0.208)	1.163 (0.282)
$(I/K)^2_{i,t-1}$	-0.060 (0.010)	-1.992 (0.459)	-0.649 (0.162)	0.059 (0.201)	-1.047 (0.185)	-1.311 (0.338)
$(Y/K)_{i,t-1}$	0.021 (0.013)	-0.023 (0.013)	-0.070 (0.023)	0.057 (0.698*10^{-2})	-0.046 (0.021)	0.040 (0.766*10^{-2})
$(res/K)_{i,t-1}$	0.043 (0.019)	0.053 (0.021)	0.200 (0.054)	0.038 (0.023)	0.171 (0.056)	-0.039 (0.028)
$(borr/K)_{i,t-1}$	-0.044 (0.019)	0.013 (0.018)	0.038 (0.018)	-0.873*10^{-2} (0.018)	0.020 (0.016)	0.017 (0.024)
$d_{i,t}(I/K)_{i,t-1}$	0.366 (0.189)	-2.327 (0.476)	-1.716 (0.219)	-0.374 (0.290)	-2.157 (0.231)	-1.538 (0.348)
$d_{i,t}(I/K)^2_{i,t-1}$	-0.258 (0.174)	2.325 (0.506)	0.321 (0.141)	-0.222 (0.345)	0.818 (0.174)	1.651 (0.429)
$d_{i,t}(Y/K)_{i,t-1}$	0.024 (0.013)	0.034 (0.012)	0.098 (0.019)	0.017 (0.504*10^{-2})	0.080 (0.018)	0.028 (0.566*10^{-2})
$d_{it}(res/K)_{i,t-1}$	-0.040 (0.020)	-0.068 (0.020)	-0.228 (0.065)	-0.068 (0.026)	-0.176 (0.063)	-0.025 (0.033)
$d_{it}(borr/K)_{i,t-1}$	0.043 (0.019)	-0.436*10^{-2} (0.019)	-0.017 (0.022)	0.479*10^{-2} (0.019)	-0.018 (0.017)	-0.318 (0.027)
dummy88	0.892*10^{-2} (0.028)	-0.011 (0.028)	-0.052 (0.026)	-0.032 (0.023)	-0.051 (0.030)	-0.049 (0.026)
dummy89	-0.027 (0.032)	-0.042 (0.026)	-0.070 (0.025)	-0.036 (0.022)	-0.100 (0.026)	-0.057 (0.026)
dummy90	-0.051 (0.031)	-0.057 (0.029)	-0.163*10^{-2} (0.027)	-0.014 (0.022)	-0.043 (0.026)	-0.012 (0.025)
dummy91	-0.043 (0.029)	-0.249*10^{-2} (0.027)	-0.021 (0.021)	-0.024 (0.020)	0.575*10^{-2} (0.022)	-0.043 (0.021)
m1	-1.12	-15.10	-9.89	-12.96	-10.85	-12.27
m2	-1.03	-1.06	0.27	1.16	-0.40	1.10
Sargan (degrees of freedom)	58.67 (44)	64.09 (44)	49.95 (44)	53.76 (44)	46.83 (44)	50.57 (44)
p value	0.069	0.026	0.249	0.149	0.357	0.230

* 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) Instruments used are lagged values of (I/K), $(I/K)^2$, (Y/K) (res/K), $(borr/K)^2$ dated *t-2, t-3, t-4, t-5* (where available).

(2) year dummies (denoted dummy-) were included in the specification

Appendix 1. Derivations

First Order Conditions

From the dynamic programme ([1] , [2a]-[2f]) the lagrangian for period t is as follows:

$$\begin{aligned} L = & \pi_t((1-\delta)K_{t-1}+I_t, L_t, I_t, A_t) - r_{t-1}d_{t-1} + (1-\alpha)b_t - a_t \\ & +\theta_t E_t\left[V_{t+1}((1-\delta)K_{t-1}+I_t, d_{t-1}+b_t-a_t)\right] \\ & +\mu_t\left(\pi_t((1-\delta)K_{t-1}+I_t, L_t, I_t, A_t) - r_{t-1}d_{t-1} + b_t - \alpha b_t - a_t - \overline{C}_t\right) \\ & +\lambda_t\left(\overline{d} - d_{t-1} - b_t + a_t\right) \\ & +\varphi_t a_t \\ & +\eta_t b_t \end{aligned}$$

The first order conditions for this problem are as follows:

$$L_t : (1+\mu_t)\frac{\partial \pi_t}{\partial L_t} = 0 \qquad \text{[I]}$$

$$I_t : (1+\mu_t)\left(\frac{\partial \pi_t}{\partial I_t} + \frac{\partial \pi_t}{\partial K_t}\right) + \theta_t E_t\left[\frac{\partial V_{t+1}}{\partial K_t}\right] = 0 \qquad \text{[II]}$$

$$b_t : (1+\mu_t)(1-\alpha) + \theta_t E_t\left[\frac{\partial V_{t+1}}{\partial d_t}\right] - \lambda_t + \eta_t = 0 \qquad \text{[III]}$$

$$a_t : -(1+\mu_t) - \theta_t E_t\left[\frac{\partial V_{t+1}}{\partial d_t}\right] + \varphi_t = 0 \qquad \text{[IV]}$$

$$\begin{aligned} & \mu_t : \pi_t((1-\delta)K_{t-1}+I_t, L_t, I_t, A_t) - r_{t-1}d_{t-1} + b_t - \alpha b_t - a_t - \overline{C}_t \geq 0, \mu_t \geq 0 \\ & \quad \mu_t\left(\pi_t((1-\delta)K_{t-1}+I_t, L_t, I_t, A_t) - r_{t-1}d_{t-1} + b_t - \alpha b_t - a_t - \overline{C}_t\right) = 0 \end{aligned} \qquad \text{[V]}$$

$$\lambda_t : \overline{d}_t - d_{t-1} - b_t + a_t \geq 0, \lambda_t \geq 0, \lambda_t\left(\overline{d}_t - d_{t-1} - b_t + a_t\right) = 0. \qquad \text{[VI]}$$

$$\varphi_t : a_t - \overline{a}_t \geq 0, \varphi_t \geq 0,\ \varphi_t a_t = 0 \qquad \text{[VII]}$$

$$\eta_t : b_t \geq 0, \eta_t \geq 0, \eta_t b_t = 0 \qquad \text{[VIII]}$$

Equation [3]

To derive equation [3] one obtains from the lagrangian, (applying the envelope theorem) that

$$\frac{\partial V_t}{\partial K_{t-1}} = (1-\delta)\left((1+\mu_t)\frac{\partial \pi_t}{\partial K_t} + \theta_t E_t\left[\frac{\partial V_{t+1}}{\partial K_{t+1}}\right]\right)$$
$$= -(1-\delta)(1+\mu_t)\frac{\partial \pi_t}{\partial I_t} \qquad \text{(from equation [II])}$$

Therefore,

$$E_t\left[\frac{\partial V_{t+1}}{\partial K_t}\right] = -(1-\delta)E_t\left[(1+\mu_{t+1})\frac{\partial \pi_{t+1}}{\partial I_{t+1}}\right] \qquad \text{[IX]}$$

Substituting [IX] back into equation [II] gives equation [3] as required.

Equation [4]

Equation [4] is obtained in a similar manner. Firstly, apply the envelope theorem to obtain:

$$\frac{\partial V_t}{\partial d_{t-1}} = -r_{t-1}(1+\mu_t) + \theta_t E_t\left[\frac{\partial V_{t+1}}{\partial d_t}\right] - \lambda_t$$
$$= -(1+\mu_t)(1+r_{t-1} - \alpha) - \eta_t \qquad \text{(substituting from equation [III])}$$

Hence,

$$E_t\left[\frac{\partial V_{t+1}}{\partial d_t}\right] = -E_t\left[(1+\mu_{t+1})(1+r_t - \alpha) - \eta_{t+1}\right] \qquad \text{[X]}$$

Substituting [X] into [III] gives equation [4].

Equation [5] and [6]

Combining equations [3] and [4] gives the single combined Euler equation.

$$-E_t\left[(1+\mu_{t+1})\left((1-\delta)\frac{\partial \pi_{t+1}}{\partial I_{t+1}} - \frac{1}{1-\alpha}\left((1+r_t-\alpha) - \lambda_t' - \eta_t' + \eta_{t+1}'\right)\left(\frac{\partial \pi_t}{\partial I_t} + \frac{\partial \pi_t}{\partial K_t}\right)\right)\right] = 0$$

where $\lambda_t' = \dfrac{\lambda_t}{\theta_t(1+\mu_{t+1})}, \eta_t' = \dfrac{\eta_t}{\theta_t(1+\mu_{t+1})}$

Equations [5] and [6] follow under the capital market structure

For example, for case (a) and (b) ($\bar{d}_t \to +\infty$ or $d_t < \bar{d}$ and $\alpha = 0$) implies $\lambda'_t = \eta'_t = \eta'_{t+1} = 0$ and [5] follows under rational expectations.

For case (c) and (d) ($\bar{d}_t \to +\infty$ or $d_t < \bar{d}$ with $b_t > 0$) implies $\lambda'_t = \eta'_t = 0$ and therefore empirical Euler equation [6] holds conditional on $b_{t+1} > 0$.

Equation [8]

Given the net revenue function as $\pi_t = p_t F(K_t, L_t, A_t) - p_t G(I_t, K_t) - w_t L_t - p_t^I I_t$

with $F(K_t, L_t, A_t) = dK_t^{\gamma_1} L_t^{\gamma_2} A_t^{1-\gamma_1-\gamma_2}$, $G(I_t, K_t) = bK_t (I_t / K_t - c)^2$ and $Y = F - G$.

Hence, it follows that

$$\frac{\partial \pi_t}{\partial I_t} = -bp_t \left(\frac{I}{K} \right)_t + bcp_t - p_t^I, \quad \frac{\partial \pi_t}{\partial K_t} = \gamma_1 p_t \left(\frac{Y}{K} \right)_t + bp_t \left(\frac{I}{K} \right)_t^2 - bcp_t \left(\frac{I}{K} \right)_t$$

Substituting for these expressions in equation [9] using the definitions

$\phi_{t+1} = (p_t / p_{t+1})(1 + r_t / 1 - \delta)$, $Q_t = \dfrac{1}{p_t} \left(\dfrac{r_t p_t^I + (p_t^I - p_{t+1}^I) + \delta p_{t+1}^I}{1 + r_t} \right)$, gives [8] after rearrangement.

Appendix 2 : Sub-sample estimations remainder (a *priori* more likely to be credit constrained)

Table A2. Debt Contraints only

(A *priori* constrained sample : Farms <= 40 ESU and => median debt/asset ratio)

Dependent variable $I/K_{i,t}$ T=1988-1992 (1)	France		UK	
	<= 40esu (N=881)	D/A> median (N=736) (2)	<= 40esu (N=254)	D/A< median (N=407) (2)
$(I/K)_{i,t-1}$	0.286 (0.964)	0.020 (0.019)	-0.224 (0.032)	-0.173 (0.086)
$(I/K)^2_{i,t-1}$	-0.436 (0.299)	-0.028 (0.266*10^{-2})	0.261 (0.052)	-0.874*10^{-2} (0.076)
$(Y/K)_{i,t-1}$	-0.012 (0.644*10^{-2})	-0.585*10^{-2} (0.949*10^{-2})	0.028 (0.904*10^{-2})	0.011 (0.011)
$(res/K)_{i,t-1}$	0.018 (0.010)	-0.959*10^{-2} (0.962*10^{-3})	-0.459*10^{-2} (0.575*10^{-2})	0.763*10^{-2} (0.012)
$(borr/K)_{i,t-1}$	-0.719*10^{-2} (0.577*10^{-2})	0.010 (0.166*10^{-2})	-0.232*10^{-2} (0.264*10^{-2})	0.660*10^{-2} (0.399*10^{-2})
dummy88 (3)	—	-0.042 (0.024)	-0.067 (0.028)	-
dummy89	-0.018 (0.023)	-0.025 (0.028)	-0.031 (0.032)	-0.041 (0.023)
dummy90	-0.021 (0.023)	-0.011 (0.025)	-0.013 (0.024)	-0.025 (0.021)
dummy91	-0.378*10^{-2} (0.031)	-0.039 (0.023)	-0.0039 (0.029)	-0.601*10^{-2} (0.021)
m1	-15.27	-1.15	-9.61	-3.85
m2	-0.29	-1.03	-1.58	-1.42
Sargan (degrees of freedom) p value	28.42 (28) 0.442	57.95 (49) 0.179	51.61 (49) 0.372	45.28 (28) 0.021

(1) Instruments used are lagged values of (I/K) , $(I/K)^2$, (Y/K) dated *t-2, t-3, t-4, t-5* (where available).

(2) The instruments dated t-2 are found to be invalid for this specification, hence instruments dated t-3 are used and for the estimation period 1989-1992.

(3) Year dummies (denoted dummy-) were included in the specification

Table A2. Debt Contraints + Transactions Cost on New Borrowing

(A *priori* constrained sample : Farms <= 40 ESU and => median debt/asset ratio)

Dependent variable $I/K_{i,t}$ T=1988-1992 (1)	France*		UK** (0%)		UK*** (10%)	
	>40esu (N=881) (2)	**d/a< median (N=735)**	**<=40esu (N=254)**	**d/a>= median (N=407) (2)**	**<=40esu (N=254)**	**d/a>= median (N=407) (2)**
$(I/K)_{i,t-1}$	2.161 (0.947)	0.066 (0.055)	-0.093 (0.053)	-0.161 (0.211)	-0.036 (0.072)	-0.230 (0.238)
$(I/K)^2_{i,t-1}$	-2.574 (0.917)	-0.039 ($0.690*10^{-2}$)	0.152 (0.110)	0.088 (0.229)	0.160 (0.121)	0.230 (0.316)
$(Y/K)_{i,t-1}$	-0.049 (0.034)	0.021 ($0.589*10^{-2}$)	0.052 (0.088)	$0.164*10^{-2}$ (0.028)	0.040 ($0.827*10^{-2}$)	0.058 (0.033)
$(res/K)_{i,t-1}$	-2.854 (0.997)	-0.025 (0.159)	0.030 ($0.892*10^{-2}$)	0.028 (0.040)	0.611 (0.015)	-0.083 (0.049)
$(borr/K)_{i,t-1}$	3.236 (1.015)	-0.026 (0.149)	0.013 ($0.395*10^{-2}$)	0.013 (0.015)	$0.306*10^{2}$ ($0.353*10^{-2}$)	-0.019 (0.017)
$d_{i,t}(I/K)_{i,t-1}$	0.038 (0.032)	-0.024 ($0.624*10^{-2}$)	-0.062 (0.141)	-0.181 (0.298)	-0.218 (0.109)	0.263 (0.284)
$d_{i,t}(I/K)^2_{i,t-1}$	-0.081 (0.053)	$0.326*10^{-2}$ (0.010)	-0.083 (0.292)	-0.706 (0.512)	0.049 (0.214)	-0.127 (0.426)
$d_{i,t}(Y/K)_{i,t-1}$	-0.043 (0.029)	0.025 ($0.889*10^{-2}$)	$0.693*10^{-2}$ ($0.209*10^{-2}$)	$0.472*10^{-2}$ (0.021)	$0.987*10^{-2}$ ($0.284*10^{-2}$)	-0.042 (0.026)
$d_{it}(res/K)_{i,t-1}$	0.099 (0.055)	$0.471*10^{-2}$ (0.010)	-0.063 (0.017)	$-0.645*10^{-2}$ (0.050)	-0.025 (0.022)	0.118 (0.057)
$d_{it}(borr/K)_{i,t-1}$	0.042 (0.032)	-0.019 ($0.471*10^{-2}$)	-0.014 ($0.275*10^{-2}$)	$-0.775*10^{-2}$ (0.011)	$-0.406*10^{-2}$ ($0.305*10^{-2}$)	0.018 (0.015)
dummy88	—	-0.033 (0.024)	-0.047 (0.024)	-	-0.044 (0.025)	-
dummy89	$-0303*10^{-2}$ (0.024)	-0.020 (0.029)	$-0.927*10^{-2}$ (0.025)	-0.048 (0.027)	-0.149 (0.032)	-0.034 (0.028)
dummy90	$0.275*10^{-2}$ (0.273)	-0.029 (0.026)	-0.024 (0.023)	-0.020 (0.023)	-0.025 (0.024)	$-0.316*10^{-2}$ (0.025)
dummy91	0.045 (0.033)	-0.061 (0.024)	-0.033 (0.027)	$-0.395*10^{-2}$ (0.021)	-0.040 (0.029)	-0.014 (0.025)
m1	10.78	-1.16	-8.91	-2.64	-9.03	-4.77
m2	-2.13	-1.03	-1.27	-0.43	-1.26	-0.68
Sargan (degrees of freedom)	16.13 (26)	43.38 (44)	53.51 (44)	32.27 (23)	50.33 (44)	31.38 (23)
p value	0.933	0.498	0.154	0.095	0.237	0.114

* 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) Instruments used are lagged values of (I/K), $(I/K)^2$, (Y/K) (res/K), $(borr/K)^2$ dated *t-2, t-3, t-4, t-5* (where available).

(2) The instruments dated t-2 are found to be invalid for this specification, hence instruments dated t-3 are used and for the estimation period 1989-1992.

(3) Year dummies (denoted dummy-) were included in the specification