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Abstract

This paper empirically tests whether decoupled subsidies decrease investment financing constraints faced by farms. Using a panel dataset from Ireland over the period 2005-2010, we test whether the CAP decoupled subsidy payments reduce credit constraints by altering the risk profile of farm earnings. We test for financing constraints in a neoclassical Q model using a measure of the financial composition of capital inflows as well as investment-cash flow sensitivities. Our econometric methodology controls for censoring, heterogeneity and endogeneity. We find that decoupled subsidies do reduce credit constraints and the result is robust to model selection and constraint measurement. The effect is greater for farms who face higher constraints: medium-sized farms relative to large farms and middle-age and older farm operators relative to younger farmers. This evidence suggests that, over and above the effect on production indicated in previous research, decoupling affects farm investment through financial channels.

Keywords: Decoupling, Farm investment, Access to finance, GMM, Q model of finance
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1. Introduction

The production inducing effects of decoupled payments have received considerable attention in the agricultural economics literature in both the US and the EU. The extent to which decoupled payments may affect farm production is an important policy question in the context of the World Trade Organisation (WTO). The "green boxing" of decoupled payments, within the WTO discipline, hinges on the criterion that these payments have no, or at most minimal, trade-distorting effects or effects on production. As a result, agricultural policy analysts continue to grapple with the question of what, if any, effect this redistribution will have on production levels.

The various mechanisms through which decoupled payments may affect production decisions are well reviewed in the literature (see for example Goodwin and Mishra (2005, 2006); Femenia et al. (2010); Weber and Key (2012)). Decoupled payments lead to a wealth effect which can, inter alia, induce farmers to take more "risky" production related decisions, facilitate the subsidisation of fixed costs on unprofitable farms and increase non-labour income allowing farmers to work less but maintain consumption. Decoupled payments may also have the effect of stimulating farm investments in the presence of capital market imperfections such as financial constraints on borrowing. Lenders may perceive recipients of decoupled payments as being more credit worthy because the payments increase collateral values for land owners and increase repayment capacity, reducing lenders' exposure to risk of loan defaults (Burfisher and Hopkins, 2003).

While the theoretical impact of decoupled payments on investment and as a consequence production is well understood, relatively few papers have applied empirical models to quantify this relationship. As noted by Sckokai and Moro (2009) the impact of coupled direct payments on farmers' decisions is well researched but the impact of decoupled payments on investment decisions has been neglected. Building on the existing literature (Sckokai and Moro, 2009; Latruffe et al., 2010), our research investigates one particular channel through which decoupling may influence investment behaviour. We empirically test the effect of decoupling on investment financing constraints using a direct measure of financial composition *mix* as well as traditional investment-cash flow sensitivities to identify financing constraints. We use Irish National Farm Survey data from 2005 to 2010 to estimate a fundamental Q model of investment (Gilchrist and Himmelberg, 1995). This method is used in an agricultural context by Benjamin and Phimister (2002), Bierlen and Featherstone (1998) and Chaddad et al. (2005).

We find evidence of credit constraints through a positive relationship between the farms' financial composition *mix* (or dependence on internal finance) and investment. The magnitude of the effect is greater for medium-sized farms and for middle-aged relative to younger farm operators. We also find that younger farmers face lower credit constraints. This is likely due to the fact that financial institutions may believe they have a longer economically active investment horizon with which to generate a return on invested capital and maintain repayment schedules. In this case, they are more willing to extend credit facilities.

To test the effect of decoupling on financing constraints, we use a measure of the degree to which income is protected against risk through receiving a non-production related subsidy. We define risk protection, RP, as the ratio of decoupled subsidies received by the farm relative to total farm income. Interacting RP with measures of financing constraints, we find a negative and statistically significant effect that is robust across different measures of constraints and different models of investment. As income is increasingly earned from risk-free decoupled subsidies, financing constraints are lowered. This effect is strongest for small- and medium-sized farms and for middle- and older-aged farm operators. As these are the categories facing the highest constraints, the risk protection afforded from decoupling results in an above average reduction in constraints for these groups. Our findings, which empirically show the link between decoupling and investment through the financial channel, raise further questions as to the suitable categorisation of decoupled payments as "green box", non-production inducing, subsidies under the WTO framework.

The paper proceeds as follows: Section 2 reviews previous studies of the impact of decoupled payments on farm investment. In section 3 the empirical approach to estimating the model is outlined. The data are explained in section 4, followed by a presentation and discussion of the results in section 5.

2. Decoupling, farm investment and financing constraints

There is a large body of research that focuses on the effects of decoupling on farm outcomes in both the US (Adams et al. (2001); Goodwin and Mishra (2005); Femenia et al. (2010); Weber and Key (2012)) and in a European CAP context. In spite of the broad literature dealing with policy evaluation and decoupling, only a few papers deal directly with its effects on investment behaviour, with Sckokai and Anton (2005), Coyle (2005) and Serra et al. (2009) being some notable exceptions. A number of studies have used simulation based models to evaluate the effect of CAP reforms on investment behaviour (Paloma et al., 2008; Viaggi et al., 2010; Gallerani et al., 2008). A general review of the literature and evaluation of investment under CAP reform is presented in Viaggi et al. (2011).

A number of studies are relevant to our research. Hennessy (1998) explored the interplay between decoupled payments, farmers' risk preferences and production decisions. He concluded that if farmers' aversion to risk declines as income increases, then an increase in wealth as a consequence of the decoupled payment can induce farmers to take riskier production decisions, and thus increase output compared to the situation in which no decoupled payment is made.Sckokai and Moro (2009) use FADN[1] data from Italy to examine the impact of the Single Farm Payment (SFP)[2] on farm investment and output. They use a dynamic model explicitly accounting for farmers' risk preferences and conclude that, although the SFP does affect farm investment, the effect is small relative to the effect of output prices and/or coupled payments. The channel by which SFPs are linked to investment in their paper is through price volatility. Serra et al. (2009) consider the effect of production flexibility contract payments on dynamic investment decisions of farmers in the

[1]The Farm Accountancy Data Network (FADN) is an instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy. The concept of the FADN was launched in 1965, when Council Regulation 79/65 established the legal basis for the organisation of the network. It consists of an annual survey carried out by the Member States of the European Union. See http://ec.europa.eu/agriculture/rica/

[2]The single farm payment is the main decoupled payment in the EU.

US using micro data from the Kansas Farm Management Association. They estimate a dual model of investment under uncertainty taking into consideration irregularities in the capital stock adjustment cost function. Using a threshold regression model, they find that decoupled transfers have a strong effect on investment in a dynamic setting.

While these studies consider the effect of decoupling on investment in agriculture, they do not explicitly explore this relationship through financial channels i.e. faced with frictions in capital markets (a wedge between the internal and external cost of capital), do decoupled payments act to reduce farm financing constraints? The main channel through which decoupled subsidies affect financing constraints is by reducing the risk related to borrower repayment capacity, providing more certainty to financial providers (Vercammen, 2007). The risk-free income stream from decoupled payments is taken into account by financial institutions when evaluating credit applications. This facilitates easier access to credit for farmers whose income is earned through market sources and is subject to both market and business operational risk.[3] Additionally, in the European Union under the CAP scheme, single farm payments (SFP) are linked to acreage. As such, the payments feed into land valuations providing farmers with additional collateral to support borrowing capacity (Vercammen, 2007).

There may also be a direct effect (Latruffe et al., 2010) whereby decoupled subsidies add to the internal pool of finance available to the farmer and reduce the requirement to seek external finance. Taking these points in totality suggests that decoupled subsidies should decrease financing constraints and ease access to external finance for farm operators.

Two specific papers, already noted, are of direct relevance to our research and require further attention. Vercammen (2007) develops a theoretical framework which links decoupled payments to farm investment through the risk of bankruptcy. The model predicts that direct payments reduce the risk of bankruptcy therefore reducing the cost of capital for investing farms. This stimulates higher and more aggressive investment behaviour. He

[3]The reduction in operational risk suggests that constraints should be even lower than for farms whose income is based on coupled subsidies due to the removal of the requirement to undertake production.

finds that the effect varies with the degree of equity in the farm operation and the time horizon of the investment decision. In providing a theoretical link between decoupling and investment, Vercammen (2007) leaves scope for more empirical studies to identify if these mechanisms are quantitatively verifiable. Latruffe et al. (2010) evaluate the effect of CAP payments on farm financing constraints. They consider the impact of single area payments on farm expansion strategy in Lithuania and find evidence of a positive income multiplier effect on credit constrained farmers leading to additional expansion over and above a baseline scenario.

In this paper, we extend the current literature and provide new empirical evidence of the link between decoupled payments and financing constraints in two key ways. First, Latruffe et al. (2010) measure financing constraints using the sensitivity of investment to cash flow. This method has been used extensively in the literature but has been widely criticized (Kaplan and Zingales, 1997, 2000). More direct measures using enterprise-level information on debt or financial composition have been suggested as more appropriate in identifying financially constrained firms and in estimating the effect of different sources of capital on investment (Guariglia and Mateut, 2010; Kashyap et al., 1993; Bougheas et al., 2006; Huang, 2003). By considering not just cash flow, but inflows of debt finance on our model, we provide a better approximation of the farms choice between internal and external finance. Second, the econometric methodology used by Latruffe et al. (2010) does not directly address potential endogeneity between cash flow, sales growth and investment in the accelerator model. This potentially induces bias in the estimates and is addressed in this paper.

3. Empirical investment model

3.1. Estimating investment and financing constraints

To estimate investment equations at the farm level, there are a number of methodologies that have been widely used in the literature (see Petrick (2005) for a review). The four main models are the investment Euler equation, the neoclassical Q model of finance, the error-correction framework and the simple accelerator approach.[4] The poor performance of the Euler equation in empirical applications is well documented (Whited, 1998). One of the main reasons these problems arise is the requirement to select a specific functional form for the capital adjustment cost function and the requirement for a smooth transition of the capital stock to its long-term level. In an agricultural context, where farming systems have different requirements for capital and technology, applying a structural Euler equation to a mixed-system sample makes it very difficult to identify the structural parameters. This is also the case (arguably to a lesser extent) for the error-correction model which assumes a linear adjustment to long run capital stock relative to sales growth. As the Q model does not explicitly require the estimation of these behavioural elements, we use it as our benchmark approach.

Despite its theoretical simplicity and intuitiveness, it is an empirical challenge to estimate the Q model. This arises due to the requirement to take an empirical estimate for average Q to proxy for the underlying marginal Q statistic.[5] This can lead to measurement error issues and has been documented as the main contributing factor to the poor performance of the Q statistic in empirical studies (Erickson and Whited, 2000, 2006). In micro-data studies, this is also complicated by the fact that the most documented proxy for Q is the ratio of the market value of the firm to its book value. This requires data on the stock and bond market valuations of the firm which are unavailable for non-listed firms and farm enterprises. To overcome this difficulty, many studies (most notably Benjamin and Phimister (2002), Bierlen and Featherstone (1998) and Chaddad et al. (2005)) have used an approach outlined by Gilchrist and Himmelberg (1995) to estimate Q. Using a panel vector autoregression (VAR) approach, Gilchrist and Himmelberg (1995) create an estimate of the average profitability of an additional unit of investment to the firm using the coefficients estimated from a VAR. The VAR system is outlined as follows:

[4]For an empirical comparison of these approaches see Bond et al. (2003).

[5]See Hayashi (1982) for a detailed outline of the conditions under which average Q is a valid proxy for marginal Q.

$$\mathbf{X_{it}} = \mathbf{A}\mathbf{X_{it-1}} + \phi_\mathbf{i} + \lambda_\mathbf{t} + \epsilon_\mathbf{it} \quad (1)$$

$$Q_{it} = (\mathbf{c}'[\mathbf{I} - \lambda\mathbf{A}])\,\mathbf{X_{it}} \quad (2)$$

where $\mathbf{X_{it}}$ is a vector of variables including the cash flow to capital ratio and an estimate of the marginal product of capital (mvpk).[6] The VAR is estimated and the coefficients are used in conjunction with the identity in equation 2 to obtain an estimate of Q, given the data vector $\mathbf{X_{it}}$.[7] This estimate can then be included in a reduced form empirical investment equation:

$$\frac{I_{it}}{K_{it-1}} = \alpha + \theta_Q Q_{it} + \phi_i + \lambda_t + \epsilon_{it} \quad (3)$$

In existing research, testing for financial considerations within the context of the neo-classical Q model is undertaken by appending a measure of internal funds (usually cash flow) to the empirical Q equation (Erickson and Whited, 2000; Benjamin and Phimister, 2002; Bierlen and Featherstone, 1998; Chaddad et al., 2005). However, investment-cash flow sensitivities have been criticized for not accurately identifying credit constrained firms as some enterprises may fund investment using internal resources as a matter of business strategy. In this paper, we use a direct measure of internal finance dependence to capture financing constraints. This measure builds on the work of Kashyap et al. (1993), Guariglia and Mateut (2010) and Bougheas et al. (2006) which exploits the imperfect substitutability of differing sources of capital by defining a financial composition *mix* for the firm. It is defined as follows:

[6]We follow Benjamin and Phimister (2002) and Bierlen and Featherstone (1998) by using the profit to capital ratio to proxy the mvpk. This assumption is valid under a constant returns to scale production function and perfect competition in output markets. See Galindo et al. (2007) for a comparison of valid estimates of mvpk.

[7]For a more detailed outline of this approach see Gilchrist and Himmelberg (1995).

$$IF_{it} = \frac{Cash\ flow_{it}}{Cash\ flow_{it} + Debt\ inflows_{it}} \tag{4}$$

IF_{it} captures the degree to which a premium exists on external finance. If capital markets are perfect and farms do not face a wedge between the internal and external cost of finance, then this measure will have no effect on investment levels. If capital market imperfections exist and internal finance has a lower cost of capital than external finance, then this measure will be positively related to investment as constrained farms are more reliant on internal funds for investment. By directly incorporating external debt inflows, this measure better approximates the cost of capital differential of the alternative funding sources than a simple cash flow-investment sensitivity. As a robustness check, we also estimate the model replacing IF_{it} with cash flow. The empirical model to test for financing constraints is as follows:

$$\frac{I_{it}}{K_{it-1}} = \alpha + \theta_Q Q_{it} + \theta_{CC} CC_{it-1} + \phi_i + \lambda_t + \epsilon_{it} \tag{5}$$

where CC_{it-1} (Credit Constraint) is either the measure of internal financial dependence, IF_{it-1} or the cash flow to capital ratio, $\left(\frac{CF}{K}\right)_{it-1}$. Both of these variables are measured at period t-1 values to avoid potential reverse causation with investment levels, $\left(\frac{I}{K}\right)_{it}$. If financing constraints exist, we expect $\theta_{IF} > 0$ for IF_{it-1} and $\theta_{CF} > 0$ for $\left(\frac{CF}{K}\right)_{it-1}$. An insignificant coefficient suggests that there are no financing constraints. We also including a control for debt overhang in the empirical investment equation as suggested in Hennessy (2004). If the stock of outstanding debt is high, this may affect access to finance for farms in two ways. First, a higher level of debt heightens the bankruptcy risk for the financial institution and limits their willingness to extend new credit regardless of whether or not profitable investment opportunities are available to the farm. This scenario must be distinguished from a financing constraint which is only binding in the case where a farm has positive net present value investment opportunities and is not able to access finance to exploit these. Second, heavily indebted farms may have previously undertaken heavy investment and therefore have lower current investment. It is important to control for these influences and the inclusion of debt overhang is in line with Hennessy et al. (2007) and Hennessy (2004).

In addition to the benchmark Q model, we also use a simple accelerator model as a robustness check. The accelerator model, in distributed lag format, of order J (DL(J)) is given by:

$$I_{it} = \delta K_{it-1} + \sum_{j=0}^{J} \beta_j \Delta Y_{it-j} + \sum_{j=0}^{J} \alpha_j \Delta r_{it-j} + \epsilon_{it} \tag{6}$$

We denote output as Y_{it}, with the user cost of capital denoted as r_{it}. ϵ_{it} is a iid error term. In our empirical model, we specify a simple order 1 distributed lag accelerator model (DL(1)):

$$\left(\frac{I}{K}\right)_{it} = \alpha + \sum_{j=0}^{1} \beta_j \left(\frac{\Delta Y}{K}\right)_{it-j} + c_i + \eta_t + \epsilon_{it} \tag{7}$$

This model links the growth rate of capital stock to the growth rate in output assuming that farms maintain capital labour ratios. It is a simple comparator model as it indicates that farms should increase investment in line with output growth. More details on this model can be found in Chirinko (1993).

3.2. Decoupling and financing constraints

To empirically test the effect of decoupled payments on investment financing constraints requires an indicator that captures the degree to which farmers are sheltered from market and business operational risk due to the payment of risk-free decoupled subsidies. Drawing on the work of Kazukauskas et al. (2012), we measure the risk protection provided from decoupling as the ratio of total decoupled single farm payments (SFP) to net farm income:

$$RP_{it} = \frac{SFP_{it}}{Income_{it}} \tag{8}$$

Our measure includes net income in the denominator, as opposed to gross output, as we want to capture the effects of operational business costs on revenue risk. Net income, by including farm costs, measures the return to the farm on an annual basis, taking into consideration the risks relating output prices and production costs. The higher this ratio, the lower the overall risk as the greater the share of income that is risk free.

To estimate the effect of decoupling on financing constraints through this risk mitigation channel, we interact RP_{it} with the indicators of financing constraints:

$$\begin{aligned} \frac{I_{it}}{K_{it-1}} &= \alpha + \theta_Q Q_{it} + \theta_{CC} CC_{it-1} + \theta_{RP} RP_{it-1} + \theta_{CCRP} \left(CC_{it-1} \cdot RP_{it-1}\right) \\ &+ \phi_i + \lambda_t + \epsilon_{it} \end{aligned} \tag{9}$$

If financing constraints are reduced by decoupled subsidies, as the literature suggests, we would expect, *a priori*, to find a statistically significant coefficient with $\theta_{CCRP} < 0$. If a statistically significant association is evident, this would provide further support to the argument that decoupled payments do have a production inducing effect through easing access to investment credit.

In the accelerator model, the Q statistic is replaced by the accelerator term.

4. Econometric approach and data

4.1. Econometric approach

A number of specific econometric considerations arise in estimating investment equations. These are censoring, endogeneity and heterogeneity. Censoring occurs due to the lumpy nature of investment activity by farms. This leads to repeated zero observations for the dependent investment variable and a clustering of its distribution at zero. Our investment variable is censored from below in the standard manner:

$$y = \begin{cases} y^* & \text{if } y > 0 \\ 0 & \text{if } y \leq 0 \end{cases} \tag{10}$$

With $y^* = \mathbf{X}\beta + \epsilon$. To solve the issue of censoring in the dependent variable, following O'Toole et al. (2011) and Jones and Labeaga (2003), we estimate a tobit model of investment as a function of farm fundamentals and system average fundamentals for each annual cross section of the data. This deals with the issue of the clustered data distribution at zero. The fitted values for the censored data from these estimates are then used as the dependent variable for the main regression equations. These fitted values are non-censored as they have been predicted from the tobit model. This allows us to apply standard estimation techniques to these data.

The second part of our econometric methodology treats the potential endogeneity between Q and investment. This arises as Q is estimated using within period data on firm fundamentals (cash flow and the marginal value product of capital proxy) from the VAR given in equations (1) and (2). For example, if a firm invests and that investment begins to produce profits and cash flow within the year, this will affect the value of Q. In this case, we require the use of instrumental variables so as to ensure the causality is running from Q to investment. Additionally, as we are using a proxy for the underlying theoretical marginal Q, measurement error in Q will bias the parameter estimates. Both issues can be resolved using an instrumental variables method.

The final issue that arises is individual heterogeneity that is potentially correlated with the lagged levels of the independent variables. To treat this issue, we take first differences of the data. We therefore use difference GMM (Arellano and Bond, 1991; Arellano and Bover, 1995) with internal instruments to deal with endogeneity. The exogeneity condition that needs to be satisfied for appropriate instruments is as follows:

$$E(\triangle u_{it} x_{i,t-s}) = 0 \forall s > 1 \tag{11}$$

In sum, our approach controls for censoring, heterogeneity and endogeneity. Standard errors are also robust to heteroscedasticity, clustered at the farm level.

4.2. Data

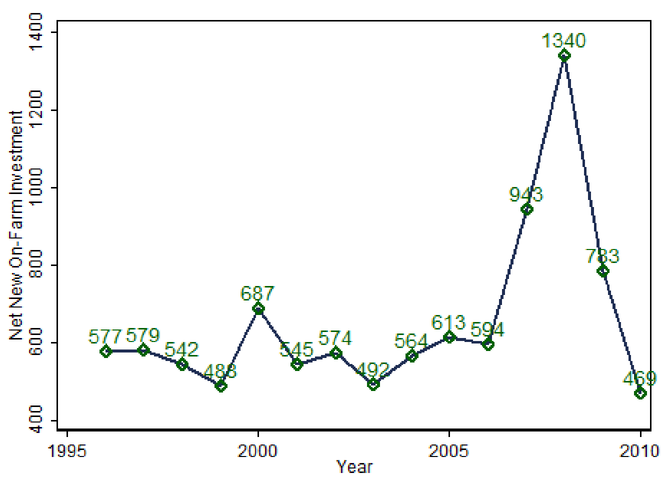
The data used in this paper are taken from the Irish National Farm Survey (NFS) which is compiled annually by Teagasc.[8] The NFS is a representative sample of farms in

[8]See Annual National Farm Survey, Teagasc by Connolly, L., Kinsella, A., Quinlan, G. and Moran, B.

the Republic of Ireland covering all of the main farming systems including dairy, beef, sheep and cash crops. The survey contains detailed information on both the demographic characteristics of the farm households as well as the financial position and investment activity of the farm business. Our main investment variable is net new on-farm investment[9] as a percentage of the beginning period capital stock. It relates to the purchases of machinery, buildings and investments in land improvements. We limit our sample to the period 2005 - 2010 as this is the period since farm direct subsidy payments have been decoupled from production under the CAP in Ireland.[10]

Figure 1: Net New On Farm Investment in Ireland

Figure 1.A



Source: Author's calculations using Teagasc National Farm Survey.

The trend in net new investment in Irish farms is presented in figure 1. Trend invest-

[9]This is defined as "all capital expenditure during the year, less sales of capital and grants received" (Connolly et al, 2008, p.20)

[10]We choose to use only the period post decoupling as our interest is in considering how the between farm distribution of risk protection from decoupled subsidies impacted financing constraints. An alternative would have been to use a structural break pre and post the introduction of decoupling, but we believed that this would not give enough between farm variation and the identification could have been clouded by other sector wide influences such as the macroeconomic environment.

ment remained reasonably consistent until the period 2007-2008 in which a considerable investment spike is seen. This peak was driven by the availability of government investment grant supports for the capital expenditures both as part of a productivity enhancing investment scheme (Farm Improvement Scheme) as well as state supports for capital investment to comply with various EU environment directives (Farm Waste Management Scheme and Dairy Hygiene Scheme). The increase in this period highlights the role of government policy in providing capital supports.[11]

Table 1 provides summary statistics for the key variables included in the model. All variables are treated for outliers by removing data that lies outside three standard deviations from the mean (within 99 percent of the distribution). This is a standard treatment in the literature (Chaddad et al., 2005). In addition, the requirement to use lagged variables to instrument Q reduces the sample size. Our final sample consists of circa 3,350 observations depending on the variables included.[12] In general the average investment level is approximately 16 percent of the capital stock. The capital stock variable itself measures the value of buildings and machinery held by the farm at the beginning of the period and, like investment, is not influenced by land purchases or valuations. Debt to capital is approximately 23 percent while cash flow to capital stock is high at 88 percent.[13] The measure of financial composition, *IF*, is 93 percent on average. This indicates funds generated on the farm are the main source of annual capital inflows for farmers.

The mean value of *RP*, the measure of the degree of risk protection of income due to decoupled subsidies, is 0.73. The Irish government applied a full decoupling strategy

[11]We have included a number of controls for this in our analysis, most importantly excluding grant subsidies from the investment variable as well as including controls for the level of grants received. Much of this deviation will also be captured in the sector dummies and year dummies.

[12]While a number of farms are dropped due to attrition, we have tested the means of the key variables in our sample relative to the full sample and there is no statistically significant difference between these. The results of the t-test are available on request from the authors.

[13]This reflects that fact that the valuation of capital stock does not include the value of livestock or land which would lower these ratios considerably.

Table 1: Summary statistics

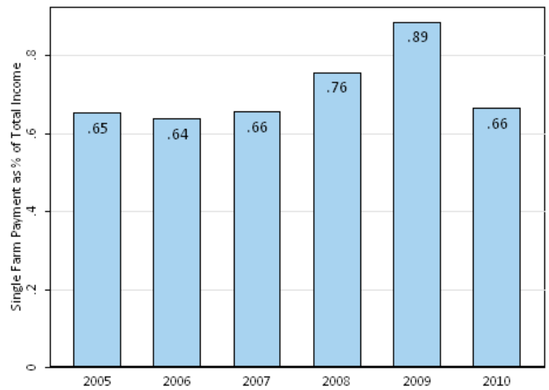
Variable	Observations	Mean	St. Dev	Min	Max
$\frac{I}{K}$	3,347	.16	.31	0	2.54
$\frac{S}{K}$	3,382	1.72	1.87	.07	22.43
$\frac{P}{K}$	3,386	.57	.80	-5.25	8.57
$\frac{DO}{K}$	3,384	.23	.43	0	3.64
$\frac{CF}{K}$	3,386	.96	1.31	-2.10	16.98
IF	3,289	.93	.14	.35	1
RP	3,375	.73	3.36	-63.59	62.26
Age	3,387	54.13	11.75	21	86
Size	3,387	54.06	41.34	6.1	417.4

Source: Teagasc National Farm Survey.

from 2005 for all payments therefore we do not need to be concerned about the gradual introduction of the policy on farm behaviour. The value of RP varies considerably by system and year. Figures 2 A and B plot the evolution of RP by year and by system year. Values fluctuate around the 65 - 66 percent level but increase markedly in 2009. This is due to the significant fall in agricultural commodities prices that occurred internationally in 2009.

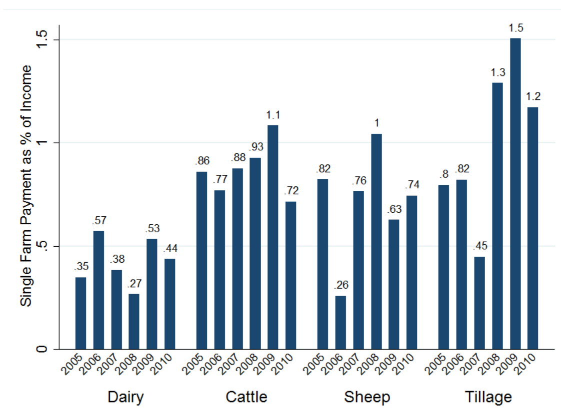
Figure 2: Decoupled payments as protection against business risk

Figure 2.A: RP



Breakdown by farm system

Figure 2.B: RP



Source: Author's calculations using Teagasc National Farm Survey.

The breakdown of the data in the sample by farm system is given in table 2. Approximately 42 percent of the observations relate to farms in the dairy sector, 42 percent are in beef rearing or other beef farming activities, 10 percent are in the sheep sector with the remaining 6 percent in the cash crops sector.

5. Empirical results

This section presents our main empirical findings. The first step, obtaining Q, estimates the VAR using a generalized method of moments approach (Holtz-Eakin et al., 1988). In

Table 2: Data by farm system

System	Freq.	Percent	Cum.
Dairy	1,423	42.01	42.01
Beef	1,426	42.10	84.12
Sheep	340	10.04	94.15
cash crops	198	5.85	100.00
Total	3,387	100.00	

Source: NFS

the subsequent reduced form regressions, the instruments for Q are lags of the elements of the fundamental VAR dated t-2, t-3 and t-4 as well as higher order terms of the lags. The estimate of Q is then included in the main investment equation. For the accelerator model, the change in output in t-3 and t-4 are also used as instruments. Sensitivities have been conducted using additional lags and dropping the second lag. Our main results remain unchanged in these scenarios and so these results are not presented.[14] Hansens J test of overidentifying restrictions is used to test instrument validity. The p-values for this test are presented in each of the following tables. All regressions include year dummies, to pick up any impacts of the general business or macroeconomic climate on the farm investment decision, system dummies, to control for any system specific heterogeneity and controls for the age of the farmer and the size of the farm. Including year dummies, system dummies and removing firm level heterogeneity should ensure that the user specific cost of capital is controlled for in the investment regressions. The level of investment grants received is also included. Standard errors are robust to heteroscedasticity and are clustered at the farm level.

[14] These results are available on request from the authors.

5.1. Testing for financing constraints

We first test for the effect of financial considerations on investment using both the Q and accelerator models and both measures of financing constraints, *IF* and cash flow. The results of the GMM regressions are presented in table 3. The second order term in the accelerator model is not statistically significant so it has been removed from these estimations. Columns 1 and 2 test only the main terms in the Q and accelerator models. Columns 3 and 4 introduce the debt overhang correction term as well as *IF* to measure financing constraints. Columns 5 and 6 replace *IF* with cash flow.

Q and $\frac{\Delta Y}{K}$ are positive and significant in all regressions. In the case of Q, this indicates that farmers' investment behaviour is guided by the underlying fundamentals of the farm operation. In the accelerator model, the positive and significant association shows that as farm output grows, capital stock is increased in line with this. These results are robust to the inclusion of both the debt overhang and financing constraints variables in columns 3-6.

Turning to the financial variables, the control for debt overhang is negative and significant in all cases. This is in line with the a priori expectations that farms who are carrying high levels of debt invest less due to a) less available collateral and a reluctance of lenders to extend further credit to heavily indebted borrowers and b) heavily indebted farms may have invested previously and do not require large investments in the current period.

Our main variables of interest are the measures of financing constraints. *IF* is positive and significant at the 1 percent level in both the Q and accelerator models. This indicates that farms with a higher share of new financial flows coming from internal resources invest more than farms without. As internal and external finance are imperfect substitutes if capital market imperfections exist, this suggests that financing constraints are evident in the sample and farms are reliant on internal funds to invest. In a world of perfect capital markets, this variable would be insignificant. Column 5 and 6 replaces *IF* with cash flow and tests the sensitivity of investment to direct changes in cash flow. We find cash flow to be positively and significantly related to investment in both the Q and the accelerator models which supports our findings.

To test the main hypothesis of this paper, we interact the indicators of financing con-

Table 3: Financing constraints and investment

	Q	Accelerator	Q	Accelerator	Q	Accelerator
	(Column 1)	(Column 2)	(Column 3)	(Column 4)	(Column 5)	(Column 6)
$\mathbf{Q}_t$	0.247**		0.196*		0.235**	
	(0.100)		(0.104)		(0.101)	
$\frac{\Delta Y}{K}_t$		0.077***		0.061***		0.050**
		(0.027)		(0.023)		(0.025)
$\left(\frac{DO}{K}\right)_{t-1}$			-0.176***	-0.138***	-0.103***	-0.110***
			(0.042)	(0.038)	(0.035)	(0.035)
IF_{t-1}			0.451***	0.432***		
			(0.047)	(0.045)		
$\left(\frac{CF}{K}\right)_{t-1}$					0.025***	0.039***
					(0.010)	(0.013)
Hansens J (p-value)	0.37	0.47	0.39	0.76	0.14	0.13
Year and system controls	Yes	Yes	Yes	Yes	Yes	Yes
Age, size and subsidy controls	Yes	Yes	Yes	Yes	Yes	Yes
n	3,291	3,291	3,157	3,157	3,291	3,291

Notes: (1) Cells show coefficients and standard errors.

(2) * p<0.1, ** p<0.05, *** p<0.01.

(3) All models estimated by GMM, clustered at firm level.

(4) Instruments selected from sales to capital, mvpk, cash flow to capital and squared terms dated t-2, t-3, t-4.

straints with our measure of the risk protection provided from decoupled payments, RP. The results are presented in table 4. In columns 1, 2, 5 and 6, RP is included in the regressions with the financial constraints to test if a level effect is present. There is no evidence of this as the variable is insignificant in all cases. In columns 3, 4, 7 and 8, RP is interacted with IF and cash flow. Both the interaction between RP and IF and cash flow are negative and significant at the 5 percent level in the Q and accelerator models. Financing constraints decrease as the share of single farm payments in total farm income increases. In other words, as incomes become increasingly free of market and operational risk, the ability of farms to access external finance improves and they are less reliant on internal financial resources. These results clearly indicate that decoupled subsidies do potentially have an impact on production by facilitating access to investment finance. Our findings also support the theoretical interactions between financial markets and decoupled subsidies presented in Vercammen (2007).

Table 4: Decoupled subsidies, financing constraints and investment

	Q	Accelerator	Q	Accelerator	Q	Accelerator	Q	Accelerator
	(Column 1)	(Column 2)	(Column 3)	(Column 4)	(Column 5)	(Column 6)	(Column 7)	(Column 8)
$\mathbf{Q}_t$	0.209**		0.219**		0.235**		0.189*	
	(0.106)		(0.104)		(0.101)		(0.111)	
$\frac{\Delta Y}{K}_t$		0.060**		0.059**		0.042*		0.042*
		(0.027)		(0.024)		(0.025)		(0.023)
$\left(\frac{DO}{K}\right)_{t-1}$	-0.172***	-0.162***	-0.177***	-0.171***	-0.103***	-0.114***	-0.109***	-0.111***
	(0.042)	(0.044)	(0.044)	(0.046)	(0.035)	(0.035)	(0.036)	(0.036)
IF_{t-1}	0.451***	0.458***	0.500***	0.513***				
	(0.047)	(0.047)	(0.055)	(0.054)				
RP_{t-1}	0.000	0.000	0.054	0.060*	0.000	0.000	0.003	0.003
	(0.002)	(0.001)	(0.037)	(0.036)	(0.002)	(0.002)	(0.003)	(0.003)
$\left(\frac{CF}{K}\right)_{t-1}$					0.025***	0.027*	0.044**	0.054***
					(0.010)	(0.014)	(0.020)	(0.021)
$IF_{t-1} \cdot RP_{t-1}$			-0.081**	-0.085**				
			(0.041)	(0.040)				
$\left(\frac{CF}{K}\right)_{t-1} \cdot RP_{t-1}$							-0.040**	-0.042**
							(0.017)	(0.016)
Hansens J (p-value)	0.38	0.42	0.37	0.35	0.13	0.26	0.15	0.18
Year and system controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age, size and subsidy controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n	3,147	3,147	3,023	3,023	3,280	3,280	3,204	3,204

Notes: (1) Cells show coefficients and standard errors.
(2) * p<0.1, ** p<0.05, *** p<0.01.
(3) All models estimated by GMM, clustered at firm level.
(4) Instruments selected from sales to capital, mvpk, cash flow to capital and squared terms dated t-2, t-3, t-4.

5.2. Results by age and size

There is considerable evidence that farm investment and financing constraints differ by operator age and farm size (Bierlen and Featherstone, 1998; Benjamin and Phimister, 2002; Petrick, 2004, 2005). Larger farms, with potentially higher levels of income and collateral are expected to be less financially constrained relative to small- and medium-sized farms. On the direction of the effects for age, there is some ambiguity. It could be argued that older farmers may find it less difficult to obtain finance due to well established relationships with financial providers, however, younger farmers have a longer investment horizon with which to realize a return on investment making banks or other potential investors more likely to lend.

To get an understanding of whether the system average effect of decoupled subsidies on financing constraints identified above differs across the distribution of farms, we explore the relationship by farm operator age, farm size and farm system. For brevity and given that both measures provide similar results, we only report the estimates using the *IF* measure of financial constraints. To test for operator age effects, we define three categories of farm operator, young (less than or equal to 40 years of age), middle aged (between 40 and 65) and old (greater than 65 years of age). We then interact binary indicators for these categories with financing constraints and the decoupling variable. The breakdown of observations across these categories is presented in table 5. The majority of observations are the the middle-age category, 68 percent with 13 percent in the young category and nearly 20 percent in the old-age bracket. Table 6 presents the estimates of the main model where the omitted category is young farmers.

Table 5: Data by age category

System	Freq.	Percent	Cum.
Young	405	12.76	12.76
Middle Age	2,148	67.65	80.41
Old	622	19.59	100.00
Total	3,175	100.00	

Source: NFS

IF is positive and significant at the 1 percent level in all regressions suggesting that the effect of constraints on investment is evident regardless of operator age. However, the interactions between middle age and old with *IF* are also positive and significant. The magnitude of the coefficient is larger for older farmers than for middle-aged farmers. These results indicate that middle-aged and old farmers face higher credit constraints than young farmers, with old farmers in particular facing considerably higher constraints. Intuitively, this finding can be reconciled if financial institutions take into account the investment appraisal period available to younger farmers. Banks may be more willing to lend to young farmers as they know that the young farmer has a longer period in which to productively use new capital and ensure repayment to the financial institution.

On the effect of decoupling on financing constraints across the age brackets, a number of interesting results are evident. In columns 3 and 4, we interact *IF*, *RP* and the age categories. For the sample as a whole, the main finding we identify in table 4 holds: decoupling reduces financing constraints. However, the interactions between *IF*, *RP* and indicators for middle and old operator age are negative and significant. Again the magnitude of the effect is greatest for older farmers. This suggests that, while middle aged and older farmers are more constrained relative to young farmers, as the share of risk protection that comes from decoupled subsidies increases, access to finance is improved for these age cohorts. As business risk is eliminated for older farm operators through the decoupling of payments, banks are more likely to extend credit.

Table 6: Decoupling and financing constraints by operator age

	Q	Accelerator	Q	Accelerator
	Column 1	Column 2	Column 3	Column 4
$\mathbf{Q}_t$	0.192*		0.211**	
	(0.105)		(0.105)	
$\frac{\Delta Y}{K}_t$		0.064**		0.055**
		(0.028)		(0.026)
$\left(\frac{DO}{K}\right)_{t-1}$	-0.159***	-0.157***	-0.158***	-0.164***
	(0.046)	(0.048)	(0.048)	(0.049)
IF_{t-1}	0.493***	0.513***	0.555***	0.584***
	(0.054)	(0.053)	(0.062)	(0.062)
Age (Middle)	-0.037**	-0.038**	-0.037**	-0.036**
	(0.017)	(0.017)	(0.017)	(0.017)
Age (Old)	-0.029	-0.031	-0.021	-0.021
	(0.020)	(0.020)	(0.020)	(0.020)
Age (Middle) $\cdot IF_{t-1}$	0.118***	0.128***	0.149***	0.158***
	(0.045)	(0.046)	(0.049)	(0.049)
Age (Old) $\cdot IF_{t-1}$	0.113	0.140	0.228**	0.245**
	(0.118)	(0.113)	(0.111)	(0.108)
RP_{t-1}			0.084**	0.095**
			(0.040)	(0.039)
Age (Middle) $\cdot RP_{t-1}$			0.008	0.009*
			(0.006)	(0.006)
Age (Old) $\cdot RP_{t-1}$			-0.006	-0.004
			(0.017)	(0.016)
$IF_{t-1} \cdot RP_{t-1}$			-0.109**	-0.120***
			(0.044)	(0.043)
Age (Middle) $\cdot IF_{t-1} \cdot RP_{t-1}$			-0.114**	-0.116**
			(0.056)	(0.056)
Age (Old) $\cdot IF_{t-1} \cdot RP_{t-1}$			-0.508***	-0.506***
			(0.164)	(0.158)
Hansens J (p-value)	0.39	0.37	0.43	0.35
Year and system controls	Yes	Yes	Yes	Yes
Age, size and subsidy controls	Yes	Yes	Yes	Yes
n	3,109	3,109	2,988	2,988

Notes: (1) Cells show coefficients and standard errors.
(2) * p<0.1, ** p<0.05, *** p<0.01.
(3) All models estimated by GMM, clustered at firm level.
(4) Instruments selected from sales to capital, mvpk,
cash flow to capital and squared terms dated t-2, t-3, t-4.

In addition to age, we also explore whether the relationship between decoupling and access to credit differs across farms of varying size. We identify three size categories; small (farm size of less than 32 hectares)[15], medium (farm size is between 32 and 64 hectares) and large (farm size is greater than 64 hectares). As is the case with age, we interact binary variables for these categories with each of *IF*, *RP* and their interaction. The breakdown of the number of observations between these categories is given in table 7. Just over 44 percent of the observations are in the medium-size category with 28 and 27 percent respectively in the small and large categories.

Table 7: Data by farm size

Size	Freq.	Percent	Cum.
Small	900	28.43	28.43
Medium	1,400	44.22	72.65
Large	866	27.35	100.00
Total	3,166	100.00	

Source: NFS

The results of the interactions between size, decoupling and financing constraints are presented in table 8. Columns 1 and 2 test whether investment is more sensitive to financial access across farm size while columns 3 and 4 introduce the interactions with *RP* to test the effect of decoupling. As is the case with our general findings, the coefficient on IF is positive and significant, as are the fundamentals in the Q and accelerator models. Debt overhang is negative and significant as expected.

In this analysis, the omitted base case for the categories of size is large farms so comparisons are made relative to this group. The interaction between *IF* and small is insignificant while the interaction between *IF* and medium is positive and significant. As compared to

[15] The average size of Irish farms was 32 hectares according to the CSO Census of Agriculture 2010. As our mean size is slightly larger (50 hectares), the brackets have been set to capture the fact that less than 32 hectares is a small farm in our sample.

large farms, medium-sized farms face higher financing constraints. As the size of the farm increases, the available collateral increases due to the large land holdings, in this case, banks are more willing to lend to larger farms. One explanation why small farms do not have higher constraints relative to large farms may relate to the availability of positive NPV investment opportunities. Smaller farms may have fewer profitable investment opportunities and so may not face binding credit constraints in accessing finance to invest. Medium farms may have identified profitable investment opportunities but due to capital market imperfections cannot get access to the full credit required and are more dependent on internal resources relative to large farms.

Turning to the interactions between IF and RP, we find the overall level effect is negative and significant as observed in our main analysis. The interactions between both size categories, IF and RP, are also negative and significant with the magnitude of the effect larger for medium-sized farms. This suggest that while decoupled payments reduce credit constraints for all farms, the effect is greater for small- and medium-sized farms. This finding is intuitive as smaller farms are potentially more risky from a lender's perspective due to a lack of collateral and less revenue generation potential. As farm income becomes increasingly risk free, they face a greater reduction in financing constraints relative to large farms.

5.3. Results by farm system

Enterprises across different farming systems have very different requirements for capital and technology and thus have very different investment strategies and capital acquisition programmes. In this section, we test how the effects of financing constraints, decoupling and their interaction differ across the main systems in Ireland. We focus on four farm systems: dairy, beef, sheep and cash crops. The spread of observations across these systems is presented in table 2 in section 4.2.

As beef and sheep farmers in Ireland are the most challenged systems in terms of ongoing profitability, we use these as a our omitted benchmark category and compare them with the well performing dairy sector and the cash crops farmers. We interact indicator variables for the dairy and cash crops sectors with IF and RP to test whether these sectors face different constraints and reactions to decoupled subsidies through the financing constraints channel. Farms across different systems in Ireland face some differences in financing constraints. The interactions between IF and dairy are insignificant but the is some evidence that cash crops farmers face lower financing constraints relative to those in sheep and beef. cash crops and IF is significant and negative at the 10 percent level in one model.

The interactions between RP, IF and dairy is insignificant. The interaction with cash crops is positive and significant. This suggests that while for farms on average there is a reduction in credit constraints due to risk free decoupled subsidies, cash crops farms do not benefit as much from this dynamic.

6. Conclusions and policy implications

This paper considers the effects of decoupled subsidies on investment through the credit access channel. Decoupled payments were introduced in the US in 1996, in the form of Flexibility Contracts (PFCs) and in the EU in 2005. Decoupled payment programmes are also in operation in Mexico and Japan. As decoupled subsidies free farms from undertaking production activities, they reduce the risk profile of income streams and reduce farm bankruptcy risk (Vercammen, 2007). If the overall income risk falls due to decoupling, financing institutions may be more willing to lend to farms thus decreasing financing constraints. Using a neoclassical Q model of finance, we test empirically whether this effect exists on a panel of farms in Ireland. Our econometric approach uses a combined GMM and tobit method controlling for censoring, heterogeneity and endogeneity in panel data. While considerable research has to date focused on investment and decoupling (Sckokai and Moro, 2009; Serra et al., 2009; Viaggi et al., 2011, 2010, 2011), fewer studies test the link between decoupled subsidies in the EU and farm investment financing constraints.[16]

We test for financing constraints using a measure of the financial composition *mix* of new capital inflows similar to Kashyap et al. (1993) as well as using investment-cash flow sensitivities. Our benchmark Q results are backed up using a simple neoclassical accelerator model. We find evidence of potential investment credit constraints. This relationship is stronger for medium-sized farms relative to large farms and for middle-aged relative to younger farmers.

To test the effect of decoupling on financing constraints, we develop a risk protection measure, RP, which is the ratio of decoupled subsidies received by the farm relative to total farm income. This captures the degree to which income is risk free for the farm. Interacting RP with the measures of financing constraints, we find a negative and statistically significant effect that is robust across both measures of constraints and both investment models. This suggests that as income is increasingly earned from risk free decoupled sub-

[16] The obvious exception is Latruffe et al. (2010).

sidies, credit constraints faced by farmers are reduced. This effect is strongest for small- and medium-sized farms and for middle- and older-aged farm operators. Our findings show that decoupling does impact investment through the financing channel.

The introduction of subsidy decoupling was an important policy change in the operation of the CAP support programme, with the aim of bringing more market-based evaluation to European farmers' production plans. Decoupled subsidies, as they theoretically do not affect the level of production, are classified as "Green Box" supports under the WTO categorisation of acceptable policies. However, as this and other research demonstrates, decoupled subsidies can have a production altering effect through the investment channel. We have identified that decoupled subsidies, by reducing the risk related to earned income, can reduce financing constraints faced by farms, especially small- and medium-sized operations. This research therefore calls into question the classification of decoupled subsidies as entering into the "Green Box" category of acceptable WTO agricultural supports in future trade negotiations.

The European Commission's 2011 proposals for CAP reform propose to redistribute direct payments by moving to a flat(ter) structure of direct payments across the member states, and to redistribute payments within member states by moving from the historic model of farm payments (in the majority of member states which operate this system) to a regional flat rate system, Matthews (2011). These proposals to redistribute direct payments have re-stimulated the debate on how decoupled the direct payments are and what if any effects on production this redistribution is likely to entail. This study highlights the significant effect of decoupled payments on investment and while the final effect on production is still likely to be small, the results are interesting especially for a country like Ireland that is currently facing the prospect of moving away from the historical single farm payment model. The shift away from the single farm payment model from Ireland is likely to lead to a redistribution of payments away from large cash crops farms towards small extensive non-dairy livestock farms. The results of this study suggest that other things being equal this will lead to a reduction in investment on cash crops farms in Ireland.

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Annex: VAR coefficients for Q

Table 8: Decoupling and financing constraints by farm size

	Q	Accelerator	Q	Accelerator
	Column 1	Column 2	Column 3	Column 4
$\mathbf{Q}_t$	0.212**		0.233**	
	(0.107)		(0.105)	
$\frac{\Delta Y}{K}_t$		0.059**		0.050**
		(0.027)		(0.025)
$\left(\frac{DO}{K}\right)_{t-1}$	-0.175***	-0.163***	-0.175***	-0.173***
	(0.046)	(0.048)	(0.048)	(0.049)
IF_{t-1}	0.489***	0.504***	0.557***	0.579***
	(0.053)	(0.052)	(0.061)	(0.061)
Size (Medium)	-0.008	-0.007	-0.012	-0.011
	(0.011)	(0.011)	(0.011)	(0.011)
Size (Small)	-0.004	-0.002	-0.001	0.000
	(0.013)	(0.013)	(0.013)	(0.013)
Size (Medium)IF_{t-1}	0.147**	0.170***	0.188***	0.206***
	(0.060)	(0.062)	(0.063)	(0.065)
Size (Small) $\cdot IF_{t-1}$	-0.060	-0.041	-0.030	-0.013
	(0.094)	(0.095)	(0.100)	(0.100)
RP_{t-1}			0.084**	0.093**
			(0.041)	(0.040)
Size (Medium)RP_{t-1}			0.002	0.003
			(0.005)	(0.005)
Size (Small) RP_{t-1}			0.001	0.002
			(0.005)	(0.005)
$\cdot IF_{t-1} \cdot RP_{t-1}$			-0.113**	-0.121***
			(0.046)	(0.045)
Size (Medium) $\cdot IF_{t-1} \cdot RP_{t-1}$			-0.129*	-0.136*
			(0.071)	(0.071)
Size (Small) $\cdot IF_{t-1} \cdot RP_{t-1}$			-0.092**	-0.089**
			(0.041)	(0.041)
Hansens J (p-value)	0.37	0.39	0.39	0.34
Year and system controls	Yes	Yes	Yes	Yes
Age, size and subsidy controls	Yes	Yes	Yes	Yes
n	3,109	3,109	2,988	2,988

Notes: (1) Cells show coefficients and standard errors.
(2) * p<0.1, ** p<0.05, *** p<0.01.
(3) All models estimated by GMM, clustered at firm level.
(4) Instruments selected from sales to capital, mvpk,
cash flow to capital and squared terms dated t-2, t-3, t-4.

Table 9: Decoupling and financing constraints by farm system

	Q	Accelerator	Q	Accelerator
	Column 1	Column 2	Column 3	Column 4
$\mathbf{Q}_t$	0.128*		0.255**	
	(0.074)		(0.110)	
$\frac{\Delta Y}{K}_t$		0.066**		0.058**
		(0.028)		(0.026)
IF_{t-1}	0.418***	0.444***	0.486***	0.511***
	(0.077)	(0.077)	(0.085)	(0.084)
$\left(\frac{DO}{K}\right)_{t-1}$	-0.175***	-0.160***	-0.173***	-0.170***
	(0.042)	(0.044)	(0.044)	(0.045)
Dairy	0.010	0.014	0.010	0.013
	(0.009)	(0.009)	(0.010)	(0.010)
cash crops	0.027	0.039*	0.052**	0.059**
	(0.020)	(0.020)	(0.025)	(0.026)
Dairy $\cdot IF_{t-1}$	0.069	0.041	0.040	0.029
	(0.094)	(0.094)	(0.097)	(0.098)
cash crops $\cdot IF_{t-1}$	-0.227	-0.219	-0.314	-0.343*
	(0.184)	(0.189)	(0.193)	(0.198)
RP_{t-1}			0.067*	0.077**
			(0.038)	(0.036)
$IF_{t-1} \cdot RP_{t-1}$			-0.079*	-0.088**
			(0.041)	(0.039)
Dairy $\cdot RP_{t-1}$			-0.050*	-0.051*
			(0.028)	(0.029)
cash crops $\cdot RP_{t-1}$			-0.104**	-0.105**
			(0.052)	(0.052)
Dairy $\cdot IF_{t-1} \cdot RP_{t-1}$			-0.086	-0.087
			(0.077)	(0.080)
cash crops $\cdot IF_{t-1} \cdot RP_{t-1}$			0.618*	0.581*
			(0.338)	(0.346)
Hansens J (p-value)	0.47	0.44	0.45	0.38
Year and system controls	Yes	Yes	Yes	Yes
Age, size and subsidy controls	Yes	Yes	Yes	Yess
n	3,157	3,157	3,157	3,157

Notes: (1) Cells show coefficients and standard errors.
(2) * p<0.1, ** p<0.05, *** p<0.01.
(3) All models estimated by GMM, clustered at firm level.
(4) Instruments selected from sales to capital, mvpk,
cash flow to capital and squared terms dated t-2, t-3, t-4.

Table 10: VAR coefficients for Q estimates

Depvar	$\frac{Cashsales}{K}_i t$
$\frac{Cashsales}{K}_i t-1$	-1.788***
	(0.229)
$MVPK_{it-1}$	0.343
	(0.252)
Depvar	$MVPK_i t$
$\frac{Cashsales}{K}_i t-1$	-.277***
	(0.124)
$MVPK_{it-1}$	-1.547***
	(0.172)
Time and system dummies	Yes
n	126,330

Notes: (1) * p<0.10, ** p<0.05, *** p<0.01.

(2) All estimates are robust to heteroscedasticity, clustered at the firm level.

(3) Instruments are lagged values of VAR variables.