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Dynamic target capital structure and speed of adjustment in farm business

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Abstract

This paper quantifies the determinants and speed of adjustment to the target capital structure for a panel of 1,500 Dutch farms over the years 2001–2015. Using the System General Method of Moments (System-GMM) estimator, the results show that farm profitability, earnings volatility, asset tangibility and growth opportunity are important determinants of leverage. Leverage is highly persistent, i.e. the average adjustment speed is relatively low, with variations among farm types. This variation is mainly attributed to the difference in adjustment costs. Further, we show that the pecking order and signalling theories explain these leverage dynamics.

Keywords: farm business, System-GMM estimator, target capital structure, speed of adjustment

JEL classification: Q12, Q13, Q18

1. Introduction

A question often asked in the literature is whether firms set a target capital structure and adjust to it regularly. Although research in corporate finance has focused on explaining the determinants of target capital structure and speed of adjustment, less attention has been paid to understanding the financing behaviour of farm businesses. The farming business is characterised by a number of specific circumstances, including: (i) dependency on government subsidies to stabilise income (Zhengfei and Oude Lansink, 2006); (ii) the seasonal nature of production, leading to mismatches in cash inflow and outflow; (iii) different legal forms, whereby sole proprietorship is the predominant

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form, meaning that debt has a larger disciplinary power when running a farm and (iv) limited access to equity markets. Further, unlike corporate firms that rely on external professional management, farm businesses have a small decision-making unit that consists of the owner or family members. These unique characteristics of the farming sector lead to different patterns of capital structure decision making.

The management of the capital structure influences farm performance in terms of profit, financial risk and survival. Changes in a farm's production structure affect its capital structure by either tying up capital when farm production capacity increases or freeing up capital when it decreases. Hence, measuring the speed of adjustment is important to understanding the agility of farms in adapting to changing production and finance structures. Farm financing behaviour and capital structure decisions also have an important implication for the return and stability of lenders and financial institutions. In 2016, for example, Rabobank, a popular bank among Dutch farmers with nearly EUR 92.3 billion in outstanding loans to agricultural businesses, announced that one-third of its dairy farm customers were in financial difficulty (CBS, 2016).

It is also relevant to examine whether the existing corporate finance theories (e.g. pecking order and signalling) account for the relationship between target capital structure and the speed of adjustment in the farming business. These theories rely on the assumption that a company has two external financing choices: debt and equity. Note that the pecking order theory may not hold in more complex corporate capital structure settings, for example when a firm chooses between straight and convertible debts or, in the event of an agency problem, between a shareholder and a manager (Zhao, Katchova and Barry, 2004). In addition, the presence of many financial tactics and easy access to capital markets make the measurement and identification of the signalling effect difficult in a corporate finance setting. Farm businesses are less prone to these criticisms and provide an interesting background for testing how these corporate finance theories explain capital structure decision making because: (i) often, there are two financing options: retained earnings (internal) and debt (external), (ii) the facts that sole proprietorship is the predominant legal form and farms have limited access to the capital market minimise the agency problem[1] and (iii) farms have very few financial tactics, such as leverage and profit, to use as signals, which makes identification of the signalling effects easier.

In this paper, we analyse the determinants of farm target capital structure decisions, the adjustment speed towards the target capital structure and examine whether the pecking order and signalling theories help explain farm financing decisions. Few studies have attempted to test the applicability of corporate finance theories to agriculture. Using 5-year panel data (1990–1994), Barry, Bierlen and Sotomayor (2000) tested whether internal funds are preferred over the use of short- and long-term sources of capital (i.e. the applicability of the pecking order theory) and examined whether farms adjust their level of debt,

1 According to Lowder, Skoet and Raney (2016), family farms operate about 75 per cent of the world's agriculture.

equity and leasing towards an optimal structure. Zhao, Barry and Katchova (2008) have also shown that farm businesses depend on their size and operation records as financing signals, unlike corporate firms who can choose high leverage as a signalling tool to facilitate investment.

Building on previous literature, particularly extending Barry, Bierlen and Sotomayor (2000), we aim to contribute to the literature in several ways:

- We present findings in the context of the European policy and market. While extreme price volatility occasionally occurred in world commodity markets, the European market was protected by the prevailing Common Agricultural Policy (CAP). However, since the year 2000, major policy changes in Europe, such as the CAP reforms and trade liberalisation, have linked the European agricultural sector to the global market.
- We cover the period 2001–2015, which includes the financial crisis of 2007/2008, and we consider four farm types: dairy, field crop, horticulture and livestock farms, to provide a better understanding of the farming business in Europe in general and the Netherlands in particular. In addition, the period of analysis allows us to examine the capital structure decision-making process during the financial crisis and whether the theories stand the test of time.
- The panel structure of our data and the advancement of the dynamic panel System General Method of Moments (System-GMM) estimator in recent years enable us to disentangle the endogeneity issue by explicitly specifying predetermined endogenous variables and using their lag structures as valid instruments.
- Finally, it is worth noting that most of the empirical studies in the literature[2] use observed leverage as a proxy for optimal leverage and static capital structure models (Fama and French, 2002; Iliev and Welch, 2010). Using observed leverage instead of optimal leverage is problematic due to the presence of adjustment costs. Static capital structure models cannot capture the dynamic adjustments in leverage ratios (Graham, Leary and Roberts, 2015). Hence, to account for dynamics and adjustment cost in the capital structure, we use a dynamic partial-adjustment model.

The remainder of the paper is structured as follows: The next section provides a theoretical review and conceptual framework; Section 3 motivates and explains the empirical strategy, followed by a description of the variables and data used; Section 4 reports our main empirical results and Section 5 concludes.

2. Theoretical background

2.1. Theories of capital structure and the farm sector

Different theories[3] have been used in corporate finance literature to explain firms' capital structure decisions, including the pecking order theory (Myers

2 For a detailed review of the literature, please see Graham and Leary (2011).

3 For a thorough review of theories on capital structure, please see Graham, Leary and Roberts (2015).

and Majluf, 1984; Myers, 1984), signalling theory (Ross, 1977), trade-off theory (Miller, 1977), agency theory (Jensen and Meckling, 1976) and market-timing theory (Baker and Wurgler, 2002). Corporate businesses are the focus of the literature; however, farm businesses are fundamentally different from corporations, which results in different decision-making patterns. Hence, few of these theories can be applied directly in an agricultural setting. In this paper, we focus on the pecking order and signalling theories.

The pecking order theory entails that firms have two sources of funding: internal and external. The cost gap between internal and external funds, attributed to asymmetric information and agency costs, makes firms prefer internal to external financing (Frank and Goyal, 2009). Whenever external funding is required, firms will issue debt and convertible bonds before issuing equity. Meanwhile, the signalling theory states that managers have better information about their firm and a motive to transfer this information to potential investors and lenders using signals. These signals include, but are not limited to, investment, profitability, leverage, asset accumulation and repurchasing of outstanding stocks (Graham, Leary and Roberts, 2015).

Studies on the applicability of these theories in explaining the financing behaviour of farm businesses are scant. Barry, Bierlen and Sotomayor (2000) studied the financial structure of farm businesses under imperfect capital markets. They find support for the pecking order theory and report a strong relationship between cash flow and farm debt, whereby a strong cash flow leads crop farms to increase investments, pay off debts and refrain from additional borrowing. A weak cash flow, on the other hand, is related to lower investments and higher borrowing. Zhao, Katchova and Barry (2004) also examined the applicability of capital structure theories to the farming business. Using cross-sectional time-series data from the Illinois Farm Business Farm Management, they have shown that farm businesses rely on their size and operation records as financing signals, unlike corporate firms, which can choose high leverage as a signalling tool to facilitate investment.

Studies in the literature are often cross-sectional (Escalante and Barry, 2003; Featherstone *et al.*, 2005; Nurmet, 2011). While cross-section studies are appropriate during periods of stable financial conditions, evidence on the stability of leverage is inconclusive (Lemmon, Roberts and Zender, 2008; DeAngelo and Roll, 2015) and remains largely an empirical question. Further, cross-section studies fail to capture the effects of the business cycle and time-varying farm characteristics on leverage. Farm growth opportunity, for example, is an important leverage determinant, capturing the information asymmetry in the lender–borrower relationship (Zhao, Barry and Katchova, 2008). Growth opportunities are known to vary over the years due to changes in the business cycle and even differences across farm types. In addition, an optimal capital structure decision is a long-term concept with a long-run impact on the survival and success of agricultural firms. As a result, empirical studies using a longitudinal research design are preferred.

2.2. Determinants of farm businesses' capital structure

Farm capital structure, defined as the way in which a farm finances its investment through some combination of debt and equity, has been extensively studied over the years. Since farm businesses have limited access to equity markets, leverage is often used as a proxy for farm capital structure. The literature on the determinants of the leverage decisions of farm businesses is wide ranging. Major factors include ownership (Zhengfei and Oude Lansink, 2006), profitability, financing costs (Zhao, Katchova and Barry, 2004), asset tangibility, economies of scale, wealth, risk attitude, adjustment costs (Barry, Bierlen and Sotomayor, 2000), farm risk-management strategies (Katchova, 2005), credit constraints and government payments (Featherstone *et al.*, 2005). Building on the pecking order and signalling theories and on previous literature, we include the following determinants:

2.2.1. Farm profitability

According to the pecking order theory, farms prefer financing new investments out of retained earnings rather than through borrowing; they only issue debt when retained earnings are insufficient (Frank and Goyal, 2009; Graham, Leary and Roberts, 2015). The more profitable the farm, the greater the availability of internal capital should be. Therefore, we expect a negative relationship between profitability and leverage. On the other hand, the signalling theory suggests a positive relationship, since lenders are more willing to lend to profitable farms (Featherstone *et al.*, 2005; Zhao, Barry and Katchova, 2008).

2.2.2. Asset tangibility

Due to the high vulnerability of the agricultural sector to systematic and unsystematic risks, lenders prefer farms with assets as collateral to back up their loans. Tangible fixed assets are pledgeable and easier to liquidate in case of bankruptcy, thereby reducing the cost of financial distress (Chang and Dasgupta, 2009; Halling, Yu and Zechner, 2016). Also, farms with more tangible assets are more recognisable to lenders, leading to less information asymmetry (Titman and Wessels, 1988; Getzmann, Lang and Spremann, 2010; Graham and Leary, 2011). Both the pecking order and signalling theories support a positive relationship between tangibility and leverage.

2.2.3. Farm size

Larger farms are more diversified businesses, which lowers the probability of bankruptcy (Heshmati, 2001; Flannery and Rangan, 2006). Size may also be an indicator of a farm's bargaining power (Graham, Leary and Roberts, 2015) and is considered to be positively correlated to leverage. This relationship lends support to the argument by Frank and Goyal (2009) and Getzmann, Lang and Spremann (2010) that larger farms are easily noticeable, in that lenders have more information about them, and thus have easier access to loans.

2.2.4. Growth opportunities

Farms attempt to signal their positive expectations on investment through high leverage (Zhao, Barry and Katchova, 2008). Lenders provide loans based on these signals. This would lead to a positive relationship between growth opportunity and leverage. The pecking order theory, however, suggests that firms rely on retained earnings rather than debt to finance investments (Frank and Goyal, 2007; Graham, Leary and Roberts, 2015). This would imply a negative relationship between farm growth opportunity and leverage.

2.2.5. Risk

A higher variability of earnings increases the risk that farms will be unable to fulfil their interest and principal payment obligations (Barry, Bierlen and Sotomayor, 2000; de Mey *et al.*, 2016). This implies the existence of a negative relationship between leverage and income variability. The signalling theory based on information asymmetry and adverse selection arguments, on the other hand, suggests a positive relationship between leverage and risk, i.e. volatility of earnings, stressing that firms with high-income volatility and operational risk tend to be the ones that apply for loans (Flannery and Rangan, 2006; Halling, Yu and Zechner, 2016; Hang *et al.*, 2017). Table 1 summarises the determinants of target capital structure and the expected relationship based on the pecking order and signalling theories.

Macroeconomic factors: there is evidence of the impact of farm-specific factors on capital structure decisions. Often ignored and less investigated are the possible implications of macroeconomic factors for the target farm's decision making on capital structure (Korajczyk and Levy, 2003). The recent financial crisis of 2008 and the sharp economic recession following the crisis have sparked substantial interest in the link between macroeconomic conditions and financial structure (Halling, Yu and Zechner, 2016).

Table 1. Expected relationships between the determinants of target capital structure and leverage

	Determinant	Pecking order theory	Signalling theory
1	Farm profit	−	+
2	Asset tangibility	+	+
3	Farm size	+	+
4	Growth (investment) opportunity	−	+
5	Risk (earnings volatility)	−	+

A literature review reveals that inflation, government debt relative to GDP (Debt-to-GDP) and employment level in the industry have a significant impact on capital structure[4](Frank and Goyal, 2009). Accordingly, we have included these variables in our model.

2.3. Target capital structure and speed of adjustment

In a perfect market, the cost of adjustment would be zero, and adjustment to the target capital structure would be instantaneous (Faulkender *et al.*, 2012; Flannery and Hankins, 2013). The presence of market imperfections, however, such as transaction costs and information asymmetry, causes firms to temporarily deviate from their optimal target leverage (Hüttel, Mußhoff and Odening, 2010).

Frank and Goyal (2007) provided the framework of the target adjustment hypothesis, where the adjustment speed towards the target capital structure depends on two costs: adjustment costs to the target and costs of deviating from the target. When adjustment costs are high, the adjustment speed to the target will be slow. Meanwhile, when the costs of deviating from the target are high, the adjustment speed will be faster (Fischer, Heinkel and Zechner, 1989; Flannery and Rangan, 2006). The incentive to reduce leverage is greater than that to increase leverage, implying an asymmetry in target adjustment, whereby firms would adjust downward faster than upward (Faulkender *et al.*, 2012).

Fama and French (2002) estimated the target leverage adjustment and found that firms tend to adjust to their target slowly. On average, firms close about 15 per cent of the gap between the actual and target leverage yearly. Conversely, Flannery and Rangan (2006) reported a much faster speed of adjustment, with an annual reduction of one-third of the difference between the actual and target leverage. They argued that the slower rate reported by previous studies was mainly attributable to the noise in the strategy to estimate the target leverage. Drobetz, Schilling and Schröder (2015) also found a speed of adjustment of about 25 per cent per year, supporting the economic relevance of dynamics in the capital structure decision. The literature is still inconclusive as to the measurement of annual adjustment speed rates (Graham and Leary, 2011). The measures are usually expressed in terms of the time needed to return to the target capital structure after a shock.

4 Note that the policy of the European Commission under the CAP may influence the capital structure of farm businesses in Europe. For example, Jongeneel *et al.* (2010) analysed the impact of a 'soft landing' scenario, quota enlargement, free trade agreements and environmental legislation on the overall structural change and financial performance of the Dutch Dairy sector. Their simulation results show that milk production is expected to increase by 11 per cent after the soft landing and the abolition of the milk quota and that integration into the world market may result in an 8 per cent decline in the milk price.

3. Research design

3.1. Dynamic partial-adjustment model

Let the leverage[5] of farm i in period t, denoted as Leverage_{it}, be a function of farm-specific (X_{it}), macroeconomic (Z_t) and time-specific determinants represented by time dummies (Γ_t):

$$\text{Leverage}_{it} = f(X_{it}, Z_t, \Gamma_t) \tag{1}$$

In a frictionless economy, the observed leverage of farm i at time t, Leverage_{it}, should be the target leverage, Leverage^*_{it} ($\text{Leverage}_{it} = \text{Leverage}^*_{it}$). However, Titman and Wessels (1988) and Fischer, Heinkel and Zechner (1989) show that transaction costs are important determinants of a capital structure decision. Even after an active capital structure adjustment, the presence of convex or proportional transaction costs makes reaching the target leverage impossible or suboptimal (Halling, Yu and Zechner, 2016). Adjustment to the target occurs gradually over time, depending on the trade-off between not operating at target leverage and the costs of adjustment towards the target (Leary and Roberts, 2005). This trade-off suggests that farms adjust their current leverage with a certain speed of adjustment (λ) to attain the desired target leverage, expressed as:

$$\text{Leverage}_{it} - \text{Leverage}_{it-1} = \lambda(\text{Leverage}^*_{it} - \text{Leverage}_{it-1}) \tag{2}$$

Leverage_{it-1} is a lagged leverage variable, included to construct a dynamic specification that allows for the potential effect of the autoregressive (AR) process and adjustment costs (Byoun, 2008), λ represents the rate of convergence of Leverage_{it} to Leverage^*_{it} or the magnitude of the adjustments between two subsequent periods.[6] Hence, the change in leverage depends on

5 We calculated leverage as total farm debt divided by total assets. We opt to use the ratio variable because it makes comparing farm leverage between farm types easier. Also, dividing total farm debt by the total assets, allows us to eliminate the differences in farm size. To obtain a more accurate reflection of farm total assets, we take the average total asset as a denominator, i.e. the average of the opening total assets at the beginning of the accounting period and closing total assets at the end of the accounting period.

6 We assume the speed of adjustment to be constant over time and across farms. To allow the speed of adjustment to vary over time, one can specify it as a function of farm characteristics. Doing so, however, has two major implications for the dynamics of leverage and statistical inference (Flannery and Rangan, 2006). First, if not restricted to a constant speed, the adjustment parameter may be positive in one period (a farm adjusts its leverage away from the target), negative in the next (a farm adjusts its leverage towards the target) and zero in another (a farm ignores the target). This behaviour is inconsistent with the assumptions that farms make financing decisions according to the pecking order and signalling theories outlined in the introduction section. Second, allowing the speed of adjustment to vary over time complicates statistical inference. The parameter is highly sensitive to whether or not the process is stationary and requires mean reversion tests. Since one has to specify the period in which mean reversion is being tested, and the adjustment parameter is unique for each farm and time period in that we only observed it once in 1 year for each farm, any mean reversion test will have little power. Hence, we assume a constant speed of adjustment.

the speed of adjustment and the distance between lagged leverage (Leverage_{it-1}) and target leverage (Leverage^*_{it}).

The existence of adjustment costs is represented by the restriction that $|\lambda| < 1$, which is the condition that Leverage_{it} converges to Leverage^*_{it} as $t \to \infty$. A $|\lambda| = 1$, indicates an immediate and full correction of deviations from the target farm leverage in one period. The case of $\lambda < 1$ implies that the farm does not fully adjust from period $t-1$ to t. If $\lambda > 1$, the farm adjusts more than required and is still not at its target leverage level. Finally, a $\lambda = 0$ shows the absence of adjustment, i.e. the random leverage hypothesis.

In the absence of adjustment costs, the inferred relationship will suffer from specification error if the observed farm leverage is regressed on the determinants of target capital structure alone (Heshmati, 2001). In order to avoid a misspecification error, equation (2) can be rewritten as:

$$\text{Leverage}_{it} = (1-\lambda)\text{Leverage}_{it-1} + \lambda(\text{Leverage}^*_{it}) + \varepsilon_{it} \tag{3}$$

Rewriting equation (3) and substituting equation (1) results in the following relationship for farm leverage at time t:

$$\text{Leverage}_{it} = (1-\lambda)\text{Leverage}_{it-1} + \lambda\left(\sum_{\text{jmn}} \beta_{\text{j}} X_{it} + \gamma_m Z_{it} + \Delta_{\text{n}}\Gamma_{\text{t}}\right) + \varepsilon_{it} \tag{4}$$

Farm leverage is modelled as a linear combination of farm-specific, macroeconomic and year-specific factors. Including this relation and rearranging equation (4), we specify equation (5), which is the integrated dynamic partial-adjustment model[7] and the basis of our empirical investigation:

$$\begin{aligned}\text{Leverage}_{it} = \alpha &+ (1-\lambda)\text{Leverage}_{it-1} + \beta_1\text{Tangibility}_{it} + \beta_2\text{Size}_{it} \\ &+ \beta_3\text{Profitability}_{it} + \beta_4\text{Growth}_{it} + \beta_5\text{Risk}_{it} + \gamma_6\text{Debt} \\ &- to - \text{GDP}_t + \gamma_7\text{Inflation}_t + \gamma_8\text{Employment}_t + \Gamma_t + \varepsilon_{it}\end{aligned} \tag{5}$$

where the variables in equation (5) were defined in Section 2.2, ε_{it} is the error term, which consists of individual effect (μ_i) and disturbance (ν_{it}), while α, β, γ and Γ are parameters to be estimated.

When estimating equation (5) with a short time-series panel, we have a dynamic panel bias or 'Nickell bias' (Nickell, 1981) where the coefficient of the lagged dependent variable is biased towards zero.[8] In addition, in

7 A similar model is used by Banerjee, Heshmati and Wihlborg (1999) to test the dynamics of capital structure in panels of UK and US companies. Getzmann, Lang and Spremann (2010) also used the earlier version of the model to investigate the determinants of the target capital structure and adjustment speed in Asian capital markets. See Chang and Dasgupta (2009) and Iliev and Welch (2010) for a discussion of the partial-adjustment model.

8 Nickell (1981) shows that the demeaning process that subtracts the individual's mean value of y and each X from the respective variable creates a correlation between the regressor and error term. The mean of the lagged dependent variable contains observations 0 through $(T-1)$ on y,

equation (5), we suspect that some of the explanatory variables are potentially endogenous.[9] One solution to this problem involves taking first differences of the original model.

Arellano and Bond (1991) proposed a Difference General Methods Moment (Difference GMM) in which regression equations are expressed in terms of their first difference and endogenous variables are instrumented using lags of their own levels. It allows specifying the endogenous variables and involves first differencing that removes the time-invariant farm-specific effects.

This approach has limitations, however, as the lagged levels may be weakly correlated with first differences. Notably, this bias is not eliminated by using fixed-effects estimators since the regressors and the error term continue to be correlated after such a transformation. This is particularly the case when the lagged levels used as instruments are highly persistent (Roodman, 2015).

To address this limitation, Arellano and Bover (1995) developed an improved estimator known as the 'Level GMM', in which regressions are expressed in levels and endogenous instruments in terms of their lagged differences. Finally, Blundell and Bond (1998) combined both approaches to construct a system of equations known as the 'System-GMM'. It combines the sets of moments from the difference and level equations into instrument-endogenous variables.

The System-GMM is particularly suitable for this study because: (i) it has better asymptotic and finite sample properties than the Difference GMM; (ii) it uses difference equations for instrument-endogenous regressors, so that they are also able to handle time-invariant farm-specific attributes, e.g. heterogeneity and endogeneity and (iii) it is well suited to datasets with large numbers of cross-sections, *N*, and small numbers of available periods, *T*.

Nevertheless, the System-GMM estimator has limitations too. It requires orthogonality between the lagged levels of the variables used as instruments and the differences of the error terms and, simultaneously, orthogonality between farm-specific effects and the lagged difference of the variables used as instruments. Hence, a specification test on overidentifying restrictions is

and the mean error, which is being subtracted from each, ε_{it} contains contemporaneous values of ε for $t = 1 \ldots T$. The resulting correlation creates a bias in the estimate of the coefficient of the lagged dependent variable.

9 While this paper deals with the effect of profitability on a farm's capital structure, a farm's choice of capital structure may, conversely, also affect its profitability. Both directions of causality are thus possible: increased leverage can positively or negatively affect farm profitability, but leverage can also be affected by profitability. On the one hand, highly leveraged farms may suffer from financial distress, face conflicts of interest between the owners and creditors and incur bankruptcy cost, thus decreasing their profitability. On the other hand, the impact of profitability on leverage is described by the pecking order and signalling theories, each providing a different explanation. The pecking order theory hypothesises that higher profitability results in higher retained earnings and that farms prefer to use these retained earnings to finance their investments rather than issue debt. As such, this theory suggests a negative relationship between profit and leverage. The signalling theory, however, holds that higher profitability often reduces the bankruptcy cost of a farm. In addition, farms that perform well can usually project higher expected returns. Both these relationships send a positive signal and lenders are more willing to provide loans to more profitable farms. Contrary to the pecking order theory, the signalling theory thus suggests a positive relationship between profit and leverage.

required to check the validity of the additional instruments (Flannery and Hankins, 2013; Roodman, 2015).

3.2. Data and descriptive statistics

This paper has benefited from a unique longitudinal dataset of Dutch farms that have been participating in the Farm Accountancy Data Network (FADN). After the USA, the Netherlands is the second largest exporter of agricultural products (Berkhout, 2017). The Dutch agriculture sector accounts for 2 per cent of the country's economy, 20 per cent of the country's total export value and 2.5 per cent of employment. It is further characterised by highly educated farmers, large-scale and capital-intensive farming, export orientation, increasing input and output-price volatility and an orientation towards sustainability (van der Meer, van der Veen and Vrolijk, 2013; Berkhout and van Bruchem, 2015).

The Dutch FADN samples are randomly selected using the disproportional stratified random sampling[10] technique from the farm census. Economic size and farm type are the stratification criteria used to select farms. The data we use in this paper are unique in that: (i) they constitute the sole source of farm-level (microeconomic) data across more than 15 years; (ii) the samples are representative of 80 per cent of the farms and more than 90 per cent of production in the Netherlands and (iii) they allow for separate estimation of farm types for comparison purposes thanks to the harmonised data-collection procedure.[11] The World Bank provided us with the macroeconomic data on inflation, government debt-to-GDP ratio and employment in the industry.

The panel is unbalanced and covers the period from 2001 to 2015. We use the following filters for including a farm in the analysis: first, a farm must have a non-zero debt, as farm target leverage and adjustment will not occur without liabilities. Second, given the lag structure of our model, farms need to remain in the sample for at least 3 years. Finally, to address outlier concerns, extreme values in the dataset are dealt with by dropping the top and bottom 0.5 per cent observations of the variable from the analysis. Table 2 presents the definitions of the variables used in the empirical analysis and summary statistics of Dutch farms.

We note that the average farm leverage ratio for all farms is 36.3 per cent over the 2001–2015 period. The average leverage for dairy, field crop, horticulture and livestock farms is 27.4, 25.3, 45.7 and 41.4 per cent, respectively,

10 Stratified random sampling implies that the whole farm population is divided into groups (strata). Subsequently, farms are selected from each of the groups. This ensures the inclusion of farms from all groups with different characteristics. Disproportional sampling means that not all farms have the same chance of being included in the sample. Farms in relatively homogenous groups have smaller chances as a limited number of observations would be sufficient to draw a reliable conclusion. The chance of being included is higher for farms in less homogenous groups, which allows for the proper representation of all groups. For details of the Dutch FADN sampling procedure, we refer to van der Meer, van der Veen and Vrolijk (2013).

11 The bookkeeping principles and sample selection plans are identical for all farm types in the Netherlands and similar to those of other European countries participating in the FADN.

Table 2. Variables and summary statistics of Dutch farms, 2001–2015

Variable	Explanation	Obs.	Mean	Median	Min.	Max.	SD
Leverage	The total debt to total assets ratio[a]	15,682	0.363	0.322	0	9.307	0.289
Dairy farms		4,101	0.274	0.267	0	0.998	0.163
Field crop		2,695	0.253	0.221	0	2.1675	0.204
Horticulture		5,136	0.457	0.413	0	9.307	0.375
Livestock		3,750	0.414	0.408	0	3.043	0.259
Asset tangibility	The fixed asset to total assets ratio	15,682	0.709	0.740	0.011	0.997	0.172
Farm size	The natural log of total assets	15,682	14.567	14.591	10.624	17.714	0.847
Profit (ROA)	Ratio of net farm income[b] to total assets	15,682	0.025	0.021	0	0.676	0.091
Growth opportunity	The total investment to total assets ratio	15,682	0.043	0.017	−0.027	1.147	0.078
Earnings volatility	The standard deviation of ROA	14,076	0.0423	0.0197	0.0025	5.0591	0.0713
Debt-to-GDP	Government debt to GDP percentage	15,682	56.300	55.10	40.2	73.2	10.294
Inflation	Inflation percentage	15,682	1.884	1.70	0.60	4.20	0.874
Employment[c]	Employment ratio in the industry	15,682	2.490	2.50	1.80	3.0	0.369

[a]Depreciation and changes in market value have been taken into consideration in calculating the value of assets.
[b]We calculate net farm income (NFI) using the FADN principle as NFI = Operating receipts − intermediate costs − depreciation + balance of subsidies and tax − wages − rent. Note that in the profit variable, the interest payment is added back to the NFI calculation to account for differences in farm capital structure.
[c]Employment is the ratio of employment in the agricultural sector relative to employment in all other industries in the Netherlands for each year.

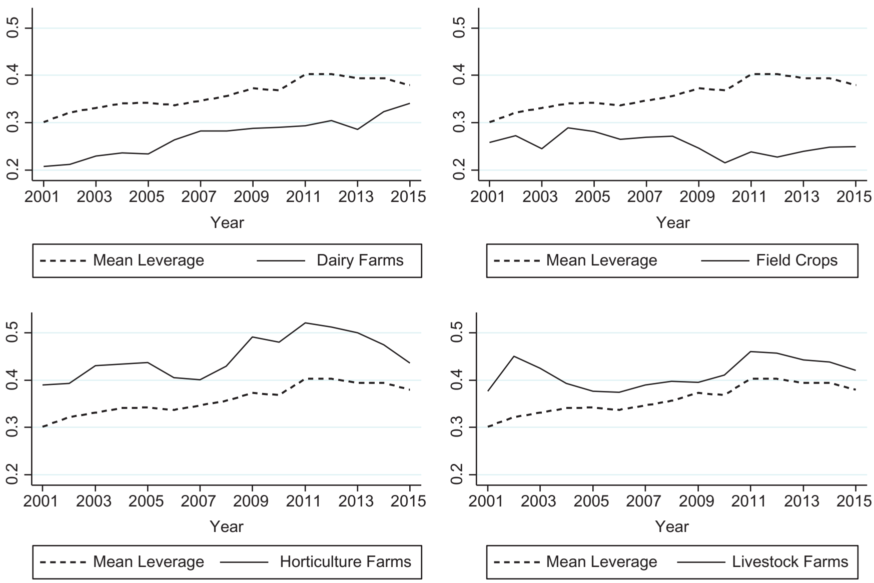

Fig. 1. Farm leverage by farm type, 2001–2015.

with horticulture scoring the highest. Farms earn a 2.53 per cent profit on average. Figure 1 shows the variation in leverage over the years across the four farm types.[12]

General observation reveals that the average leverage ratio for dairy and livestock farms shows a gradual increase over the years. The increased borrowing among Dutch dairy farms may be due to the heavy investments required to comply with obligatory manure processing in 2014 and the scale increases prior to the abolition of the milk quotas on 1 April, 2015 (Jongeneel et al. 2010). The farm leverage ratio of horticulture farms reached its peak in 2011 and 2012, when the cold spring weather sparked the need for extra cash to cover the higher energy bills (Berkhout and van Bruchem, 2015).

Interestingly, the increasing trend in the leverage ratios of dairy and livestock farms supports the notion that neither the changes in farm-specific characteristics nor the relationship between these characteristics and leverage alone are able to explain the increase. A change in major macroeconomic and financial policies is also relevant in explaining the existing capital structure, as well as the observed shifts in leverage ratio over the years (Graham, Leary and Roberts, 2015). Figure 2 shows the variation in profitability over the years across the four farm types.

Note that horticulture farms exhibited a relatively stable growth in profitability compared to other farm types since the year 2011. This is largely

12 We followed the Dutch FADN sampling principle to categorise farms into four types. For a detailed explanation of farm categorisation, we refer to van der Meer, van der Veen and Vrolijk (2013).

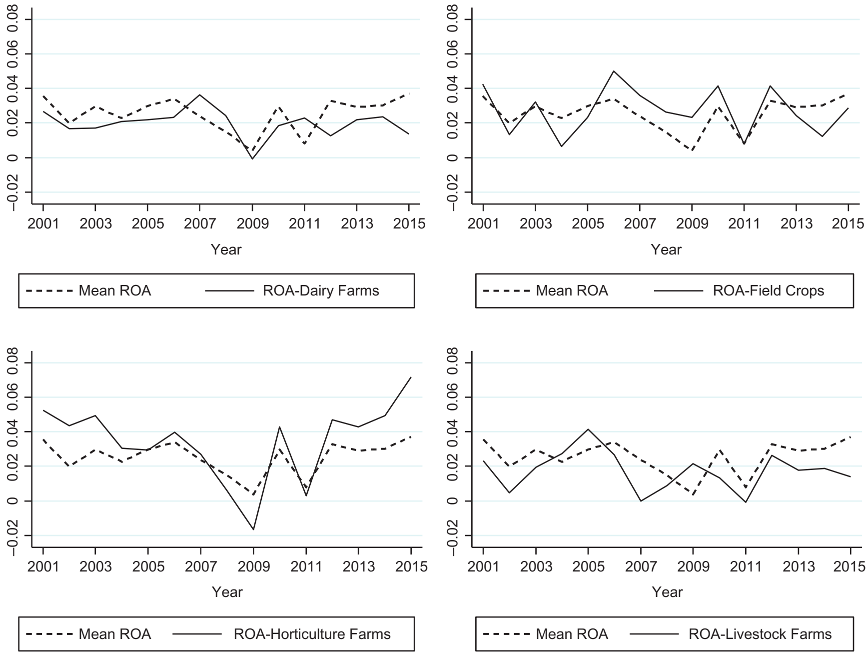

Fig. 2. Farm profitability by farm type, 2001–2015.

attributed to poor production figures in Southern Europe during the summer months after the financial crisis (Berkhout and van Bruchem, 2015). The increase in the profit levels of horticulture farms asserts the economic significance of the profit variable on leverage ratio. The next section presents the empirical results.

4. Results

We start by establishing stylised facts about the determinants of farm target leverage. Most importantly, however, we address the question whether or not the pecking order and signalling theories of corporate finance can explain the financing behaviour of farm businesses. In the next step, we analyse the dynamics of farm leverage and the speed of adjustment to the target. The last section summarises the results from splitting our sample according to size, growth opportunities and year.

4.1. Determinants of target capital structure

Table 3 shows the estimates of the System-GMM based on the empirical model discussed in Section 3.1. The Sargan test of overidentifying restrictions suggests that the instruments used in the System-GMM are valid. The Wald test is significant at the 1 per cent level for all farm types, ensuring the significance of the right-hand side variables. The AR(2) test implies that there

Table 3. Dynamic panel data estimation results (dependent variable: Leverage$_{it}$)

Variables	Dairy	Field crops	Horticulture	Livestock
Leverage $_{t-1}$	0.8688***	0.8262***	0.3597***	0.8862***
	(0.0137)	(0.0184)	(0.0144)	(0.0110)
Profit	0.2187***	−0.4724***	−1.6320***	−0.8748***
	(0.0655)	(0.0626)	(0.0625)	(0.0469)
Tangibility	0.09545***	−0.02789	−0.1387**	−0.03510
	(0.0150)	(0.0359)	(0.0515)	(0.0236)
Size	0.03426***	−0.01504	0.006263	0.04842***
	(0.0063)	(0.0072)	(0.0134)	(0.0089)
Growth	0.3825***	0.3470***	0.1911***	0.3868***
	(0.0153)	(0.0178)	(0.0357)	(0.0208)
Risk	0.00641	−0.00831**	−0.0079***	−0.0426**
	(0.0961)	(0.0631)	(0.0850)	(0.0454)
Debt-to-GDP	0.0001773	0.000030	0.006117***	0.00063**
	(0.0001)	(0.0002)	(0.0005)	(0.0002)
Inflation	−0.0083***	−0.0009796	0.003652	0.01960***
	(0.0011)	(0.0016)	(0.0037)	(0.0017)
Employment	0.01146**	−0.001333	0.07799***	0.03152***
	(0.0042)	(0.0057)	(0.0129)	(0.0064)
Constant	0.4516***	0.2833**	−0.1635	−0.7688***
	(0.0900)	(0.0980)	(0.1997)	(0.1323)
Year	Yes	Yes	Yes	Yes

Wald $\chi^2(9) = 9{,}569.28$, p-value = 0.0000.
Sargan Test $\chi^2(206) = 219.3$, p-value = 0.2701.
AR(1) $Z = -7.8711$, p-value = 0.0000.
AR(2) $Z = -1.5186$, p-value = 0.1419.
Note: Numbers in parentheses are robust standard errors, and *** and ** are significant at the 1 per cent and 5 per cent levels, respectively. The dummy reference level is the year 2001.

is no serial correlation. These results indicate that the key identifying assumptions required for the System-GMM estimator are satisfied.

Results in Table 3 show a significant and negative relationship between farm profit and leverage for all farm types except dairy farms. These results lend support to the applicability of the pecking order theory, in that other factors remain constant, the high profit earned by farms reduces the need for external funding, and hence more profitable farms should be less leveraged over time. Similar results were reported by Barry, Bierlen and Sotomayor (2000), Zhao, Katchova and Barry (2004) and Frank and Goyal (2003). Nevertheless, the estimates show a positive and significant relationship for dairy farms.

Dutch dairy farms are the most regulated farm type and are subject to frequent policy changes, such as obligatory manure processing and the abolition of the milk quota system (Jongeneel *et al.*, 2010; Boere *et al.*, 2015; Samson, Gardebroek and Jongeneel, 2017). These regulations and policy changes may increase the need for cash, either to comply with the regulations or to expand to meet the expected increase in milk demand after the abolition of the quota. There is a marked difference in the size of the coefficients of profitability, implying different degrees of economic significance of profitability on farm leverage. The negative coefficient, in absolute terms, is the largest for horticulture farms, followed by livestock farms.

The estimated relationship between asset tangibility and leverage is significant and positive for dairy farms. This is consistent with signalling theory, which holds that tangible assets are more valuable to creditors, should farms go into liquidation. The result also supports the importance of tangible assets as collateral for debt financing in the agriculture business. The structure of the Dutch dairy sector has changed significantly in recent years. Compared to the year 2000, the total number of farms had decreased by 29 per cent to 16,500 in 2016, while average farm size had increased by 47 per cent to 56 ha (CBS, 2016). This structural change, combined with the increase in land value over the years, sends a positive signal to lenders. These findings are also consistent with the existence of a supply effect, whereby lenders might put more emphasis on asset tangibility in loan approval when loan requests are high. Also, larger farms are known to be less exposed to bankruptcy risk and hence are likely to receive more loans from lenders (Frank and Goyal, 2007). Consistent with this argument, farm leverage is positively related to size for horticulture and livestock farms.

The significant and positive relationship between growth (investment) opportunity and leverage for all farm types provides further evidence of the applicability of the signalling theory. The theory suggests that farms with more investment or growth opportunities borrow more over time. Farms with substantial growth rates can afford more financial leverage since they can generate enough earnings to offset the additional interest expenses. Similar findings were reported by Barry, Bierlen and Sotomayor (2000).

The estimated relationship between risk (earnings volatility) and leverage is significant and negative for all farms but dairy farms. This result provides evidence of the applicability of the pecking order theory, which assumes that the probability of financial distress increases and a farm's debt repayment capacity decreases with rising earnings volatility, resulting in a negative relationship between leverage and risk.

Compared to the farm-specific effects, the macroeconomic factors have a less economically significant effect on the capital structure decision. The government debt-to- GDP ratio has a significant and positive effect on leverage for horticulture and livestock farms. Mixed results are found regarding the relationship between inflation and farm leverage ratio. The positive and significant coefficient estimates for horticulture and livestock farms are consistent with the fact that inflation makes the real cost of borrowing cheaper, thereby encouraging farms to issue more debt. Lastly, we find a significant coefficient showing a positive relationship between employment in the industry and farm leverage for dairy, horticulture and livestock farms. Table 4 summarises the results as to which theory better explains the capital structure decision-making pattern of each of the farm types.

Table 4. Farm capital structure and the pecking order and signalling theories[a]

	Determinant	Dairy farms	Field crop	Horticulture	Livestock
1	Farm profit	+ (ST)	− (PO)	− (PO)	− (PO)
2	Asset tangibility	+ (ST and PO)	NS	NS	NS
3	Farm size	+ (PO and ST)	NS	NS	+ (PO and ST)
4	Growth opportunity	+ (ST)	+ (ST)	+ (ST)	+ (ST)
5	Risk	NS	− (PO)	− (PO)	− (PO)

Note: PO, ST and NS stand for pecking order theory, signalling theory and not supported, respectively.
[a]Please note that we are not defining the signalling and pecking order theories as the opposite signs for each variable in Table 4. These theories may, nevertheless, provide alternative explanations for the impact of the same variable on farm leverage. When considering farm profitability, for instance, the signalling theory holds that farm profit sends a positive signal to lenders to provide more loans. This would lead to a positive relationship between profitability and leverage, which is indeed the case for the dairy farms in our study (see Table 3). The pecking order theory, on the other hand, suggests that higher profit is associated with less borrowing because high profits reduce the need for external funding, in that farms rely on retained earnings rather than debt to finance investments. This would imply a negative relationship between farm profitability and leverage, which is indeed the case for field crop, horticulture and livestock farms. In these cases, the theories offer opposing explanations of the same variable. We only seek to examine which theory better captures the existing capital structures of the four farm types considered.

4.2. Adjustment speed

The first row of Table 3 reports the estimated coefficients of the lagged leverage, which are significant and positive at the 1 per cent level for all farm types. The results are consistent with the findings reported by Frank and Goyal (2009). The coefficients are between zero and one, implying that farm leverage ratio converges to the target level over time. This also confirms the presence of dynamics in the farm capital structure decision.

We infer from the estimated lagged leverage coefficient values of 0.8688, 0.8262, 0.3597 and 0.8862, for dairy, field crop, horticulture and livestock farms, respectively, that farms adjust leverage towards the target. The adjustment speed is 13.12 per cent $(1-\lambda)$ per year for dairy farms, 17.38 per cent for field crop farms, 64.03 per cent for horticulture farms and 11.38 per cent for livestock farms.

This speed of adjustment corresponds to a half-life[13] of leverage shocks of about 4.9, 3.6, 0.67 and 5.7 years, respectively. Compared to findings in other industries, the adjustment speed of Dutch farms is slow, with the exception of horticulture farms. Frank and Goyal (2003), for instance, report an adjustment speed of around 25 per cent for US publicly listed companies.

The slow adjustment to the target leverage is mainly attributed to high adjustment costs. Two factors might explain the high adjustment costs of Dutch farm businesses. First, it is not easy for farm businesses to gain access to loans. There are only a few financial institutions in the Netherlands that specialise in agricultural financing (CBS, 2016). Second, compared to corporations, farm businesses are small and medium in size. Hence there is an

13 For example, the λ estimate in Table 3 for dairy farms is 0.8688, which means that a typical dairy farm closes about 13.12 per cent $(1-\lambda)$ of the gap between its current level of leverage and its target in 1 year. At this rate, it takes approximately 4.9 years for the farm to close half of the gap between the current and target leverage.

adverse selection issue as a result of information asymmetry, which makes adjustments costly. The high adjustment speed of horticulture farms could indicate the ease with which horticulture farms have been able to acquire financing through debt and lower the adjustment cost.

All in all, the less significant impact of macroeconomic factors, both in sign and magnitude, suggests that farm-specific factors are the core determinants of the target capital structure decision. We performed a separate analysis excluding the macroeconomic factors to further substantiate our conclusion. The result is reported in Table A1 of the Appendix section. We found that size has a negative and significant relationship with leverage, suggesting that larger farms are able to retain their profit rather than rely on external financing. Also note that the coefficient estimates of the risk variable in Table 3 are not statistically significant, i.e. not supported, for all farm types. Otherwise, the results largely remain the same as the results in Table 3, both in sign and magnitude.

4.3. Farm size, growth opportunity and financial crisis

We split the sample and re-estimated our model to examine whether our findings were robust to differences in size classes, growth opportunities[14] and sample year. Table 5 shows the results.

Although the profitability variable has a similar impact on small and large farms, its magnitude is higher for large farms. In addition, the speed of adjustment is much higher for large than for small farms, asserting the applicability of the pecking order and signalling theories in explaining farm businesses' capital structure decisions; it holds that creditors prefer larger, more visible farms. According to the pecking order theory, size provides bargaining power for larger farms, which will reduce the cost of adjustment and thus lead to faster adjustment to the target. Frank and Goyal (2003) also confirm that the pecking order theory is a better descriptor of the behaviour of large firms compared to small ones because large firms usually face relatively lower costs of adverse selection than smaller firms when considering the possibility of a risky or mispriced debt.

We also split the sample into sub-samples[15] based on growth opportunities. The results in Table 5 show that farms in the lowest and highest growth-opportunity brackets are similarly affected by farm-specific factors. Only the leverage ratio of high-growth farms is significantly and negatively affected by the tangibility of their assets. We also find that profitability has a negative impact on target leverage, that size is used as a dominant signal to obtain credit and that farms with higher growth opportunities exhibit much higher adjustment speeds.

14 The top and bottom 25 per cent of farms in terms of total annual output and investment are grouped as large and small and high and low growth-opportunity farms, respectively.

15 We conducted a *T*-test to check whether the split sample was significantly different. The results indicate that there is a statistically significant difference between the mean leverage for pre-crisis and post-crisis periods ($t = -10.2205$, $p = 0.0000$) for larger and smaller farms ($t = 7.7971$, $p = 0.0000$) and for high and low growth-opportunity farms ($t = 18.0041$, $p = 0.0000$).

Table 5. Farm size, growth opportunity and financial crisis (dependent variable: Leverage_{it})

	Farm size		Growth opportunity		Sample year	
Variables	Large	Small	High	Low	2001–2007	2008–2015
Leverage_{t-1}	0.1740***	0.9339***	0.7277***	0.9873**	0.8309***	0.4571***
	(0.0193)	(0.0303)	(0.0233)	(0.0136)	(0.0187)	(0.0095)
Profit	−1.1989**	−0.8310***	−0.7822***	−1.4058***	−0.8614***	−1.4673***
	(0.7640)	(0.0492)	(0.0621)	(0.4748)	(0.1080)	(0.0462)
Tangibility	0.0809	−0.1487**	−0.1905***	−0.5210**	−0.0425	−0.0763
	(0.0583)	(0.0253)	(0.0259)	(0.0323)	(0.0303)	(0.0249)
Size	–	–	0.0425***	−0.1397**	−0.0575***	0.0476**
	–	–	(0.0083)	(0.0108)	(0.0084)	(0.0931)
Growth	0.3022***	0.3506***	–	–	0.4006***	0.2513**
	(0.0387)	(0.0184)	–	–	(0.0192)	(0.0188)
Risk	−0.3828***	−0.1954**	0.04692	−0.6614***	−0.1061**	−0.5694***
	(0.01039)	(0.04257)	(0.0553)	(0.0648)	(0.0503)	(0.0589)
D-Field	−0.2101	−0.0100	0.0501***	0.0598**	0.0133	0.0614***
	(0.0561)	(0.0189)	(0.0157)	(0.0220)	(0.0171)	(0.0161)
D-Horticulture	0.1625	0.06022**	0.03831**	0.1476**	0.01657	0.2319***
	(0.0481)	(0.01622)	(0.01652)	(0.0220)	(0.0191)	(0.0135)
D-Livestock	−0.1765**	−0.0603	0.2193	−0.0614**	0.01745	0.1094**
	(0.0704)	(0.0136)	(0.0145)	(0.1583)	(0.0137)	(0.0130)
Constant	3.4859	0.1502	−0.4073	2.3571***	0.9093***	0.6495***
	(0.2987)	(0.1344)	(0.1246)	(0.1591)	(0.1274)	(0.1339)
Year	Yes	Yes	Yes	Yes	No	No
Wald (*p*-value)	$\chi^2(9) = 1090$	0.0000	$\chi^2(9) = 3712$	0.0000	$\chi^2(9) = 448$	0.0000
AR-1 (*p*-value)	$Z = -6.1653$	0.0000	$Z = -4.1325$	0.0000	$Z = -2.3491$	0.0186
AR-2 (*p*-value)	$Z = -1.5142$	0.1230	$Z = -1.5582$	0.1192	$Z = -0.5169$	0.6052

Note: Numbers in parentheses are robust standard errors, and ***and ** are significant at the 1 per cent and 5 per cent levels, respectively. The dummy reference levels are dairy farms and the year 2001.

Finally, we split the sample into two periods (2001–2007 and 2008–2015), to examine the farm capital structure decision pre and post the 2008 financial crisis. The analysis shows that the impacts of profit and earnings volatility on leverage are much higher and farms adjust to their target capital much quicker in the post-crisis period. In addition, the coefficients of the farm type dummies are positive and significant in the post-crisis period, suggesting that farm-specific factors played a more prominent role in determining the target capital structure in the post-crisis period than in the pre-crisis period.

We also show that the speed of adjustment towards the target leverage was significantly lower during the period prior to the financial crisis than after. During the period after the crisis, an average farm would close about 54.29 per cent of the gap between its target and its actual leverage ratio per year, compared to only around 16.9 per cent in the pre-crisis period. This finding is consistent with the apparent increase in market frictions in times of recession relative to expansion. We note that the impact of size on leverage is negative and significant in pre-crisis periods. This can be attributed to the fact that credit markets do not tighten up equally for farms during pre-crisis periods as loans become disproportionately more expensive and harder to obtain for smaller farms with little collateral.

5. Conclusions

In this paper, we aimed to examine the applicability of the pecking order and signalling theories to farm businesses, the effects of farm-specific and macroeconomic factors in determining the capital structure and the speed of adjustment to the target. We applied a partial-adjustment model to a unique panel consisting of 1,500 farms across 15 years (2001–2015).

Results from the System-GMM estimation support that the signalling behaviour in the farm–lender relationship matches the pecking order theory's explanation of the leverage ratios in farm businesses. The most robust findings are the negative association between farm leverage and profit and the support provided to the pecking order theory by earnings volatility (risk). In addition, consistent with the signalling theory, we find that farm leverage is positively related to asset tangibility and growth opportunity, something that has often been rejected for publicly listed firms. Decomposing our analysis into farm types, we show that dairy farms predominantly follow the signalling theory. Horticulture, livestock and field crop farms, on the other hand, appear to follow the pecking order theory more closely when it comes to their financing opportunities. All farm types use their growth opportunities to effectively send signals that will facilitate their access to credit. As farms do not have much access to external equity, signalling their good prospects through profits and investments plays a major role in the borrower–lender relationships. Based on these findings, we were able to provide supporting evidence for both the pecking order and signalling theories being good predictors of the capital structure of firms in the agricultural sector.

Farm profitability, asset tangibility, growth opportunity and size significantly determine farm capital structure. Although most of the variables identified in the literature affect the leverage of farms, the degree and importance of these factors are farm-type specific. Macroeconomic factors also determine a farm's decision on its capital structure, albeit not strongly. The capital structure decision of a farm is thus not only the product of its own specific characteristics but partially also of the macroeconomic environment in which it operates.

Further, the empirical results indicate that farms appear to adjust their leverage towards the optimal level over time in response to endogenous and exogenous shocks. The speed of adjustment to the target capital is slow and varies according to size and farm type. It is worth noting that farm leverage is highly persistent, i.e. adjustment speed is slow, and that lagged leverage is the best predictor of subsequent leverage ratios. The speed of adjustment is relatively faster for horticulture farms and slower for livestock farms. This variation is mainly attributed to the difference in adjustment costs. The evidence further confirms the existence of dynamics in the farm capital structure decision.

The results shed further light on the dynamic nature of the capital structure of farms and the applicability of capital structure theories to farm businesses. The results could also help policy makers and lenders develop effective instruments to control and influence the financial leverage of farms. For example, the estimate of farm size indicates that the speed of adjustment is slow for smaller farms. This suggests that lenders use size as a predominant signal of farm creditworthiness. It also suggests that policy makers should consider size when designing policy instruments to facilitate access to credit.

The understanding gained from studying the applicability of the pecking order and signalling theories to the farming business benefits both farms and lending institutions. Since historical financial performance is used as a valid signal, farms are encouraged to keep accurate and detailed financial records. It also enables lenders to better understand the dynamics of farm financing decisions and easily identify creditworthy farm businesses through the appropriate signals.

This paper has some limitations that motivate further research. Despite our use of unique and high-quality panel data, it is merely an accounting dataset. Future research may complement this with behavioural and demographic data on, for example, education, farm risk attitude and risk perception. Another interesting extension would be to conduct a farm survey on funding preferences or an experimental procedure as an alternative to the econometrics method used in this paper. Future research may also test for the applicability of other theories of capital structure to the farming business and their impact on farm performance in terms of profitability, survival and viability.

Even though we have used the partial-adjustment model to account for leverage dynamics and adjustment cost, this study is limited in that it explores leverage as the only dependent variable. Future research may test some of the richer relationships that come with the pecking order and signalling theories, such as the relationship between cash flow, debt and equity. Using cash flow, investment and short- and long-term debt as dependent variables might also be an interesting avenue for future research, as is refining the relationship between asset tangibility and the pecking order theory. This study has only found a weak relationship due to limitations in the information available.

Finally, a promising direction for future research would be to improve our understanding of the variations in farm leverage dynamics across countries and economies. This paper documents a number of interesting variations across the four farm types. A better understanding of these variations across economies of, for example, developed vs. developing countries and across countries with different legal, tax and farm-support systems, such as European countries and the United States, could lead to a valuable understanding of the dynamics and determinants of leverage in farm businesses.

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Appendix

Table A1. Dynamic panel regression results (dependent variable: Leverage$_{it}$)

Variables	Dairy	Field crops	Horticulture	Livestock
Leverage$_{t-1}$	0.8541***	0.8379***	0.3472***	0.9112***
	(0.020)	(0.042)	(0.135)	(0.067)
Profit	0.238**	−0.501***	−1.972***	−0.827***
	(0.119)	(0.165)	(0.528)	(0.1059)
Tangibility	0.0896***	−0.053	−0.0297	−0.0183
	(0.016)	(0.071)	(0.210)	(0.0475)
Size	−0.0234**	−0.0139	0.0875	0.0338
	(0.0122)	(0.011)	(0.0586)	(0.0205)
Growth	0.372***	0.3551***	0.0923**	0.404***
	(0.042)	(0.061)	(0.0620)	(0.0543)
Risk	0.0013	−0.08701**	−0.0501**	−0.00176*
	(0.0112)	(0.0359)	(0.0176)	(0.0857)
Constant	0.3188***	0.2839	−0.8822	−0.4354
	(0.174)	(0.1776)	(0.9946)	(0.3022)
Year	Yes	Yes	Yes	Yes

Wald $\chi^2(6) = 482.670$, p-value = 0.990.
Sargan test $\chi^2(151) = 945.1$, p-value = 0.990.
AR (1) $Z = -7.4523$, p-value = 0.000.
AR (2) $Z = -1.6229$, p-value = 0.1050.
Note: Numbers in parentheses are robust standard errors, and *** and ** are significant at the 1 per cent and 5 per cent levels, respectively. The dummy reference level is the year 2001.