THE DETERMINANTS OF EXTERNAL PRIVATE EQUITY FINANCING IN AGRICULTURAL PRODUCTION BUSINESSES

Mario P. Mondelli

Principal Investigator
CINVE - Centre For Economic Research
Av. Uruguay 1242
Montevideo, Uruguay. Post Code:11200
mondelli@cinve.org.uy

Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

The Determinants of External Private Equity Financing in Agricultural Production Businesses

ABSTRACT

This study investigates the determinants that influence a firm's decision to use external private equity in agriculture. The use of external equity as a funding source in agriculture has increased since 1990; however, the literature addressing this phenomenon is limited. The asset specificity approach (Williamson 1988) offers insightful contributions to understand the choice of financial mechanisms. Specifically, financial structure is related to asset specificity, the extent to which assets are redeployable to alternative uses, a particularly important attribute in agricultural production. I construct an international dataset of companies that receive external private equity finance to test the determinants of using external equity finance. Results show that the attributes of the assets involved in agriculture are important determinants of financing choices.

Key words: asset specificity, external equity, agricultural finance.
JEL Classification: D23, Q14, G24, G32

1. INTRODUCTION

One salient feature of modern economic organization is the transition from small family firms to large-scale corporations. However, certain industries have resisted the transition to large corporate ownership, remaining privately held firms as the dominant organizational form. Even in the United States where the public corporation is well established, the total value of private equity is similar in magnitude to the public equity market (Moskowitz and Vissing-Jorgesen 2002).

Private equity capital[1] has developed as an important source of funding for private middle market companies, firms in financial stress, and as growth capital. The private equity market has been the fastest growing financial market since the late 1980s, and during that period several organizational innovations have been developed to mitigate the problems that arise at each stage of the investment process (Gompers and Lerner 2001). Despite the growing literature that examines venture capital financing in industries such as biotechnology, software, and

[1] This research uses the following definitions for the terms private equity and venture capital. Venture capital refers to investment in earlier-stage firms (e.g., seed or start-up firms). Private Equity is a broader term that also encompasses later-stage projects, buyouts, and turnaround investments. Hence, the term private equity encompasses all private investment stages, including venture capital.

pharmaceuticals; the private equity market has received relatively little academic attention in other sectors, in particular, if compared to the public equity market.[2]

In this study, I examine the use of external equity finance by firms in the agricultural production, a sector in which private companies are the dominant organizational form. Specifically, this study investigates the determinants that influence a firm's decision to use external private equity in the agricultural production.

The use of external equity as a funding source by companies in the agrifood sector has increased since late 1990s.[3] Similar features apply for companies operating in agricultural production industries. However, the literature on the use of external private equity in the farming sector is very limited.

The importance of this phenomenon is twofold. First, because external equity capital allows farms to expand and take full advantage of business opportunities without incurring excessive financial risk from high levels of debt drains (Collins and Bourn 1986; Fiske, Batte and Lee 1986; Raup 1986; Lowenberg-Deboer, Featherstone and Leatham 1989; Wang, Leatham and Chaisantikulawat 2002). Second, because private equity plays a critical role at financing companies that pose numerous risks and uncertainties that discourage other investors (Lerner, Hardymon and Leamon 2009). Financing firms by private equity investors has become increasingly more important, both strategically and financially (Caselli 2010). In addition, the option of public equity is restricted for most companies in agricultural production, which enhance the importance of the option of external private equity for companies in this sector.[4]

External equity capital enters agriculture through two mechanisms. First, when external investors buy farmland directly. In this case, investors generally lease the land to farm operators. Second, when agricultural producers attract equity through limited partnership or common stock. In this study, I focus on the second mechanism and on the following implications. When a firm raises equity from outside investors, several problems arise due to uncertainty and informational asymmetries. The firm shifts from a single owner to a mixed ownership structure with outside equity investors. Additionally, it is subject to the fundamental conflict between the objectives of investors and the owner-manager. The firm's problem is to choose the financial mechanism that minimizes the costs of external funding.

The asset specificity approach (Williamson 1988) offers insightful contributions to understand the use of different financial mechanisms across farming industries. This approach to financing decisions brings additional insights and complements agency theory that has been the dominant perspective in the finance literature. However, empirical analysis and test of the asset

[2] Private equity securities do not involve any public offering and, hence, are exempt from registration with the Securities and Exchange Commission. This has been an obstacle for research in this area and explains the relative more abundant literature in finance focusing in the public corporation.

[3] For example, based on the information captured by the Venture Economics database, the number of agrifood companies that received their first investment from external equity investors in North America and the European Union increased from less than 40 in the 1980s to 210 in the 2000s. Data extracted from Thomson Financial´s SDC Platinum VentureXpert. Included countries of the European Union 15

[4] In addition, private equity has fostered entrepreneurial activity because it can lead to better coordination of assets across firms and markets, as assets are redeployed to higher-value uses (Klein 1999; Chapman and Klein 2010).

specificity approach to financial decisions has been limited, partially because of data constraints and difficulties to find good measures of asset specificity in databases of secondary data.

The empirical analysis is designed to test hypotheses of the determinants of the use of external equity finance by firms in the agricultural production industries. The dataset contains 99 private firms in agricultural production industries operating in North America (52), EU-15 (36), and Oceania (11). I use two data sources to construct an international dataset of companies that receive external private equity finance. I use the Venture Economics dataset to identify companies that received external equity. I use primary data from a survey to credit officers conducted to measure the degree of relationship-specific investments for each farm activity in the agricultural production sector (dairy, beef, corn, etc.). Finally, to obtain additional information on the companies that receive external private equity finance I use other databases such as LexisNexis, Business & Company Resource Center; Hoovers Online, Factiva, and SEC online.

This study contributes to our understanding of what drives the use of external equity capital in the agrifood production. In particular, this research illuminates the effects of industry factors in the financial choice. A better understanding of the use of external equity capital informs the design of private strategies and public policies to promote economic development in countries/regions with comparative advantages in the agrifood sector.

The study proceeds as follows. Section 2 presents the theoretical framework and discusses the hypotheses tested in this study. Section 3 describes the data and method used in the empirical analysis. Section 4 discusses the results and Section 6 discusses the implications and consequences of these results for the theory and future empirical research.

2. THEORETICAL FRAMEWORK

This study deals with the firm's choice of using external private equity. This decision affects the ownership structure of the firm, and hence, the fraction of equity held by the owner-manager. In this study, the term private equity encompasses all private investment stages, including venture capital.

There are several finance options for a firm in the agricultural production sector. Farming enterprises, in particular, have the following choices: rent versus buy land; debt versus equity; internal versus external equity; and public versus private equity. In this study, I focus on the external finance choice between debt capital and private equity.

The finance literature has evolved from treating profitability as independent of the way the firm is financed (Modigliani and Merton 1958),[5] to acknowledging that capital structure and managerial actions affect a firm's profitability, to recognizing that firm value depends also on the allocation of decision (control) rights between entrepreneurs and investors (Grossman and Hart 1986; Hart and Moore 1990).

[5] Modigliani and Miller derived their results under the assumption of the existence of a perfect capital market, no taxes, and no incentive or information problems.

Agency theory has motivated a large volume of empirical studies in corporate finance. The main finding of the literature on the agency problem is that the best way to deal with them is to put the agent on an optimal incentive scheme (Hart 2001). Agency problems are reduced through an appropriate scheme that aligns the manager's incentives with investors' interests.

Within agency theory, capital is assumed to be undifferentiated and there is no suggestion that debt is better suited for some projects and equity for others (Williamson 1988 p. 579). Williamson (1988) argues that additional elements need to be taken into account to understand when it is optimal for a firm to use external equity finance. He develops an asset specificity approach to finance and argues that whether a project should be financed by debt or equity depends principally on the characteristics of the assets. Assets that are highly specific to the project will have lower value for other use in case the project is liquidated (lower salvage value). When the assets involved in a project/enterprise are highly specific and, hence, have lower value for other purposes, bondholders are subject to opportunistic behavior by the owner-manager of the firm, as bondholder have no control over firm management. The effect of asset specificity in the cost of capital is associated with an ex-post occurrence of bankruptcy.

In this setting, asset specificity and agency theory perspectives are approached as complementary. The differential attributes of the assets involved in agricultural production are an important source of variation across farm activities. Whereas some farm activities heavily rely on highly redeployable assets, farmland being the most distinctive one; other farm activities rely on single purpose equipment and facilities that are, in certain cases, non-redeployable.

The literature on agricultural finance has been successful at addressing the effect that the non-depreciable attribute of land has on the financial characteristics of agriculture (Barry and Robison 2001). However, little is known about the effect that other attributes of the assets involved in agricultural production have on the use of alternative financing mechanisms.

2.1. Asset Specificity

The asset specificity approach to the firm's financing decisions approaches debt and equity as alternative governance structures rather than as financial instruments. The governance structure associated with debt is of a very market-like kind and that associated with equity is the administrative form.

The 'debt versus equity' question is treated in this framework as a 'rules versus discretion' tradeoff. Debt represents a more rigid financial mechanism that follows the rules and equity is a more flexible and discretionary mechanism. In the event of failure, control over the underlying asset reverts to the creditor, who might exercise liquidation of the assets. Although the creditor might choose to concede some discretion allowing the borrower to work things out, the advantage of equity is that "it features administrative processes that are specifically designed to facilitate 'working things out'." (Williamson 2010, p. 245) While the need to work things out would be low for financing of projects with redeployable assets, the demand to work things out increases as redeployability diminishes.

Equity is much more intrusive and involves active role of investors in the management of the project. In this setting, the condition of asset specificity is the primary factor to explain the use of debt versus equity finance (Williamson 1988).

The problem faced by firms is to choose the financial mechanism that minimizes the costs of external funding. Debt is a low cost governance arrangement for projects involving highly redeployable assets, because if the project is successful, interest and principal will be paid on schedule and if the project fails, debt-holders can liquidate assets to recover their investments. The opposite applies when the assets involved in a project are highly specific (i.e., non-redeployable) and, hence, have lower value for other purposes in case the project is liquidated. In this case, the terms of debt financing will be adjusted adversely as the degree of redeployability of assets declines, because the loss in case of failure increases as asset are less redeployable.

Creditors may not have the skills or means to actively monitor projects that involve few collateralizable assets. These projects involve high risk for banks and even if banks were to make loans to high risk projects, the interest rate required would be extremely high, creating liquidity problems for the firm (Gompers 1995).

Equity governance provides incentives for investors to monitor firms more closely. By taking equity ownership, investors in private companies can access the benefits if the firm does well. Equity governance has the following properties: (i) investors bear a residual-claimant status to the firm in both earnings and asset-liquidation respects, (ii) it is a contract for the duration of the life of the firm, and (iii) control rights are awarded to equity holders (usually exerted through a board of directors) (Williamson 1988).

Based on these insights, those farm activities that rely more on assets with low redeployability are expected to have higher equity requirements than those farming activities relying on multiple purpose facilities and equipment, and land. Asset specificity considerations inform the following general prediction: *the higher the level of asset specificity, the higher the probability a firm uses external equity finance.* Equity governance can better coordinate the relationship between outside investors and the owner-manager when assets have low liquidation value. In addition, lower liquidation value reduces the firm's collateral, constraining access to debt capital.

Williamson (1991) discusses six types of asset specificity. The first three—physical, human, and site specificity—have received more attention in the empirical literature on contracting decisions. Physical-asset specificity refers to equipment, machinery and facilities that are required to provide a product or service. Human-asset specificity arises when specific knowledge, experience or human capital is required to support the transaction. Site specificity refers to situations where successive stations or assets are located closely to one another. The fourth is brand-name capital. The fifth is dedicated assets, which are substantial investment in general purpose assets made for a particular customer. Although not specific to that customer, because of the level of the investment their release to the market would depress the market value of the assets.

The sixth is temporal-asset specificity, which refers to assets that must be used in a particular sequence and where timely responsiveness is important. "'Temporal specificity' may arise because a product's value is inherently time dependent, like newspapers; because of the serial nature of production, as in construction projects; or because the product is perishable, as is the case, of course, with agricultural commodities." (Masten 2000, p. 180) Timing factors create temporal specificities in certain agricultural industries such as poultry and dairy milk. For example, because of the risk of contamination with pathogens, poultry has narrow range of time which it must be sent to processors (Martinez 1999).

In the setting of the choice of using external private equity by firms in the agricultural production sector, I focus on four types of asset specificity—physical, temporal, site, and human. Masten (2000) argues that temporal- and site-asset specificity are expected to play an important role in agriculture. Perishability is the most conspicuous attribute of agricultural products when compared to non-agricultural products. Similarly, many agricultural products have high weight-to-value ratio, which translates in economic incentives for producers and processor to be located in proximity of each other. Farming activities differ significantly in the attributes of the assets involved in the production process. Physical asset specificity is also expected to play an important role at explaining organizational choices in agriculture. Finally, human-asset specificity is also included in this discussion. Although *a priori* it does not appear to be a distinctive characteristic in agriculture, additional implications for the financing choices might be involved. In that respect, the asset specificity prediction needs to be discussed for each type of asset specificity.

Physical-asset specificity

Physical assets that are highly specific to a firm's production or project usually cannot be used as collateral. If lenders decide to finance projects with low redeployable assets, the cost of finance will be higher, as the loss in case of liquidation is higher. Investments in this type of assets involve higher costs associated with debt capital because lenders have limited ability to control owner-manager's decisions. Equity capital, although not costless, involves control over the firm which mitigates opportunistic behavior by the owner-manager.

Farm activities with high physical-asset specificity are those that rely, in a great extent, on single-purpose assets and face small numbers bargaining. These conditions can usually be found, for example, on poultry, hog, floriculture, fruit and tree nut production. Advance rates would be adjusted adversely for farm activities that rely on high level of relationship-specific assets if compared with farm activities that rely on highly redeployable assets such as cash crops. Hence, higher costs of debt capital are expected for those farm activities that rely on low redeployable assets.

The problem associated with assets with a low degree of redeployability is intensified for debt financing because of the following situation. Due to banking regulations, banks in the U.S. are not allowed to hold assets beyond a certain period of time. That is, banks have to liquidate assets after certain time and, as it approaches, the value of the assets might go down. As the number of potential buyers is lower for single-purpose assets with low degree of redeployability,

this problem is particularly serious for these types of assets. Potential buyers know about this and use this information to negotiate down the price of the assets.

The alternative mechanism for external funding—equity—although not costless, it can mitigate part of the problems described above. In addition, in case of failure, equity investors who participate in other businesses in the same industry or in related industries might be able to repossess and redeploy the assets more efficiently than the bank. Unlike banks, equity investors can usually wait to sell the assets.

Physical-asset specificity considerations inform this hypothesis.

H_1: the higher the level of physical-asset specificity, the higher the probability a firm uses external equity finance.

Temporal-asset specificity

Firms that focus on farm activities that involve high level of temporal-asset specificity are, from the lender's point of view, more risky. Lenders evaluate not only aspects related to the farm operation and the investment project, but also the relationship with the processor/buyer and its viability.

Asset in farm activities in this group are more likely to lose value in case of failure because the relationship with the processor becomes a relevant factor for the viability of the farm project. Potential buyers in these farm activities need not only the facilities and machinery for these farm activities, but also some type of specialized vertical coordination agreement with the processor. As a result, the number of potential buyers will be reduced and, hence, the salvage value of those assets is adjusted adversely.

Lenders will evaluate not only aspects related to the farm operation and the investment project, but also the relationship with the processor/buyer and its viability. Assets involved in farm activities with high temporal-asset specificity in this lose value in case of failure because the relationship with the processor becomes a relevant factor for the farm project. The cost of debt increases as the salvage value of the assets decreases. Examples of farm activities involving high level of temporal-asset specificity can be found in dairy (confinement), berry, and shellfish fishing.

Temporal-asset specificity considerations inform this hypothesis.

H_2: the higher the level of temporal-asset specificity, the higher the probability a firm uses external equity finance.

Site specificity

The effect associated with higher levels of site-specificity is very similar to the one of temporal-asset specificity. Given the dependency that farmers in farm activities that involve high site-specificity have with the buyer, lenders evaluate not only aspects related to the farm operation and the investment project, but also the relationship with the processor/buyer and its viability.

In case of failure, potential buyers will need not only the facilities and machinery but also need to develop commercial relationship with the buyer/processor located closely to the farm operation.

Site specificity considerations inform this hypothesis.

H_3: the higher the level of site-asset specificity, the higher the probability a firm uses external equity finance.

Human-asset specificity

The effect human capital has on the use of external private equity leads to a different prediction than the other three types of asset specificity discussed above—physical, temporal, and site. Hart and Moore (1994) develop a model of financing decisions in which an entrepreneur who has access to a profitable investment project, does not have the funds to finance it, and he or she cannot costlessly be replaced (i.e., high human-asset specificity). They distinguish between physical assets (the project capital) and human assets (the entrepreneur's human capital), and analyze the financial implications of the inalienable nature of human assets—that is, the entrepreneur's human capital always resides with him.

Because of this condition, if the entrepreneur cannot costlessly be replaced, he or she "can always threaten to repudiate the contract by withdrawing his human capital." Hart and Moore show that the threat of walk away (by the entrepreneur) means that some profitable projects will not be financed. External investors (banks or private equity investors) foreseeing this hold-up problem will be less likely to provide capital when the knowledge and skills of the entrepreneur are important for the project and cannot be replaced.

One solution to this problem is that the entrepreneur should have a greater stake in the company. The prediction associated with this analysis is that the condition of high human-asset specificity reduces the probability that a firm will access to external investors (both debt and equity).

Human-asset specificity considerations inform this hypothesis.

H_4: the higher the level of human-asset specificity, the lower the probability a firm uses external equity finance.

2.2. Moral hazard incentives and gains from specialization

In addition to the asset specificity approach, other insight associated with moral hazard incentives, monitoring problems, and gains from specialization are also considered. Allen and Lueck (1998) develop a model to explain the organizational choice of farming venture—family

farm, partnership, or corporate farm—based on a trade-off between *moral hazard incentives* and *gains from specialization.*

The model developed by Allen and Lueck (1998) is approached as complementary rather than substitute of the asset specificity approach. The empirical analysis of this paper focuses on the comparison between the asset specificity model and the Allen and Lueck (1998) model. I test whether, as argued by Allen and Lueck, asset specificity is not a relevant factor for the explanation of the choice of organizational forms in farming agriculture. [6] Alternatively, the different types of asset specificity are important determinates to explain the use of external equity finance and, hence, the use of partnerships in agriculture.

The specific characteristics of the agricultural production sector that affect organizational choices, as developed by Allen and Lueck (1988), are the following. Mother Nature puts seasonal restrictions and random shocks, and the interaction of these attributes generates moral hazard, limits gains from specialization, and causes timing problems between stages of production. The production process involves several stages that are linked to biological processes (e.g., planting, flowering, harvesting) and are required to be performed in certain moments of the year and under certain conditions (e.g., temperature, rainfall). A high degree of moral hazard is a problem because monitoring and evaluation is typically difficult and limited.

The gains from specialization argument is explained by the increases in worker's marginal productivity when he or she spends more time working at a particular task, which depends also on how many tasks the worker is performing during a stage. Moreover, tasks might differ in the potential gains from specialization. For example, the quality of management decisions might be improved if the worker focuses in that activity. Hence, for a task with high importance of specialization, the greater gains from specialization occur, for example, when many production cycles can be completed in one year, there are few tasks, or each worker can specialize in one task.

Allen and Lueck (1998) incorporate features that affect a production activity through the following parameters: *cycles* (number of times per year the entire production cycle can be completed); number of *stages* in the production process; and number of *tasks* in a given stage (well-defined jobs such as operating a combine, planning activities, etc.).

The agricultural production activities that succeed in controlling the effects of nature (i.e., reducing the effects of seasonality and random production shocks) have greater potential gains from specialization and lower monitoring costs of wage labor. As a result, firms in these activities will require higher levels of capital and, hence, will be more likely to use equity capital to fulfill their financial needs. The inverse also applies, the gains from specialization will be limited and wage labor expensive to monitor for farming activities that cannot control the effects of natural forces, with short production stages, infrequent, and that require few distinct tasks. Those activities, as corroborated by Allen and Lueck, will be better organized by family farms (as opposed to partnerships and corporations) that require lower capital investments.

[6] Allen and Lueck state that "[a]lthough our approach does not depend on asset specificity, we do incorporate an agricultural version of "temporal specificity" (Masten, Meehan, Snyder, 1991)." (Allen and Lueck 1998, p. 345)

Based on the above discussion, two sets of variables are introduced into the model that refers to the idiosyncratic characteristics of agricultural production sector. First, factors that explain gains from specialization in agricultural production sector. Second, the importance of random shocks and farm product sensitivity to task timing in explaining the production output and, hence, the importance of the moral hazard problem which results in increasing monitoring costs. These factors capture situations of firms that are more likely to expand and, hence, face greater capital needs. Greater capital needs are associated with the use of external equity capital, considering that the access to debt capital is limited by the equity capital of the farm (collateral) and that the option of public equity is restricted for most companies in agriculture.

The moral hazard incentives and gains from specialization considerations for agricultural production activities inform the following predictions.

H_5: The higher the gains from specialization for a firm/project, the higher the needs for external funding, and hence, the higher the probability of using external equity capital.

H_6: The greater the effect of random shocks in farming output, the lower the probability of using external equity capital.

2.3. Other factors

The institutional environment in which the parties operate affects the financial contracts. Access to equity capital might be facilitated for firms in some countries but not in others. Although in this study I explore comparative analysis between country/regions, I do not test specific hypotheses for factors related to the institutional environment or country level effects. I do include country specific factors to control for macro-economic and legal environment effects that might facilitate/constraint financial contracts between private firms and investors.

Additional factors on the decision to use debt versus equity capital are discussed in the literature review. Agency theory has informed an important volume of studies in corporate finance. Similarly, additional factors can be found in the entrepreneurship literature. I incorporate some of these factors in the empirical analysis as control variables.

3. DATA AND METHOD

3.1. Data

To construct an international dataset of companies that receive external private equity finance I use two data sources: the Venture Economics dataset to identify companies that received external equity; and primary data from a survey to credit officers designed to measure the degree of relationship-specific investments for each farm activity in the agricultural production sector (i.e., dairy, beef, corn, etc.). In order to obtain additional information on the companies that receive external private equity finance I use other databases such as LexisNexis, Business & Company Resource Center; Hoovers Online, Factiva, and SEC online.

The combination of primary and secondary data allows to overcome measurement problems on the asset specificity variables (using survey data), while avoiding sample size

problems that are common in studies relying on survey data. That is, this strategy exploits the advantages of both sources of data—survey and secondary data.

Sample of companies that received external private equity finance

The Venture Economics dataset was accessed through Thomson Financial´s SDC Platinum VentureXpert. Venture economics data have been extensively used in previous studies (c.f., Gompers 1995; Kaplan and Schoar 2005; Dushnitsky and Shapira 2010).

Venture economics collects quarterly information on investment funds in the private equity industry. The collected data consists of voluntary reporting of fund information by the private equity firms (or general partners) as well as by their limited partners. Venture economics claims that there is little room for inconsistencies because they receive information from both—general partners and limited partners. Although this statement is difficult to validate, Kaplan and Schoar (2005) argue that if there is a bias it would take the form of underreporting by worse performing funds. This type of bias is of particular importance for studies using performance variables. In that respect, this type of bias is considered a minor problem for this study considering that I do not rely on performance variables for the empirical analysis.

The sample covers portfolio companies that received the first external private equity investment after 1990. Because of the rapid growth of the private equity industry in the 1990s, earlier periods contain less financing information. Moreover, it is convenient to avoid the financial crisis of the farming sector during 1980s.

Table 1 summarizes the screening steps to construct the final sample of companies in agricultural production industries that received external equity finance.[7]

[7] Venture Economics database contains information about companies receiving investments and their respective investors (private equity firms and funds). I rely on "industry affiliation" for each company to select firms in the agrifood sector that received external equity finance.

Table 1. Steps building the dataset of companies in agricultural production using external private equity

Step 1: Download database from SDC Platinum VentureXpert

- I selected the companies in the following Company Venture Economics Primary Industry Class (VEIC): 9500 Agriculture, Forestry, Fishing; 9510 Agriculture related; 9520 Forestry related; 9530 Fishing related; 9540 Animal husbandry; 9599 Other Agriculture, Forestry, Fishing.
- In this dataset, I selected all variables that contained information about the companies that receive investments (portfolio companies) and about the investors (PE firms and PE funds).
- Based on the 'business description' and 'primary product description', I classified each portfolio company by sector.
- For those companies whose primary business description is agricultural production, I classified each company according to their farming activities using SIC codes (4 digits).

Step 2: Screening

- Selected companies in agricultural production industries
- Dropped companies with date that received first investment prior to 1990.
- Dropped companies with missing values in most relevant variables.
- Dropped public companies.

Step 3: additional information on portfolio companies in agricultural production in the U.S. and Canada

- Obtained additional information using the following databases: Hoovers, LexisNexis, Factiva, Business & Company Resource Center Compustat and SEC website.
- I tried to contact each company to corroborate/complete information.

The initial data sample contains 293 private firms in the agrifood sectors North America, European Union-15 and Oceania (Table 2). The final dataset contains 99 private firms in agricultural production industries operating in North America (52 companies), EU-15 (36 companies), and Oceania (11 companies).[8]

Table 2. Number of agrifood companies that received external equity investments by sector. North America, EU-15, Australia-New Zealand, 1990-2010.

Sector	North America (N)	EU-15 (N)	AU-NZ (N)	Total (N)
Agricultural inputs	35	31	1	67
Agricultural production	52	36	11	99
Agrifood processing	35	19	3	57
Wholesale	9	3	2	14
Service to agricultural production	32	17	7	56
Total	163	106	24	293

Source: Thomson Financial´s SDC Platinum VentureXpert.

[8] It is important to mention that unfortunately cases such as the "New Generation Cooperatives" (with financing coming from members of the cooperative) are not reported in the Venture Economics database.

Survey data for asset specificity variables

Empirical studies using the asset specificity approach to financing decisions have used proxies such as advertising intensity and R&D intensity, which are poor measures of the liquidation value of the assets involved in the project. Other studies use the ratio of tangible assets to total assets. However, the "intangible breakdown is a very incomplete measure of asset specificity. Thus although intangible investments in R&D and advertising have poor redeployability properties, this is also true of many tangible assets." (Williamson 1988 p. 588) Tangible assets can also involve high levels of asset specificity such as physical assets in activities that involve high levels of temporal-asset specificity (e.g., dairy industry). Finding good proxies for asset specificity in databases of secondary data has and will probably continue to be a major challenge for empirical studies using asset specificity insights.

I attempt to avoid the common problem of using poor proxies for asset specificity when using secondary data, by using survey data to measure asset specificity variables. The survey designed for this study required each credit officer to rate the level of asset specificity of the assets in each farm activity (i.e., dairy, beef, corn, etc.). For each company, I matched the value of physical-asset specificity based on the Standard Industry Classification (SIC) 4-digit membership of the company.

Credit officers are a relevant source of information because when evaluating a farm project to approve loans to farmers, they perform an assessment of the farm assets that serve as collateral. In addition, credit officers have significant experience in evaluating farm assets in different commodity sectors.

The survey was mailed to 300 credit officers distributed in 38 States in the U.S. from agricultural banks and credit organizations of the Farm Credit System in April 2011. Each credit officer was asked to name up to ten farm activities with which they were familiar with. The respondents rated each farm activity across seven questions that cover the four types asset specificity tested in this study (physical, temporal, site, and human). Table 3 reports the survey questions used to measure the four types of asset specificity variables. [9]

[9] This strategy of data collection is based on previous surveys by Masten, Meehan, and Snyder (1991), Poppo and Zenger (1998), and Anderson and Schmittlein (1984).

Table 3. Survey questions used as indicator variables for asset specificity.

Variable	Survey question	Scale
Physical-asset specificity	To what degree would assets in this farm activity lose value in the event of bankruptcy (consider all assets as a bundle)?[/1]	1 to 7
	How costly would it be for the producer to switch where they sell their product (consider all costs, including time and resources to find new buyers)?[/2]	1 to 7
	To what degree are facilities and equipment used in the production process specific to this product (specialized/single use facility and equipment)?	1 to 7
	How important are bargaining problems caused by small numbers of potential buyers (concentration in buyer´s market)?	1 to 7
Temporal-asset specificity	How important is timely delivery of this product to processors/distributors (consider the time period within which the product must be sent to buyers)?	1 to 7
Site specificity	How important is it to be close to buyer's facilities for this product (consider the distance between farmers and buyers)?	1 to 7
Human-asset specificity	To what degree are skills, knowledge, or experience of the farmer/ manager, specific to this production activity and to particular buyers?[/1]	1 to 7

[/1] Adapted from Masten et al. (1991). [/2] Adapted from Poppo and Zenger (1998).

Out of 50 returned questionnaires, 48 were usable and contained 319 case observations. A case refers to one individual respondent's assessment of a farm activity and these 319 cases cover 40 farm activities (on average, eight responses per farm activity). Although the variation in number of responses per farm activity is a natural consequence of the distribution of farm activities, to mitigate potential measurement problems I used observations of those farm activities rated by three or more credit officers. That is, I use measures of asset specificity for 31 farm activities.

3.2. Measures and Descriptive Statistics

Measures

The dependent variable indicates the level of investments that a firm receives from external private equity investors. That variable is captured by the 'number of investment funds received by the portfolio company' in the Venture Expert database. I use a dummy variable for multiple investment funds (*multiple_inv_funds_dummy*) that equals 1 if company receives two or more funds and 0 otherwise. Similarly, I also use an ordinal variable containing the number of investment funds received by each company (*multiple_inv_funds_ord*).

Ideally, I would only use the variable 'total amount a company has received to-date from all investors' (*inv_total_rcvd_ord)* but unfortunately I cannot rely entirely on this measure due to

missing values in 50% of the companies in the final sample. However, I report a model using this variable for robustness check of the results.[10]

Table 4 presents a description of the variables used in the empirical analysis, expected signs and results. To represent H_1, I used a measure of 'physical-asset specificity' at the farm activity level. For each company, I matched the value of physical-asset specificity based on the SIC 4-digit membership of the company. When a company has more than one farm activity (e.g., soybean and wheat), I computed the average value among farm activities.

To mitigate measurement problems I used the information contained in four questions to derive a multidimensional measure of physical-asset specificity per farming activity using factor analysis. These questions cover, for each farm activity, the salvage value of the assets involved, the switching cost, the degree to which facilities and equipment are specific to the product involved, and how sever bargain problems are.

Similarly, H_2 is represented by a measure of the degree of 'temporal-asset specificity' that captures the importance of timely delivery of the farm product involve to processors/distributors. H_3 is represented by a measure of 'site-specificity' that captures the importance of being close to buyer's facilities for the product involved in each farm activity. Finally, H_4 is represented by a measure of 'human-asset specificity' that captures the importance of the degree to which skills, knowledge, or experience of the farmer/manager is specific to the production activity and to particular buyers.

[10] That is, to support the use of the variable 'multiple investment funds' as a proxy for the level of investments received by a company I rely not only on the positive correlation of 0.35 between 'multiple_inv_funds_dummy' and 'inv_total_rcvd_ord', but also on the estimates of the models using each of these dependent variables.

Table 4. Dependent and independent variables: variable name, definition, source, and expected sign.

Variable	Definition	Source	Hyp.	Pred sign	Result
multiple_inv_funds_dummy	Number of investment funds received by company. Dummy=1 if two or more funds were invested in company; 0 if 1 fund was invested.	SDC	--	DV	--
multiple_inv_funds_ord	Number of investment funds received by company. Ordinal (1-4): 1 if 1 fund was invested in company; 2 if 2 funds; 3 if 3 funds; 4 if 4 or more funds were invested in company.	SDC	--	DV	--
inv_total_rcvd_ord	Total known amount a portfolio company has received to-date from all investors. Ordinal (1-4): 1 if 'inv tot rcvd' < 25th percentile; 2 if between 25&50th; 3 if between 50&75th pctile; 4 if > 75th pctile. Comparison among companies in agricultural production in NA, EU15, Oceania.	SDC	--	DV	--
physical_asset_sp	Physical-asset specificity. 7-point scale in which '1' represented 'low degree' and '7' represented 'high degree./a	Survey	H_1	(+)	(+)
temporal_specificity	Temporal-asset specificity. 7-point scale in which '1' represented 'low degree' and '7' represented 'high degree./a	Survey	H_2	(+)	(+)
site_specificity	Site asset specificity. 7-point scale in which '1' represented 'low degree' and '7' represented 'high degree./a	Survey	H_3	(+)	(-)
human_asset_specificity	Human-asset specificity. 7-point scale in which '1' represented 'low degree' and '7' represented 'high degree./a	Survey	H_4	(-)	(-)
Control Variables					
sum_vc_invest_gral	VC activity by state/country. Mean 2000-2008 ($Mill)./b	/c		(+)	(-)
ag_gdp	Agricultural GDP by state/country in 2009 ($Mill)./b	/d			NS
merger_acquisition_dummy	Dummy=1 if portfolio company was acquired or merged with another firm; 0 otherwise.	SDC		(+)	(+)
lbo_dummy	Dummy=1 if portfolio company has received Leveraged Buyout (LBO) financing; 0 otherwise.	SDC		(+)	NS
ipo_dummy	Dummy=1 if portfolio company had an initial public offering; 0 otherwise.	SDC		(+)	(+)
start_early_stage_1st_round	Dummy=1 if startup or early investment stage at 1st round; 0 otherwise.	SDC		base	--
expansion_stage_1st_round	Dummy=1 if expansion investment stage at 1st round; 0 otherwise.	SDC			NS
later_stage_1st_ round	Dummy=1 if later investment stage at 1st round; 0 otherwise.	SDC			NS
buyout_acquis_stage_1st_round_	Dummy=1 if buyout/acquisition investment stage at 1st round; 0 otherwise.	SDC			(-)
firm_size__mean	Total investment by investment firm(s) in all companies. Mean value when more than 1 investment firm. ($Mill).	SDC			(-)
sum_pe_invest_related	Private equity activity by state/country in agrifood related companies (VEIC 9500s) ($Mill)./b	SDC		(+)	NS
Allen and Lueck (1998) variables					
cycles_less1	1 if farming activity has less than a production cycle per year; 0 otherwise./a	/e	H_5	(-)	--
cycles_equal1	1 if farming activity has on production cycle per year; 0 otherwise./a	/e	H_5	(-)	NS
cycles_more1	1 if farming activity has more than a production cycle per year; 0 otherwise./a	/e	H_5	base	--
under_cover	1 if farming activity under cover; 0 otherwise./a	/e	H_6	(+)	(+)
irrigated	1 if farming activity use irrigation; 0 otherwise.	/e	H_6	(+)	--

Note: DV=Dependent variable. 'Company' refers to portfolio company that received the investment. 'Firm' refers to investment firm. SDC= Venture Economics through Thomson Financial´s SDC Platinum VentureXpert. NS=Not statistically significant difference.
/a Average when company has more than 1 farming activity. /b By state for U.S. and by country for EU-15, Canada, Australia, and New Zealand. /c For U.S., Thomson Reuters, taken from the National Venture Capital Association 2009 Yearbook. For other countries (EU, Oceania), VentureXpert. /d For U.S., Regional Economic Accounts at the U.S. Bureau of Economic Analysis. For other countries (EU, Oceania), CIA World Factbook.[11]
/e Based on Allen and Lueck (1998). Criteria for 'Cycles': "Included in CYCLES > I are hay crops, pasture, nursery crops, vegetables, and sugarcane (planted only once every 3-5 years); included in CYCLES = 1 are annual grain crops such as barley, rice, soybeans, and wheat; and included in CYCLES < 1 are tree fruits, nuts, and timber." (1998, p. 375)

The variables related to the Allen and Lueck (1998) model were computed for each of the 40 farm activities with measures on the asset specificity variables. Their values were adapted from Allen and Lueck's discussion and empirical analysis.

Gains from specialization (H_5) is measured through the number of production cycles per year, where more cycles allows for specialization—'cycles<1', 'cycles=1', 'cycles>1'. *Variance in farm output (H_6)* (yield or productivity) is captured through an 'irrigation' dummy for crop/vegetable production; and an 'under cover' dummy for farming activities such as fruit/vegetable production using green house or animal production under covered such as in poultry (non-cage-free). In both variables, I used a general classification for farming activity and information on the 'business description' of each company in the database to identify the use of irrigation or under cover production.

A set of control variables were included in the empirical analysis. I followed the established literature in corporate finance and included insights from the entrepreneurship literature as discussed in the literature review. Data constraints impeded the inclusion of some of the variables discussed in the literature.

Access to external equity was represented by venture capital activity (*sum_vc_invest_gral*) in the state/country where the portfolio company is located. I constructed another variable to capture access to external equity based on private equity activity in "related" industries (*sum_pe_invest_related*). For this measure, I relied on the 'total amount a company has received to-date from all investors' in agrifood industries (covering production, processing, and wholesale sectors, given by VEIC 9500s).

I used agricultural GDP (*ag_gdp*) by state/country to control for activity in the agricultural production sector. I also controlled by the size of the private equity firm(s) that invested in a portfolio company. I measured size of private equity firm through the sum of 'total investment by investment firm in all companies'.

Company stage and type of exit was controlled by three dummies—'IPO', 'LBO', and 'M&A'. Companies that go public (IPO) receive more total financing and a greater number of rounds than other companies such as those companies that are acquired (Gompers 1995).

[11] Access: https://www.bea.gov/regional/downloadzip.cfm; and https://www.cia.gov/library/publications/the-world-factbook/fields/2012.html, respectively.

Similarly, I included dummies to control for company development at the time it received its first investment from a private fund. Based on SDC VentureXpert classification of company development, four dummies were constructed—'startup/seed-early stage' (base), 'expansion', 'later stage', 'buyout-acquisition'.

Another set of variables was computed based on SDC VentureXpert and other company databases but were not included in the regression analysis due to missing values problem. These variables are the following: total assets, number of employees, total sales, and total debt.

Finally, I included dummy variables for regions to control for macroeconomic and legal environment factors that might facilitate/constraint financial contracting between private firms and investors in the agricultural production sector, as well as the access to private equity investments. I included the following dummies: United States (base), Canada, European Union-15, and Oceania.

Descriptive statistics

Table 5 reports descriptive statistics of the variables used in the regression analysis.

Table 5. Summary statistics for dependent and independent variables.

Variable	Unit/type	Obs	Mean	Std.Dev.	Min	Max
multiple_inv_funds_dummy	dummy	91	.23	.42	.00	1.00
multiple_inv_funds_ord	ord	91	1.42	0.84	1.00	4.00
inv_total_rcvd_ord	ord	46	2.54	1.13	1.00	4.00
physical_asset_specificity	(1-7)	97	4.76	0.81	2.60	6.80
temporal_specificity	(1-7)	97	4.93	1.31	2.73	7.00
site_specificity	(1-7)	97	4.62	.88	3.00	7.00
human_asset_specificity	(1-7)	97	5.37	1.00	3.82	7.00
sum_vc_invest_gral	($Mill)	98	3,398.83	4,798.23	13.80	15,567.07
sum_pe_invest_related	($Mill)	91	44.93	392.32	.43	1,154.14
ag_gdp	($Mill)	98	26,076.79	15,957.39	617.37	49,421.56
merger_acquisition_dummy	dummy	99	.05	.22	.00	1.00
lbo_dummy	dummy	99	.09	.29	.00	1.00
ipo_dummy	dummy	99	.09	.29	.00	1.00
start_early_stage_1st_round	dummy	80	.23	.42	.00	1.00
expansion_stage_1st_round	dummy	80	.45	.50	.00	1.00
later_stage_1st_round	dummy	80	.05	.22	.00	1.00
buyout_acquis_stage_1st_round	dummy	80	.28	.45	.00	1.00
(inv) firm_size_mean	($Mill)	80	9,263.75	20,081.91	.65	79,195.63
cycles_less1	dummy	97	.32	.46	.00	1.00

cycles_equal1	dummy	97	.07	.23	.00	1.00
cycles_more1	dummy	97	.62	.48	.00	1.00
irrigated	dummy	97	.03	.17	.00	1.00
under_cover	dummy	97	.32	.46	.00	1.00

4. RESULTS AND DISCUSSION

The empirical model is designed to test the influence of asset specificity variables on the use of external equity finance by companies in agricultural production.

The dependent variable multiple investment funds (*multiple_inv_funds_dummy*) indicates the level of investments that a company receives from external private equity investors. This is a dummy variable that equals 1 if the company receives two or more funds (and equals 0 otherwise). I use the probit econometric model that presents advantages over linear probability model using a binary dependent variable.

For robustness, I use two additional specifications for the dependent variable—use of external equity finance. I use an ordinal variable based on the 'number of investment funds received by company'. This dependent variable (*inv_funds_ord*) takes the value of 1 if 1 fund was invested in company, 2 if 2 funds, 3 if 3 funds; 4 if 4 or more funds were invested in company. The second specification is an ordinal measure of the 'total amount a company has received to-date from all investors' (*inv_total_rcvd_ord*). Ideally, I would use this variable in the preferred model but the number of observations used in the regression is significantly reduced due to missing values in this variable. For that reason, I use this variable for robustness check of the results. Because of the ordinal nature of these two dependent variables, I use an ordered probit model.

Regression results

Table 6 reports the regression results. In Model 1, I report the probit estimates of the asset specificity variables on multiple investment funds. The results in Model 1 indicate the following. As expected, companies in farming activities that involve higher levels of physical-asset specificity are more likely to receive external equity investment from a higher number of funds, which is interpreted as using more external equity finance. The positive and statistically significant at 1% level of the estimate of physical-asset specificity corroborates H_1.

As expected, companies in farming activities that involve higher levels of temporal-asset specificity are more likely to use higher levels of external equity finance. The positive and statistically significant at 1% level of the estimate of temporal-asset specificity corroborates H_2.

Table 6. Probit and ordered probit regressions estimating the use of external equity by companies in agriculture.[/a]

	Model 1 Probit		Model 2 Probit, A&L (1998)		Model 3[/b] Probit, (combined)		Model 4 Ordered Probit		Model 5 Ordered Probit	
Dependent Variable:	multiple funds dummy[/c]		multiple funds dummy[/c]		multiple funds dummy[/c]		multiple funds ordinal[/d]		investment received ordinal[/f]	
physical_asset_specificity	1.191	***			1.259	*	1.383	***	0.156	
	(2.830)				(1.810)		(2.730)		(0.450)	
temporal_specificity	0.863	***			0.930	***	0.495	*	0.464	***
	(2.540)				(2.640)		(1.720)		(2.470)	
site_specificity	-1.046	***			-1.126	***	-1.054	***	-0.782	***
	(2.880)				(3.220)		(3.100)		(2.990)	
human_asset_specificity	-0.842	*			-0.658		-0.688		-0.318	
	(1.890)				(1.400)		(1.520)		(0.760)	
cycles_less1			0.180		0.954					
cycles_equal1			[/e]		[/e]					
under_cover			0.950	**	0.301					
irrigated			[/e]		[/e]					
Control variables										
L_sum_vc_invest_gral	-0.493	**	-0.535	***	-0.546	**	-0.739	***	0.080	***
L_ag_gdp	-0.563		-0.164		-0.519		-0.055		-0.608	
eu_15_dummy	-0.602		-0.348		-0.931		-1.548		0.621	
canada_dummy	1.608		0.164		1.371		0.365			
au_nz_dummy	1.217		-0.200		0.960		0.272		0.163	
merger_acquisition_dummy	2.548	**	2.243	***	2.400	***	1.558	**	0.321	
lbo_dummy	1.105		-0.157		1.163		1.860	**		
ipo_dummy	2.316	**	0.469		1.937	**	1.639	*	0.039	
expansion_stage_1st_round	-0.708		-0.466		-0.678		0.043		1.556	***
later_stage_1st_round	-1.654		-0.469		-1.624		-1.071		0.288	
buyout_acquis_stage_1st_round	-1.186	**	-1.275	***	-1.152	**	-0.989	**	1.707	
L_firm_size_mean_	0.356	***	0.290	***	0.363	***	0.347	***	0.091	
Number of observations	74		71		71		74		43	
Goodness-of-fit measures:										
Log pseudolikelihood	-16.665		-20.719		-16.144		-32.822		-47.360	
Prob > chi2	0.001	***	0.000	***	0.000	***	0.000	***	0.000	***
Pseudo R2	0.622		0.503		0.613		0.504		0.204	
Correct predictions (%)	91.892				91.045					

Notes: * Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level
The table reports the probit coefficients and absolute values of z-statistics (in parenthesis). Estimations used robust standard errors.
[/a] Included Farms Businesses in the U.S., Canada, EU-15, Australia, and New Zealand.

[b] Model (1) and (2) combined.
[c] DV: multiple_inv_funds_dummy; Dummy=1 if two or more funds were invested in company; 0 if 1 fund was invested.
[d] DV: multiple_inv_funds_ord; Ordinal (1-4): 1 if 1 fund was invested in company; 2 if 2 funds; 3 if 3 funds; 4 if 4 or more funds were invested in company.
[e] Variable dropped from the estimation (Stata).
[f] DV: inv_total_rcvd_ord; total known amount a company has received to-date from all investors. Ordinal (1-4): 1 if tot inv rcvd < 25pctile; 2 if b/ 25&50th; 3 if b/50&75th; 4 if >75th.

In relation to the effect of site specificity, the result is unexpected. Companies in farming activities with higher levels of site specificity are less likely to use external equity from several investment funds. With this result (negative sign and statistically significant at 1% level), H_3 is not corroborated. The interpretation of this result requires further analysis. For instance, the robustness check presented in the next subsection suggests that this result is not associated with multicollinearity problems. Lafontaine and Slade (2007) review the literature on vertical integration and firm boundaries and conclude that "The evidence concerning site specificity … is not very conclusive" (p. 655).[12] To my knowledge, there are no empirical studies testing the effect of site specificity on financial mechanisms.

Finally, as expected, human-asset specificity has a negative effect on receiving investment from several funds. In this case, the estimate of human-asset specificity has negative sign and is marginally statistically (significant at 10% level). This result indicates that companies in farming activities that involve higher levels of human-asset specificity are less likely to use investment from several funds, which is interpreted as using less external equity finance.

Model 2 and Model 3 are used to compare the asset specificity model discussed in this study with the Allen and Lueck (1998) model. The comparison of these two models is important for two reasons. As explained in the theoretical section, the Allen and Lueck (1998) model is a significant contribution to the analysis of organizational forms in farming agriculture. In addition, Allen and Lueck's model dismisses asset specificity as a relevant factor to explain organizational choices in agriculture.

In the specification of Model 2, I use the same control variables used in Model 1 and include Allen and Lueck's variables—cycles, under cover, and irrigation. The results of Model 2 indicate that cycles is not statistically significant, meaning that those farming activities that have more cycles per year, and hence, have higher gains from specialization, are not necessarily more likely to adopt the partnership organizational form that involves equity participation from several funds. Based on the results of Model 2, H_6 is not corroborated.

In relation to the variable 'under cover', the estimate is positive and statistically significant at 5% level. This result indicates that those farming activities that are performed in greenhouses (i.e., under cover), meaning that can control the effects of mother nature and have

[12] Of three studies that address the effect of site specificity on vertical integration identified by Lafontaine and Slade (2007) , one finds a significant positive effect on vertical integration (Joskow 1985), once has negative but not significant effect (Masten, meehan Jr and Snyder 1989), and the other one has positive but not significant effect (Masten, et al. 1989).

more stable output, are more likely to use external equity from several funds. This result corroborates H_6.

Overall, the estimates in Model 2 partially corroborate Allen and Lueck's model. The next step in the comparison of the asset specificity model and the Allen and Lueck (1998) model was to run a model that combines both sets of explanatory variables.

The specification of Model 3 combines the explanatory variables of the asset specificity model (Model 1) and the Allen and Lueck's model (Model 2) and its estimates leads to the following interpretation. The sign of all four asset specificity variables remained unchanged (compared with Model 1) and the estimates of temporal-asset specificity and site-specificity remain significant at the 1% level. The level of significance of the estimate of physical-asset specificity is 10% in Model 3 and human-asset specificity is not statistically significant. The estimates of the Allen and Lueck's variables are not statistically significant, which indicates that under the presence of the asset specificity variables those repressors do not have a statistically significant effect in the dependent variable. It is important to mention that the effect of the control variables remain roughly the same in these three models (Models 1, Model 2, and Model 3).

Although the repressors in the Allen and Lueck model do not have a significant effect in the regression analysis presented here, this result needs further analysis to reach a conclusion in the comparison of the models. As discussed in the theoretical framework, the model developed by Allen and Lueck (1998) and the asset specificity model are approached as complementary rather than substitute.

Control variables

Specific factors at the country/region were controlled with the inclusion of the following dummies: EU-15, Canada, and Australia - New Zealand (with companies in the U.S. as the baseline). These dummies control for factors such as macro-economic and legal environment that might facilitate/constraint the use of external equity finance by agricultural companies. Surprisingly, none of these dummies has a statistically significant effect on the use of external equity finance.

This finding indicates that the differences in the use of external equity finance may not be attributed to intrinsic difference between countries and regions, but to company- and industry-specific characteristics. This finding constitutes an interesting result that certainly complements the results discussed above based on the asset specific variables.

Robustness analysis

For robustness analysis, I run two additional models regressing the same explanatory variables used in Model 1 on two different specification of the dependent variable. In addition, I check for potential econometric problems such as heteroskedasticity and multicollinearity.

The specification of Model 4 shares the same explanatory and control variables used in Model 1 and the only difference is that the dependent variable is ordinal, indicating different levels of the number of funds received by each company. The purpose of this model is to check

if the results change when using an ordinal specification for the 'number of funds received' (versus a dummy variable). The sign of the asset specificity variables remain unchanged and there is a slight change in the statistically significance of the variable temporal-asset specificity, which remains statistically significant at 10% level. Overall, the results do not change substantially which shows robustness in the regression results.

In the specification of Model 5, the explanatory variables used in Model 1 are regressed on an ordinal measure of the 'total amount a company has received to-date from all investors' (*inv_total_rcvd_ord*). The comparison between the results of Model 5 and Model 1 are the following. The sign and statistical significance remain unchanged for temporal- and site-asset specificity (remain statistically significant at 1% level). Physical- and human asset specificity are no longer statistically significant. As explained above, this dependent variable suffers from missing values, which reduces the number of observations in the regression from 74 to 43. For that reason, this variable is used here for robustness check and, in particular, to justify the use of the variable 'multiple investment funds' as a proxy for the level of investments received by a company. In sum, although the estimates of this model do not fully corroborates Model 1, the results are in a great extent aligned considering the limitation of Model 5 associated with a lower number of observations.

To check for heteroskedasticity, I run the same variables (dependent and independent ones) in Model 1 using OLS regression and performed the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity (hettest command in Stata). The result is 'fail to reject' the hypothesis of constant variance which allows to argue that the model does not suffer from heteroskedasticity problems. However, the use of this procedure in the absence of a test for heteroskedasticity in probit should be interpreted as an approximation.

I check for potential multicollinearity problems among the following three asset specificity variables: physical-asset specificity, temporal-asset specificity, and site specificity. For this purpose, I run Model 1 but using one of these variables at a time. The sign and statistical significance do not change in the three regressions and are the same as Model 1 reported in Table 6. This result indicates that the estimates for these variables are robust.

5. CONCLUSION

The main finding of this study is that the asset specificity model has a significant effect at explaining why some companies receive investment from multiple funds as opposed to only one fund, which indicates the use higher total amount of investment from external equity investors. The differential attributes of the assets involved in agricultural production constitute an important source of variation across farm activities and a key factor to explain financing choices in agriculture.

External equity capital in the agricultural sector has received little academic attention. Although scholars have addressed the effect that the non-depreciable attribute of farmland has on the financing of agriculture, the literature on agricultural finance has little to say about the effect

that other attributes of the assets involved in agriculture have on the use of alternative financing mechanisms. In this context, the contribution of this study to this literature is twofold. First, it goes beyond previous studies and identifies factors at the firm level that explain the use of external equity capital in farming businesses. Second, it introduces and develops the analysis of differences across farm activities. In particular, it addresses the implication that difference in the assets involved in a farm activity has on the financial choices.

An important implication of these results for the transaction cost literature is that the asset specificity approach to financing decisions is valid to understand financing problems in agriculture. The explanation to why the asset specificity approach has not been influential in the finance literature can be attributed, to some extent, to measurement problems as opposed to lack of explanatory power.

In addition, this study contributes to the discussion on what types of asset specificity play an important role in agriculture. Masten (2000) argues that temporal-and site-asset specificity play an important role in agriculture, suggesting that physical- and human-asset specificity are of limited importance. Moreover, Allen and Lueck (1998) explicitly dismissed physical-asset specificity from their model and argued that they incorporate an agricultural version of temporal specificity. The results of this study suggest that asset specificity should be included in a model that attempts to explain organizational choices in agriculture and that physical-asset specificity plays a relevant role in agriculture.

This study suffers from the following limitations. Ideally the dataset for the empirical analysis would include not only companies that received external private equity finance but also a control group of private firms that do not use external private equity. Such control group would allow to test the effect of the asset specificity variables on the decision to use external equity capital. Nevertheless, the model employed in this study provides unique information to understand the effect of the asset specificity variables on the level of external equity funds that a firm in agriculture receives.

Finally, this study suffers from a common limitation in the empirical literature on transaction cost economics, which is the selection problem. That is, the idea that the observed contractual arrangements are the efficient ones, meaning that the market forces are strong enough to select the most efficient arrangements (Masten 1993; Yvrande-Billon and Saussier 2005; Sykuta 2008). This assumption is more or less problematic depending on the data and the sector under study. Private equity investors play an important role in the review of proposed investments and, hence, companies that receive external equity are usually extensively scrutinized. Moreover, the use of private equity capital is less influenced by government programs designed to help farmers though, for example, subsidized credit capital. In that respect, it is possible to argue that there are no clear forces that might lead to less precise decisions on the use of external equity capital.

REFERENCES

Allen, D., and D. Lueck. 1998. The Nature of the Farm. *The Journal of Law and Economics* 41, 343-386.

Anderson, E., and D. C. Schmittlein. 1984. Integration of the Sales Force: An Empirical Examination. *The RAND Journal of Economics* 15, 385-395.

Barry, P. J., and L. J. Robison. 2001. *Agricultural finance: Credit, credit constraints, and consequences.* In L. G. Bruce, and C. R. Gordon, eds.: *Handbook of agricultural economics* Elsevier.

Caselli, S. 2010. *Private Equity and Venture Capital in Europe: Markets, Techniques, and Deals.* Academic Press.

Chapman, J. L., and P. G. Klein. 2010. *Value Creation in Middle-Market Buyouts: A Transaction-Level Analysis.* In D. J. Cumming, ed.: *Private Equity: Fund Types, Risks and Returns, and Regulation* Wiley, Hoboken, NJ.

Collins, R. A., and H. J. Bourn. 1986. Market Requirements and Pricing for External Equity Shares in Farm Businesses. *American Journal of Agricultural Economics* 68, 1330-1336.

Dushnitsky, G., and Z. Shapira. 2010. Entrepreneurial Finance meets organizational reality: comparing investment practices and performance of corporate and independent venture capitalists. *Strategic Management Journal* 31, 990-1017.

Fiske, J. R., M. T. Batte, and W. F. Lee. 1986. Nonfarm Equity in Agriculture: Past, Present, and Future. *American Journal of Agricultural Economics* 68, 1319-1323.

Gompers, P., and J. Lerner. 2001. The Venture Capital Revolution. *Journal of Economic Perspectives* 15, 145-168.

Gompers, P. A. 1995. Optimal Investment, Monitoring, and the Staging of Venture Capital. *The Journal of Finance* 50, 1461-1489.

Grossman, S. J., and O. D. Hart. 1986. The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *The Journal of Political Economy* 94, 691-719.

Hart, O. 2001. Financial Contracting. *Journal of Economic Literature* 39, 1079-1100.

Hart, O., and J. Moore. 1990. Property Rights and the Nature of the Firm. *Journal of Political Economy* 98, 1119.

Hart, O., and J. Moore. 1994. A Theory of Debt Based on the Inalienability of Human Capital. *The Quarterly Journal of Economics* 109, 841.

Joskow, P. L. 1985. Vertical Integration and LongTermContracts: The Case of Coal-Burning Electric Generating Plants. *Journal of Law, Economics, and Organization* 1, 33-80.

Kaplan, S. N., and A. Schoar. 2005. Private Equity Performance: Returns, Persistence, and Capital Flows. *The Journal of Finance* 60, 1791-1823.

Klein, P. G. 1999. Entrepreneurship and corporate governance. *Quarterly Journal of Austrian Economics* 2, 19-42.

Lafontaine, F., and M. Slade. 2007. Vertical integration and firm boundaries: the evidence. *Journal of Economic Literature* 45, 629-685.

Lerner, J., F. Hardymon, and A. Leamon. 2009. *Venture Capital and Private Equity: A Casebook.* 4th edition. John Wiley and Sons, New York.

Lowenberg-Deboer, Featherstone, and Leatham. 1989. Nonfarm Equity Capital Financing of Production Agriculture. *Agricultural Finance Review* 49.

Martinez, S. 1999. Vertical coordination in the pork and broiler industries: implications for pork and chicken products.

Masten, S., J. J. Meehan, and E. Snyder. 1991. The costs of organization. *Journal of Law, Economics, and Organization* 7, 1.

Masten, S. E. 1993. Transaction Costs, Mistakes, and Performance: Assessing the Importance of Governance. *Managerial and Decision Economics* 14, 119-129.

Masten, S. E. 2000. *Transaction-cost economics and the organization of agricultural transactions.* In M. Baye, ed.: *Advances in Applied Microeconomics: Industrial Organization* Elsevier Science, New York.

Masten, S. E., J. meehan Jr, and E. Snyder. 1989. Vertical Integration in the U.S. Auto Industry: A Note on the Influence of Transaction Specific Assets. *Journal of Economic Behavior and Organization* 12, 265-273.

Modigliani, F., and H. M. Merton. 1958. The Cost of Capital, Corporation Finance and the Theory of Investment. *The American Economic Review* 48, 261-297.

Moskowitz, T. J., and A. Vissing-Jorgesen. 2002. The Returns to Entrepreneurial Investment: A Private Equity Premium Puzzle? *American Economic Review* 92, 745-778.

Poppo, L., and T. Zenger. 1998. Testing alternative theories of the firm: transaction cost, knowledge-based, and measurement explanations for make-or-buy decisions in information services. *Strategic Management Journal* 19, 853-877.

Raup, P. M. 1986. Use of Equity Capital in Financing Future Agricultural Production: Discussion. *American Journal of Agricultural Economics* 68, 1337-1339.

Sykuta, M. 2008. *New Institutional Econometrics: The Case of Contracting and Organizations Research.* In É. Brousseau, and J.-M. Glachant, eds.: *New Institutional Economics: A Textbook* Cambridge University Press, Cambridge, UK.

Wang, Z., D. J. Leatham, and T. Chaisantikulawat. 2002. External Equity in Agriculture: Risk Sharing and Incentives in a Principal-Agent Relationship. *Agricultural Finance Review* 62, 13-24.

Williamson, D. V. 2010. *Financial-market contracting.* In P. G. Klein, and M. Sykuta, eds.: *The Elgar Companion to Transaction Cost Economics* Elgar Publishing Ltd.

Williamson, O. E. 1988. Corporate Finance and Corporate Governance. *The Journal of Finance* 43, 567-591.

Williamson, O. E. 1991. Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. *Administrative science quarterly* 36, 269-296.

Yvrande-Billon, A., and S. Saussier. 2005. Do organization choices matter? Assessing the importance of governance through performance comparisons. *New Ideas in Contracting and Organizational Researches, Nova Science Publishers*.