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Value adding in the agri-food value chain

RESEARCH ARTICLE

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Abstract

Global agricultural markets reflect the increasing complexity of modern consumer demand for food safety and quality. This demand has triggered changes throughout the food industry, and led to greater opportunities for product differentiation and the potential to add value to raw commodities. Greater differentiation and value adding over time has in turn dramatically changed the price spread or marketing bill between the farm value of products and the retail value. Thus a significantly greater percentage of the final price paid by consumers is now garnered down chain rather than up chain over the last 20 years. This apparent shifting of value creation or addition, as measured by the marketing margin, has invigorated empirical questions as to where, and how much value, is created along the agri-food value chain. First we define value creation/adding, and then we estimate the economic value added for 454 firms. We validate our findings by creating and employing three additional value creation measures – the modified economic value added, the creation or destruction of value, and the persistence of value creation. Finally we estimate value creation at each node of the value chain, measure the relative differences among firms and nodes, and estimate a model measuring the drivers of value adding.

Keywords: value creation, value adding, agribusiness, food, agricultural, value chain

JEL code: Q13, O31, Q16

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1. Introduction

Global agricultural markets have become increasingly complex due to changes in consumer demand, the development of complex food standards mainly related to food safety and food quality, advances of technology, and changes in the industry structure along the value chain (Goldsmith *et al.*, 2002; Humphrey and Memedovic, 2006). As a result over time, a significantly greater percentage of the final price paid by consumers is garnered down chain as opposed to up chain. The input and production stages of the food and agribusiness value chain now supply about 16% of the final food value, with the other 84% coming from post-farm gate stages (Figure 1). This change in the farm and marketing bill share suggests a shift over time in the loci of food and agribusiness value addition.

The Economic Research Service (ERS)'s Food Dollar Series (formerly the Marketing Bill), uses prices to measure the share of the consumer's dollar received by each stage of the agrifood value chain and has been of great interest to researchers and policymakers since the 1940s (Canning, 2011). Corresponding with the Food Dollar analysis, policymakers at times feel farmers do create levels of value in excess of what they capture, and as a result suspect anti-competitive forces are at play (Canning *et al.*, 2016; EU Council, 2016; U.S. Congress, 2002). But while value creation/value addition and capture along the value chain is a relevant concept in agribusiness, it is perhaps surprising that managers and academics 'often do not know how to (explicitly) define value or measure it' (Anderson and Narus, 1998; Lindgreen *et al.*, 2012). Consistent with a lack of a definition, research to date has not measured the level nor assessed the loci of value addition along the agrifood value chain. The objectives of this manuscript are threefold; to provide a financial, and thus formal, definition of value added; measure value addition by firms across the four nodes/stages of the value chain; and third to test hypotheses as to the drivers of value creation that differ across the four nodes.

Specifically we are the first to measure the economic value added (EVA) for firms and stages along the agri-food value chain. We validate our findings by creating and employing three additional value creation measures; the modified economic value added (MEVA), the creation or destruction of economic value added (CEVA), and the persistence of economic value added (PEVA). We then use the EVA to test specific hypotheses as to how and where value creation occurs along the agri-food value chain. Finally, we discuss

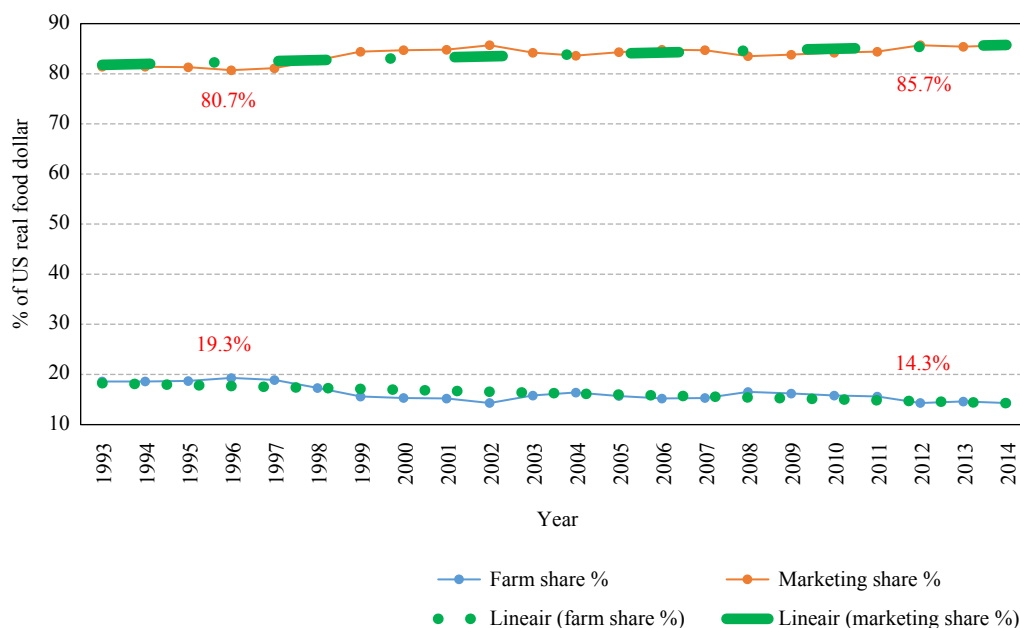


Figure 1. Food bill and farm share of the U.S. Real Food Dollar: 1993 to 2011 (adapted from USDA, 2017).

how our results inform policymakers as to the causes of value creation and capture. In short, we provide empirical evidence that producers capture relatively less value because they create relatively less value, and they create relatively less value because they differentially employ capital. We posit that stages need not equally create value nor employ equal levels of value creating capital. Therefore the differential use of capital may not reflect anti-competitive forces but reflect a form of sustainable equilibrium when the unit of analysis is not the firm or stage, but the entire value chain.

2. Literature review

Historically, the agribusiness sector has been a commodity-oriented industry, with a strong focus on maximum efficiency, homogenous products, and economies of scale (Grunert *et al.*, 2005). In the past, firms may not necessarily have needed to focus on creating value since companies could be profitable as a consequence of controlled distribution channels, regulated markets, the acquisition of badly performing firms, or a scarcity of resources to produce (Doyle, 2000; Lindgreen *et al.*, 2012). Although agri-food markets had been efficient at producing homogeneous products, the evolution of consumer demand to safe, high quality, and convenient products, as well as technological advances and increased competition, require the production of differentiated products. Therefore, a company focus on value adding activities allows firms to meet the expectations of consumers by offering high quality and differentiated products that reflect emergent agribusiness market opportunities (Alexander and Goodhue, 1999; Coltrain *et al.*, 2000; Streeter *et al.*, 1991). In recent years, value creation or value adding in agriculture, and its management, has emerged as a business survival strategy (Kampen, 2011).

The food and agribusiness literature defines value creation or value adding in agribusiness when a firm changes a product's current place, time, and form to characteristics more preferred in the marketplace (Anderson and Hanselka, 2009; Coltrain *et al.*, 2000). The concept of value creation historically has been synonymous with value adding, and the concept of value adding is helpful when analyzing the potential profitability of agriculture (Coltrain *et al.*, 2000). Coltrain *et al.* (2000) provide a more specific definition by giving an example of value adding in agriculture: 'to economically add value to an agricultural product (such as wheat) by processing it into a product (such as flour) desired by customers (such as bread bakers).' The 2002 United States Farm Bill defines value adding in agriculture as a change in the physical state of any agricultural commodity through a production method or handling process by which the agricultural commodity or product is produced or segregated (USDA, 2013). The end result of changing value is that it expands the customer base for the product, or makes available a greater portion of revenue derived from the marketing, processing, or physical segregation of the agricultural commodity or product achieved by the producer (U.S. Congress, 2002). Since 2009, the USDA has awarded 863 value-added producer grants totaling \$108 million to help firms transform their commodities or products into higher valued goods (Farm Futures, 2014). In sum, the Coltrain, USDA and U.S. Congressional definitions present value adding as encumbering, or internalizing, additional steps found in the value chain; thus their definition is an activity measure.

Amanor-Boadu (2003) integrates the activity definition with a profitability measure. He attempts to clarify the concept of value creation/adding by defining two conditions that an activity must satisfy. The first involves a firm performing an activity that traditionally has been performed at another stage farther down the value chain; or (2) if one is rewarded for performing an activity that has never been performed in the value chain (Amanor-Boadu, 2003; Evans 2006). Both are consistent with the above activity definition. He adds though that if the total profitability of the performing organization is not increased by the value-added activity, then the activity cannot be deemed to have contributed any value to the value chain or to customers, and thus it fails to qualify as a value-added activity.' (Amanor-Boadu, 2003). Thus value adding must not only disintermediate an activity (i.e. Coltrain), but must be profitable.

The finance literature adds greater specificity to the concept of value adding by focusing on capital utilization and capital use efficiency. The popularity of a capital-based definition of value creation has increased since the 1990s, and its processes have been widely studied in the mainstream business literature (Anderson, 1995;

Parasuraman, 1997; Walter *et al.*, 2001). From an economic perspective, a company creates value by producing net benefits in excess of the cost of capital (Chmelikova, 2008). Traditional accounting information such as return on equity, earnings per share, net operating profit after taxes (NOPAT) and return on investment are common measures or proxies for value creation (Ibendahl and Fleming, 2003). Although widely used, these measures fail both to capture a firm's value creation that results from management actions, and to account for the full cost of capital (Sharma and Kumar, 2010). Similarly, stock price may be an incomplete measure because it does not reflect the true value of the firm (Keef and Roush, 2003; Sparling and Turvey, 2003; Turvey *et al.*, 2000). That is, accounting income or profitability may not be a good estimator of true value creation, and value creation efficiency (Sharma and Kumar, 2010). This becomes important later on in our analysis as we show value chain nodes can exhibit comparable rates of profitability but differing levels of value creation.

A more accurate measure of value creation, EVA, represents how well a company produces operating benefits, given the amount of capital invested (Chmelikova, 2008). An increasing number of companies have begun to employ EVA to measure the value created by each business unit, since this measure provides better information than traditional measures (Geyser and Liebenberg, 2003; Ibendahl and Fleming, 2003). EVA shifts the focus simply from profitability, which may be ethereal, to earning a return on capital above the opportunity cost of the capital (Walbert, 1994). Furthermore, the EVA metric combines operating efficiency and asset management from a managerial accounting perspective (Anderson *et al.*, 2005).

The EVA of a company is defined as 'a measure of the incremental return that the investment earns over the market rate of return' (Sharma and Kumar, 2010). Formally, EVA is expressed as:

$$\text{EVA} = \left(\frac{\text{AdjNOPAT}}{\text{NOA}} - \text{Cost of Capital} \right) \times \text{NOA} \quad (1)$$

where, AdjNOPAT is the adjusted NOPAT that does not include non-operating revenues and expenses, such as training costs or restructuring expenditures. The net operating assets (NOA) represents the total capital employed by a firm via its main business activities. NOA involves an adjustment similar to that of NOPAT and removes accounting items that are not used to generate an operating profit of the core business, such as non-operating fixed assets.

The *cost of capital* is the weighted average of debt and equity cost (Equation 2). The EVA takes into account the cost of capital that managers must pay for the capital they employ. Using the cost of capital allows managers to determine the true value generated by the capital employed (Anderson *et al.*, 2005; Sharma and Kumar, 2010).

$$r_k = r_d (1 - t) \left(\frac{D}{D + E} \right) + r_e \left(\frac{E}{D + E} \right) \quad (2)$$

where, r_k is cost of capital, r_d is cost of debt, r_e is cost of equity, D is the debt, E is total capital and t is the corporate tax rate.

2.1 The value chain

The value chain is a 'series of value adding processes which flow across many companies and creates products and services which are suitable to fulfill the needs of customers (Martin and Jagadish, 2006; Noemi, 2012). Each step in the chain, from basic inputs to consumer goods, serves as a link or stage in the value chain (Opara, 2003). It is a system of firms that interact to positively impact one another's performance (Bigliardi and Bottani, 2010). The value chain framework emerges as a key aspect in the analysis of the drivers of

business success and value creation (Matopoulos *et al.*, 2007). Within this context, firms within each stage seek to offer maximum value to their customers and to improve company performance, while obtaining a competitive advantage from being part of the value chain (Bourlakis *et al.*, 2012; Ketchen *et al.*, 2008). Consequently, value creation does not occur in isolation but rather within a value chain framework where companies can operate most efficiently as members of the chain. In this position, a company may more easily establish collaborative relationships based on trust, commitment, and cooperation among the chain's members, which helps to improve all the companies' performance and thus create value (Lindgreen *et al.*, 2012; Vanyi, 2012). Additionally, the chain framework connotes a level of complementarity along the chain. Firms and stages need not all similarly employ capital or add value at the same levels. For example, some stages need not employ high levels of R&D, and thus need not create a lot of value. Yet they may still be sustainable and profitable, and comprise essential links in the food and agribusiness value chain.

For the purpose of this study, following Humphrey and Memedovic (2006), the agri-food value chain is split into four main stages or nodes: inputs, production, processing, and delivery to consumers (Figure 2). Stage 1, inputs, involves biotechnological, agro-chemical and fertilizer, animal health, animal breeding and farm equipment companies. Firms in this sector supply agricultural products and services to farmers as its primary customers. Stage 2, production, includes all of the activities involved in the production of raw food materials, such as crop and livestock commodities. Production serves mainly food processors and manufacturers, the next link down the chain. Stage 3, processing, comprises food processing and manufacturing, including beverage, breweries, wineries and packaged food companies. These firms convert raw materials into either branded or unbranded food products. These products are then marketed to the retail stage for distribution and sale to consumers, the terminal stage in the food and agribusiness value chain. Stage 4, retail, distributes, sells and markets food products to consumers. In the last stage of the agri-food value chain, we include firms involved with food distribution, grocery retail, and food service.

In general, we are curious as to value creation differences among the four chain nodes as well as to the underlying drivers of value creation. Specifically in this research we test hypotheses concerning both firm level value creation, and value adding across the various stages of the food and agribusiness value chain. We test the following hypothesis.

H₀ I: value addition levels differ across stages as each stage contributes differently to the value creation process

This hypothesis implies that dummy variable coefficients pertaining to a value chain node be significantly different from zero when the reference group is Stage 2, the production node.

Stage 1. Empirical evidence suggests that the increase in private investment among Stage 1 firms in agricultural research has been driven by the establishment and strengthening of intellectual property (Fulton and Giannakas,

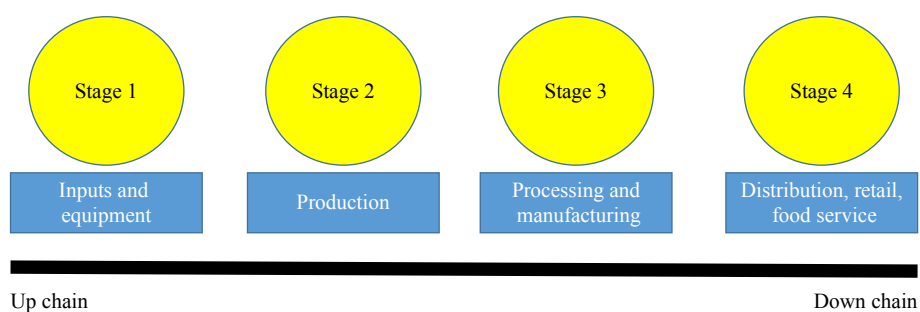


Figure 2. The four stages of the food and agribusiness value chain.

2002; Goldsmith, 2001; Moschini and Lapan, 1997). Effective intellectual property development in seed and equipment markets, for example, allows suppliers to establish internationally recognized brands reflecting highly differentiated products. Additionally, horizontal mergers through acquisition, and coordination through technology licensing, allow seed firms to achieve significant research and development, marketing, and production economies. Alternatively, though, Demont *et al.* (2007) conclude that agricultural producers capture most of the value created by upstream input suppliers, when analyzing the benefits literature, thus value addition upstream in Stage 1 may be relatively low. We test the following hypothesis.

Ho II: we expect the agricultural input Stage (1) to be a high value-adding node given the presence of input brands and the high level of agricultural research. The evidence of horizontal coordination among the companies of this stage also provides support to this hypothesis

This implies that the coefficient for the Stage 1 dummy variable be significantly different from zero, and positive, when the reference group is Stage 2.

Stage 2 is the most commoditized sector of the value chain (Carlson, 2004; Phillips *et al.*, 2007). The stage, which includes farm production, presents low product margins, high price dependence in transactions, and a low level of product differentiation. Companies often operate within competitive markets and strive to compete on cost management and economies of scale (Goldsmith and Bender, 2004). In recent years, an increasing number of structural changes have taken place within this stage, showing a decline in the number of the firms but an increase in the size of those firms (Boehlje *et al.*, 2011). Large firms that have been able to obtain the benefits of scale economies may be responsible for making this stage profitable (Humphrey and Memedovic, 2006; Lobao and Meyer, 2001). Alternatively, some firms within the production stage do perform value added activities that permit them to capture a greater proportion of the consumer dollar (Born and Bachmann, 2006; Kampen, 2011). Production firms also increasingly engage in greater levels of vertical coordination, such as contractual arrangements, or vertical integration, in order to both improve efficiency and to create more value (Hendrikse and Bijman, 2002; Sporleder, 2006). For example, shifting from commodity grain production to differentiated grain and oilseed allows producers to create and capture added value (Goldsmith and Silva, 2006; Hayenga and Kalaitzandonakes, 1999). We test the following hypothesis.

Ho III: the lack of coordination and the commercialization of undifferentiated products as well as the condition of being primarily a price taker makes the production Stage (2) exhibit the lowest levels of value addition among the four value chain nodes

Thus, the coefficient estimates for all three value chain dummy variables corresponding to the node should be positive and significantly different from zero.

Stage 3. The process of turning raw agricultural outputs into food and beverage products ‘adds value’ to raw commodities in an economic sense, but these activities may also significantly alter the appearance, storage life, nutritional value, and content of the raw materials (Gopinath *et al.*, 1996). A processor’s main activity is to transform commodities into food products, a process that adds economic value to the products. Increasingly, consumers demand higher quality and premium food products with accompanying features as their incomes rise (Sexton, 2013). Modern food systems also involve long and complex supply chains thus processing and manufacturing firms must innovate to meet the needs of buyers in terms of ingredient traceability, new product development, extending shelf life, and efficiently promoting their products. Companies at this stage may focus on producing higher-quality products, as well as manufacturing more branded and differentiated products, to achieve a competitive advantage and thus create value (Omidvar *et al.*, 2006). Product differentiation including advertising to establish and maintain branded manufacturing goods, involves significant investment in R&D and intangible assets (Oustapassidis and Vlachvei, 1999; USDA, 2013). We test the following hypothesis.

Ho IV: food manufacturing (Stage 3) will exhibit a relatively high level of value addition, compared to upstream stages, due to strong product differentiation, coordination with retailers, and access to low cost inputs from the production stage

We present no hypothesis ranking Food Manufacturing among the four nodes. However, the coefficient estimate for the Stage 3 dummy variable should be positive and significantly different from Stage 2, our reference stage.

Stage 4. The last stage of the agri-food value chain serves the consumer. One of the main drivers of innovation in this stage for food retailers, restaurants, and hospitality firms occurs by differentiating through service and retail brands to better meet consumer demand (Burch and Lawrence, 2005; Humphrey and Memedovic, 2006). Upstream integration though into brand food manufacturing and private label production changes the relationship between stages 3 and 4 as retail firms strive to support the innovations that better serve the needs of consumers (Burch and Lawrence, 2005). There is evidence of increasing market power at the retail end of the agri-food value chain as a consequence of increasing concentration and consolidation in the sector (Humphrey and Memedovic, 2006; Viaene and Gellynck, 1995). The influence of retailers over processors, manufacturers, and also the consumer allows the retailer sector to obtain a competitive advantage and capture more value created along the chain (Burch and Lawrence, 2005). The growing market power of downstream firms may limit up-chain firms from moving to high-value-added activities such as distribution, marketing and retailing (Farfan, 2005; Liu and Niemi, 2014). Greater market power down chain also allows for greater control over information flows and thus has a competitive advantage for innovation (Farfan, 2005; Humphrey and Memedovic, 2006). We test the following hypothesis.

Ho V: the retail firms (Stage 4) with their consumer orientation, need to innovate, and strategic position within the value chain, will be a relatively high value creator, compared to upstream stages

Thus, the coefficient estimate for the dummy variable for Stage 4 should be positive and significantly different from zero.

Several researchers have identified different accounting categories and business activities that determine firm-level value adding (Kalafut and Low, 2001; Kale *et al.*, 2001; Zéghal and Maaloul, 2010). Investment in innovation related activities drives value creation (Amanor-Boadu, 2003; Coltrain *et al.*, 2000). 'Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services,' (Sawang and Unsworth, 2011). Innovation associated with value creation activities refers to the performance of activities that enhance 'existing processes, procedures, products, and services or creating new ones' using organizational structures (Amanor-Boadu, 2003). R&D expenditures (Artz *et al.*, 2010; Cohen and Klepper, 1996; Damanpour, 2010; Meisel and Lin, 1983; Zona *et al.*, 2013) and goodwill and intangible assets (Kramer *et al.*, 2011) are key factors in determining firm level of innovation. Therefore, we propose the following hypotheses with respect to innovation.

Ho VI: firms with higher levels of intangible assets and goodwill create more value

The coefficient estimate for the goodwill and intangible asset variable should be positive and significantly different from zero

Ho VII: firms with higher levels of research and development expenditures create more value

Similarly, the coefficient estimate for the R&D expenditure variable should be positive and significantly different from zero.

Product differentiation is also a key component of value creation and firm success. The ratio of the cost of goods sold (COGS) to sales serves as one measure of product differentiation (Balsam *et al.*, 2011; Goldsmith

and Sporleder, 1998; Nair and Filer, 2003). The use of COGS as a measure of product differentiation results from the logic associated with raw input transformation. The more a purchased input remains the same, or passes through to the buyer's customer, the less differentiated is the product and the less value has been added by the firm. Thus if the inbound input cost per unit, *ceteris paribus*, comprises a high percentage of the outbound product's price, then the product has a relatively high COGS, and little additional value has been created and added. The expression of 'turning a sow's ear into a silk purse,' captures the COGS-product differentiation logic. The buying firm adds significant value to the low cost input, a 'sow's ear', and achieves a high valued product, such as a 'silk purse.' We test the following hypothesis.

Ho VIII: firms with higher degrees of product differentiation, a smaller ratio of COGS to sales, create more value

Thus, the coefficient for the calculated variable COGS will be negative and significantly different from zero.

Previous studies suggest that firm size is a relevant characteristic that influences the intensity of a firm's new product development (Damanpour, 2010; Hecker and Ganter, 2013; Zona *et al.*, 2013). Large firms may be more creative because of the availability of financial resources, technological possibilities, access to highly skilled labor, as well as knowledge capability and economies of scope. Furthermore, large firms have a greater capability to afford the cost of new ventures as well as to manage the risk of unsuccessful efforts (Camisón-Zornoza *et al.*, 2004; Damanpour, 2010; Hecker and Ganter, 2013). We test the following hypothesis.

Ho IX: there is a positive relationship between firm size and value creation

The coefficient for the firm size variable should therefore be positive and significantly different from zero.

Finally, we test the relationship between the level of leverage and the ability to create value. Capital structure may not be significant in the process of value creation as debt level's impact on value creation is not clear. On the one hand increasing leverage reduces the firm's tax liability, and allows, *ceteris paribus*; the opportunity to more productively invest surplus cash flow, an urgency to perform well, and the sale of underperforming or unrelated businesses or assets (Houle, 2008). However, financial leverage is a risk factor and may effect risk taking (Ely, 1995; Hua and Templeton, 2010). Also standard finance theory posits that debt and equity may be direct substitutes (see Barclay and Smith, 1999). Therefore, we offer no hypothesis as to the relationship between the level of leverage and the level of value creation.

3. Method

We estimate EVA (Equation 1) and populate the capital-asset pricing model (CAPM) model using the 10-year Treasury bond return, which reflects the risk-free rate of return. The market risk premium is calculated from the average of the last 25 years as the difference between the return of the Standard & Poor's 500 and the risk-free return. We assign the country risk premium using Moodys country rating (Moodys, 2014). The beta of each firm is estimated using the unleveraged beta by industry reflecting the average market debt/equity ratio by industrial sector.

Cost of debt is the average cost of the debt for each firm (Equation 3):

$$r_d = \frac{\text{Interest expenditures}}{\text{Total liabilities}} \quad (3)$$

The variable tax rate (t) serves as the proxy for the official corporate tax rate of each country. Weights are calculated based on the book value mix of debt and equity. To estimate the cost of equity, the CAPM is used (Equation 4), and comprises three elements: risk-free bonds (R_f), the stock's equity beta ($\beta=1.0$ is average

risk), and the market risk premium ($R_m - R_f$) needed to attract investors to hold onto the market portfolio of risky assets (Bruner *et al.*, 1998; Sharma and Kumar, 2010).

$$r_e = R_f + \beta(R_m - R_f) \quad (4)$$

The EVA metric is a dollar scaled metric and thus is highly correlated with firm size. Therefore, the EVA metric is sensitive to size bias (Anderson *et al.*, 2005; Ibendahl and Fleming 2003). That is, larger firms, *ceteris paribus*, create more nominal value. Thus, we also create and employ a second value creation metric, the MEVA, which is scale neutral, and is expressed as a net percentage rather than a nominal dollar value. We define MEVA as follows:

$$\text{MEVA} = \left(\frac{\text{AdjNOPAT}}{\text{NOA}} - \text{Cost of Capital} \right) \times 100 \quad (5)$$

MEVA captures the real and relative value addition by food and agribusiness firms, as opposed to the nominal value reflected in the EVA. Firms can either create capital, that is, produce more capital than they use; or destroy capital, produce less capital than they use. A positive EVA or MEVA indicates that the firm or value chain stage adds value because the operating assets or working capital employed generate a return sufficient to cover the capital costs of those assets. On the contrary, a negative EVA or MEVA indicates that a company destroys value because the returns from its net operating assets fall short of the returns required to capitalize the company. The EVA/MEVA concepts reflect how efficiently or inefficiently firms use capital. Both measures employ a theoretically robust conceptual framework that produces useful metrics for analyses across firms, industries, and time.

3.1 Data

We employ an unbalanced panel of a ten-year time-series (2003-2012) of 454 agri-food companies (Table 1) from 25 countries (64% are U.S. companies, 3.26% United Kingdom, 3.89% Japan, 3.36% China, and 2.86% from Mexico and others). The data originate from income statement and balance sheets for each of the firms collected by Morningstar Inc. Placing firms into discreet value chain stage categories is obviously fraught with a lack of precision and potential bias because firms may operate in more than one stage. Yet our work requires some form of data structure that permits the data be statistical analyzed and formally tested via hypotheses. As a result, we use Morningstar's classification of industry groups; which relies upon firms' self-declaration of their principle activity areas.

The data encompass all firms that Morningstar classifies as belonging to the following sectors; agricultural inputs and chemicals, beverages, packaged food, farm construction, restaurants, food distribution, farm-products, and grocery. We divide the firm-level data into stages or our nodes; inputs, production, processing, and delivery to consumers, using Morningstar's identification of the firm's stated main activity and industry. There are 97, 65, 156, and 136 firms in Stage 1, 2, 3 and 4, respectively. All financial data are converted into U.S dollar units based on the World Bank's official exchange rate.

This study, for validation purposes, creates and employs two additional value creation measures; the CEVA and PEVA. The CEVA takes a value 1 when the MEVA > 0 for any given year and, 0 otherwise. This measure accounts for the firms that may have extreme EVA and MEVA values within the ten-year study period. The second validation measure, PEVA, takes a value equal to 1 if the firm uses its capital efficiently for at least five years, and 0, otherwise. In this way, PEVA identifies firms that are consistently efficient users of capital over time.

Table 1. Summary statistics.

Variable	Definition	Unit	Stage1	Stage2	Stage3	Stage4	All
NOA	Net operating assets	\$	5,978.55	2,494.47	6,053.28	2,199.51	4,466.69
<i>Std. error</i>			-10,832.23	-4,926.71	-13,993.36	-5,188.15	-10,534.10
<i>Relative standard error of the mean</i>			1.81	1.98	2.31	2.36	2.36
AdjNOPAT	Adjusted NOPAT ¹	\$	680.456	210.218	639.48	245.093	479.824
<i>Std. error</i>			-1,465.82	-456.259	-1,993.79	-598.569	-1,443.89
<i>Relative standard error of the mean</i>			2.15	2.17	3.12	2.44	3.01
EVA	Economic value added	\$	263.579	43.349	256.586	107.024	187.868
<i>Std. error</i>			-829.093	-301.547	-1,360.62	-424.762	-944.42
<i>Relative standard error of the mean</i>			3.15	6.96	5.30	3.97	5.03
MEVA	Modified EVA		-0.195	-0.806	0.833	3.434	1.162
<i>Std. error</i>			-17.652	-19.65	-15.714	-18.421	-17.544
<i>Relative standard error of the mean</i>			90.52	24.38	18.86	5.36	15.10
CEVA	Proportion of yrs w/a pos. MEVA		0.608	0.517	0.614	0.666	0.616
<i>Std. error</i>			-0.489	-0.5	-0.487	-0.472	-0.487
<i>Relative standard error of the mean</i>			0.80	0.97	0.79	0.71	0.79
Size	Total assets- (intangible+goodwill)	\$	6,636.80	3,067.04	4,206.56	3,444.28	4,381.75
<i>Std. error</i>			-11,896.44	-6,192.53	-8,814.95	-8,490.96	-9,321.51
<i>Relative Standard Error of the mean</i>			1.79	2.02	2.10	2.47	2.13
Leverage	Total liabilities/total equity		1.449	1.122	1.099	1.561	1.315
<i>Std. error</i>			-4.893	-2.603	-20.719	-11.458	-14.123
<i>Relative standard error of the mean</i>			3.38	2.32	18.85	7.34	10.74
Innovation	R&D+intangibles+ goodwill	\$	1,021.13	282.837	2,790.08	720.667	1,479.89
<i>Std. Error</i>			-2,595.57	-690.86	-8,359.22	-2,086.82	-5,389.71
<i>Relative standard error of the mean</i>			2.54	2.44	3.00	2.90	3.64
COGS	Cost of good sold		72.716	77.535	65.204	70.59	69.96
<i>Std. error</i>			-15.934	-26.812	-17.266	-23.124	-20.646
<i>Relative standard error of the mean</i>			0.22	0.35	0.26	0.33	0.30
WACC	Cost of capital		0.072	0.063	0.063	0.064	0.065
<i>Std. error</i>			-0.067	-0.084	-0.052	-0.054	-0.061
<i>Relative standard error of the mean</i>			0.93	1.33	0.83	0.84	0.94
Companies			97	65	156	136	454
Observations			770	431	1,251	1,014	3,466

¹ NOPAT = net operating profit after taxes.

3.2 Firm size

Previous literature uses different proxy variables for firm size. Generally, firm size can be measured by using the total sales (Arundel and Kabla, 1998), total assets (Gopalakrishnan and Damanpour, 2000; Zehri *et al.*, 2012) or number of employees (Ettlie *et al.*, 1984; Sawang and Unsworth, 2011; Zona *et al.*, 2013). Following Goldsmith and Sporleder (1998), Camisón-Zornoza *et al.* (2004) and Damanpour (2010), we use total assets as a proxy for firm size in this study. From total assets the amount of intangibles and goodwill is subtracted to avoid double counting and to allow their use as a measure for the level of innovation assets.

3.3 Leverage

We represent leverage in this research as the ratio of total liabilities to total equity. The interpretation of the leverage variable is as follows: the higher the ratio, the more debt a company uses in its capital structure. Capital structure may not be significant in the process of value creation as debt level's impact on value creation is not theoretically clear. On the one hand increasing leverage reduces the firm's tax liability, and allows, *ceteris paribus*; the opportunity to more productively invest surplus cash flow, an urgency to perform well, and the sale of underperforming or unrelated businesses or assets (Houle, 2008). However, financial leverage is a risk factor and may effect risk taking (Ely, 1995; Hua and Templeton, 2010).

3.4 Cost of good sold

Cost of goods sold is the expense a company incurs in order to manufacture, and create a product. Cost of goods sold is expressed as a percentage of revenue. At high levels of COGS, *ceteris paribus*, suppliers contribute a high proportion of the value produced by the firm. In general, the higher the level of COGS, the lower the level of value adding by the firm.

3.5 Innovation

Following previous studies, we explore the role of innovation on value adding by means of three variables: R&D expenditures (Zona *et al.*, 2013); goodwill (Degryse *et al.*, 2012); and intangible assets (Kramer *et al.*, 2011). The 'Innovation 1' variable aggregates all three innovation types. The 'Innovation 2' variable encompasses only capital assets (intangible assets and goodwill) and the 'Innovation 3' variable captures only R&D expenditures.

4. Results

4.1 Summary statistics across the value chain

■ Size of firms

Stages 1 (inputs) and 3 (processing) are comparable in terms of the average size of firms with the mean value of NOA being \$5.979 and \$6.053 billion dollars per firm, respectively. Their NOA values are 34% and 36%, respectively, higher than the mean operating assets of the agri-food value chain as a whole. The average net operating assets for Stage 4 (retail) averages \$2.200 billion dollars, 12% lower than for Stage 2 (production). Stage 1 firms present the most uniform distribution in terms of size with a coefficient of variation of 1.81 about 25% smaller than the average for the entire value chain (Figure 3). While Stage 4 maintains a coefficient of variation of 2.36, about 30% larger than Stage 1.

■ Earnings

Likewise, this study does not find significant differences between Stage 1 and Stage 3 in terms of earnings as measured by AdjNOPAT. Stage 1 produces on average an AdjNOPAT of \$680 million dollars, and Stage 3 generates net operating profits of \$639 million dollars, on average, per firm. Thus stages 1 and 3 are of comparable size and earnings.

Statistically stages 2 and 4 do not differ. Stage 2 has an average AdjNOPAT of \$210 million dollars, which is 14% lower than the average net operating profits for Stage 4, which produces \$245 million dollars. This statistical equivalency in terms profitability is interesting. While Stage 2 (production) has earnings comparable with retail (Stage 4), we show later that Stage 2 employs capital quite differently, and thus creates value quite differently from Stage 4.

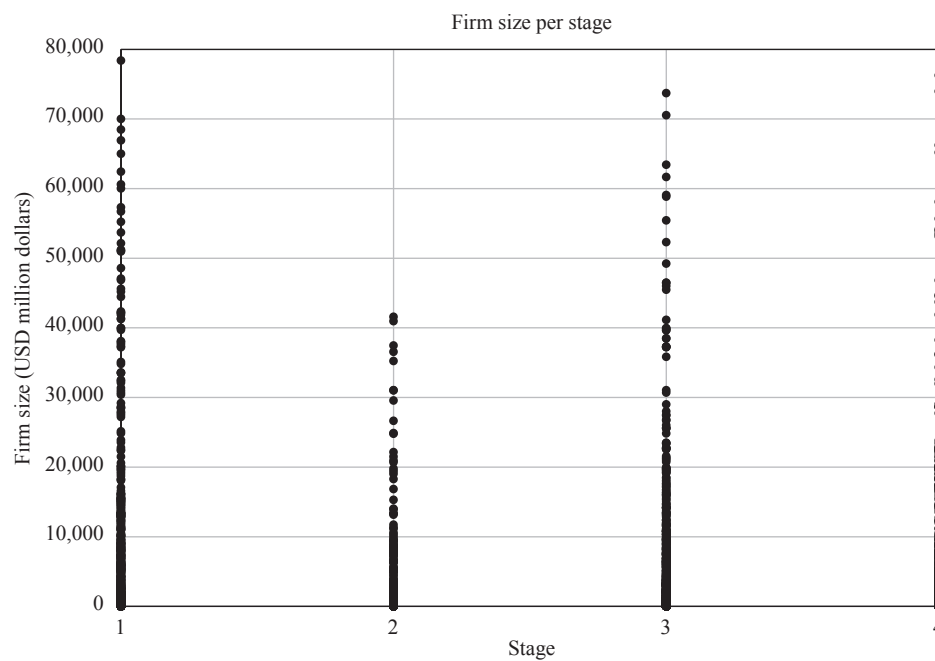


Figure 3. Firm size by stage. Firm size is measured as adjusted total assets. It is expressed in million dollars.

■ *Levels of value creation*

Agricultural inputs, Stage 1, is the node that creates the most value, producing, on average, an added economic value of \$264 million dollars per firm, which is 40% higher than the average EVA across the whole value chain (Table 1). The production stage, Stage 2, creates, on average, \$43 million dollars per firm, significantly (23%) less than the average firm along the chain. Stage 1 mean EVA statistically differs between Stages 2 (production) and 4 (retail), while the null hypothesis for significant differences between Stage 1 (inputs) and Stage 3 (processing) cannot be rejected (Table 2). As discussed above EVA, as a metric, is highly correlated with firm size.

Down-chain has the highest rates of value adding, as measured by MEVA. On average, Stage 3 (processing) and Stage 4 (retail) create additional operating capital at the rate of 0.83% and 3.43% points per year respectively above their cost of capital, while upstream the average rate of value creation within Stages 1 and 2 are negative. Stage 4 differences are statistically significant from the other three stages. Stage 4, closest to the consumer, has a mean value MEVA that is 196% higher than the mean MEVA value of the overall chain, thus is almost 3x more effective using capital compared to the average firm. Stage 4 firms also show much higher levels of MEVA homogeneity across the firms within the stage. The coefficient of variation is 1/3rd the level compared with the entire value chain, and only 5.5% the variation of Stage 1, the input stage. There are 136 companies in Stage 4, of which 71 (52%) have persistent positive levels (PEVA) of value adding; a minimum of five years of positive value creation. Stage 2, the production stage, for example comprises 65 firms, and only 32% of those firms are persistent value creators.

Up-chain nodes, on average, destroy value. Their rate of return is less than the cost of the capital they employ. Stage 1's average return on capital is 0.195% percentage points (slightly) below its average cost of capital. While Stage 2, the production stage, has a return on capital almost 1% (0.806%) less than its cost of capital. On average, up chain firms do not generate enough operating profit to cover the opportunity cost of their capital. Stage 1 MEVA differences from Stage 4 are statistically significant, but this is not true for the differences between Stage 1 and Stages 2 and 3. It is interesting to note that 68% of Stage 2 firms persistently

Table 2. Mean tests.¹

Variable	Null hypothesis						All equal
	S1=S2	S1=S3	S1=S4	S2=S3	S2=S4	S3=S4	
NOA	<i>0.00</i>	0.88	<i>0.00</i>	<i>0.00</i>	0.62	<i>0.00</i>	<i>0.00</i>
AdjNOPAT	<i>0.00</i>	0.53	<i>0.00</i>	<i>0.00</i>	0.67	<i>0.00</i>	<i>0.00</i>
EVA	<i>0.00</i>	0.87	<i>0.00</i>	<i>0.00</i>	0.24	<i>0.00</i>	<i>0.00</i>
MEVA	0.56	0.20	<i>0.00</i>	<i>0.09</i>	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>
CEVA	<i>0.00</i>	0.78	<i>0.01</i>	<i>0.00</i>	<i>0.00</i>	<i>0.01</i>	<i>0.00</i>
Size	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>	<i>0.03</i>	0.48	<i>0.05</i>	<i>0.00</i>
Leverage	0.70	0.59	0.87	0.98	0.59	0.44	0.86
Innovation 1	<i>0.02</i>	<i>0.00</i>	0.24	<i>0.00</i>	<i>0.07</i>	<i>0.00</i>	<i>0.00</i>
Innovation 2	<i>0.06</i>	<i>0.00</i>	0.52	<i>0.00</i>	0.15	<i>0.00</i>	<i>0.00</i>
Innovation 3	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>	0.14	0.99	<i>0.05</i>	<i>0.00</i>
COGS	<i>0.00</i>	<i>0.00</i>	<i>0.03</i>	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>	<i>0.00</i>

¹ The table shows the *P*-values of the mean tests calculated to determine whether the value outcomes for each stage are statistically different from each other for each variable of interest. 'S1' means Stage 1, 'S2' means Stage 2, 'S3' means Stage 3 and 'S4' means Stage 4. The null hypothesis is that the mean of particular variable are equal between two stages. Rejecting the null hypothesis means that there are statistically significant differences between two particular stages (rejecting the null are shown in italics).

destroy value, as measured by the PEVA. It is the chain node with the highest percentage of firms having negative value creation levels across time.

■ *Innovation assets and R&D investment*

Stage 3, the manufacturing stage, is the most innovative chain member as measured by the summation of goodwill, intangible assets and research and development investment. Manufacturing firms on average invest 66% of their average adjusted total assets in innovation: R&D, intangibles, and goodwill. The differences with the other three stages are statistically significant. Stage 3 has the highest coefficient of variation among its firms, thus is the most heterogeneous in terms of employing innovation capital (Figure 4). Stage 4, the retail stage, is the second most innovative value chain node, having 21% of adjusted total assets in innovation activities, which is one-third the level of Stage 3. Stage 1 assigns only 15% of adjusted total assets to innovative activities, which is one-fifth the rate occurring among Stage 3 firms. The difference in the employment of innovation assets between Stage 3 and Stage 1 is statistically significant. As the most commoditized node, it is not surprising that Stage 2, the production stage, is the least innovative chain member, with on average 9% of total assets invested in innovative assets.

Intangibles and goodwill, the Innovation 2 variable, dominate innovation activity (99%) in all stages, except for agricultural inputs (Stage 1) where R&D comprises 16% of innovation activities. Average Stage 1 R&D expenditures amount to \$141 million dollars per year per firm, or 34% of the average net income. This is eight times more than is spent in Stage 3, the next highest stage with investment in R&D. Again we point out to the reader this important statistic, whereby there are in general significant differences across the four nodes in terms of research and development investment, and specifically, differentially high levels of R&D among Stage 1 firms.

■ *Cost of goods sold*

The COGS is statistically different across the four value chain nodes (Figure 5). Consistent with the MEVA analysis, the down-chain nodes generate higher gross margins. The agricultural production stage, Stage 2, has the highest COGS at 78%, 17% above Stage 3, which has the lowest COGS at 65%. Product differentiation at Stage 1 with high performance seeds or branded equipment allow agricultural suppliers higher gross margins

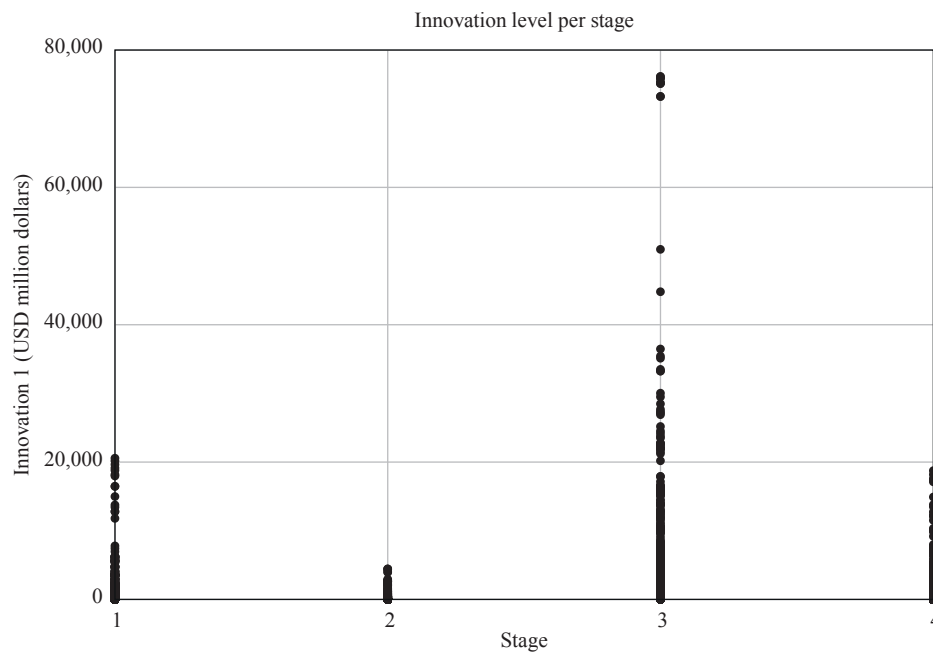


Figure 4. Innovation level per stage. The graph shows the level of innovation as measured by the variable ‘Innovation 1’, which is composed of goodwill and intangible assets, and R&D expenditures. It is measured in million dollars.

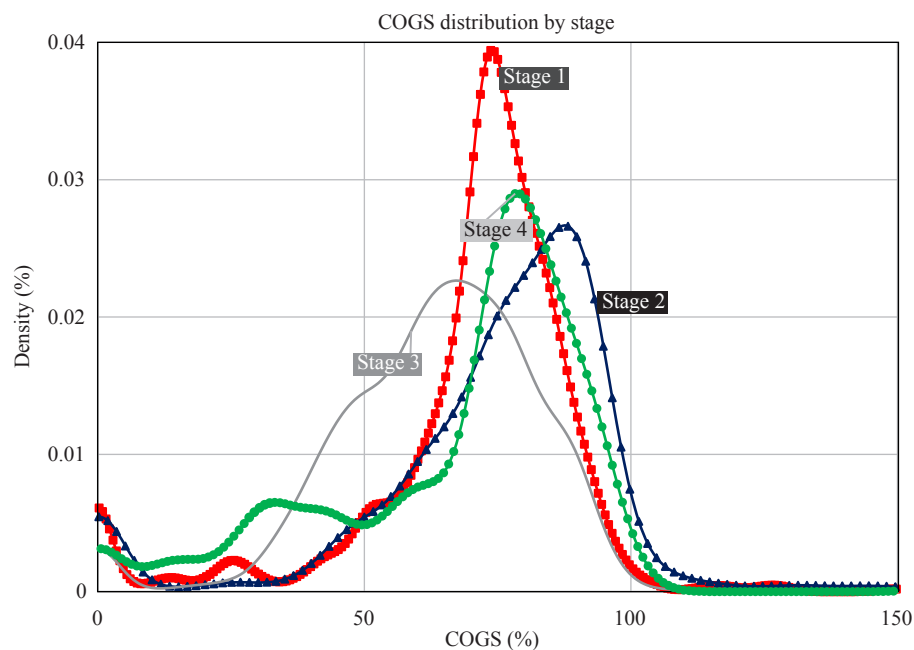


Figure 5. Differing behaviors among the four stages as measured by the density distribution of cost of goods sold (COGS). Notice the differences in the level of the mode (location of the peak) and the homogeneity (breadth) among the four stages.

compared with their customers in Stage 2. Alternatively, Stage 2’s high COGS reflects the raw commodity nature and the competitive market structure commonly found at that node of the value chain.

4.2 Empirical model

An ordinary least squares regression model provides estimates of the drivers of EVA and MEVA across the agri-food value chain. We employ a second model for validation purposes that utilizes probit regression to estimate CEVA and PEVA. Formally, the models are as follows:

$$\text{Value Added Measure } \{EVA_{it}, MEVA_{it}, CEVA_{it}, PEVA_{it}\} = \alpha + \rho\text{Stage1} + \beta\text{Stage3} + \gamma\text{Stage4} + \delta\log\text{Size}_{it} + \theta\text{leverage}_{it} + \nu\text{Inn2}_{it} + \tau\text{Inn3}_{it} + \pi\text{COGS}_{it} + \text{CountryFE} + \text{YearFE} + u_{it} \quad (6)$$

The model includes country-fixed effects (CountryFE) and year-fixed effects (yearFE) to avoid endogeneity due to unobservable information in the error term. Stage 1, 3, and 4 are dummy variables that takes a value equal to one if, respectively, the firm belongs to Stage 1, 3, or 4, and zero otherwise. The values express the difference with respect to Stage 2, the production stage. The expectation is that Stages 1, 3, and 4 create greater value than Stage 2.

The model specifies the logarithm of adjusted total assets to address the effects of firm size on value creation. The expected sign on firm size is positive. Total current liabilities over total equity serves to measure the role of debt on value creation. There is no expected sign on debt level. The model includes two innovation measures; 'Inn2' is the value of the firm's intangible and goodwill assets and 'Inn3' reflects R&D expenditures. Greater levels of innovation should produce higher levels of value creation. Finally, the variable COGS is included in the model to proxy for the level of product differentiation. The higher the level of COGS, the lower is the level of product differentiation. The expected sign is negative as it is expected that product differentiation and value adding are positively related.

Our panel involves numerous countries with differing tax policies. The NOPAT variable of the EVA estimate, employs NOPAT, thus may be biased. We validate the value creation estimate by replacing NOPAT with the net operating profits before taxes. The results are robust showing no change in the EVA coefficient estimates. Additionally, the four regression models control for the country fixed effects, which in part addresses differences in tax policies.

- *Hypothesis I: value addition levels differ across stages as each stage contributes differently to the value creation process*

We confirm Hypothesis I as the value addition levels at Stages 1, 3, and 4 significantly differ from Stage 2, the reference stage. In terms of EVA, Stage 3 contributes the most value in the chain, adding \$41 million per year per firm more than a Stage 2 firm, ceteris paribus (Table 3). The coefficient estimate is significant at the 0.10 level. Similarly, retail (Stage 4) delivers about \$39 million more dollars per year per firm in terms of EVA than Stage 2. The coefficient estimate is significant at the 0.05 level.

- *Hypotheses II: we expect the agricultural input Stage (1) to be a high value-adding node given the presence of input brands and the high level of agricultural research*

Consistent with Hypothesis II (and III), the up-chain Stages 1 and 2 attain low levels of value adding and do not statistically differ in terms of their level of value added. The superiority of the value creation levels of down-chain nodes in comparison with Stage 2 is consistent with the contemporary agribusiness literature that suggests that Stage 2 is the most commoditized stage (Van der Ploeg, 2000).

We cannot accept the null for Hypothesis II that Stage 1 firms effectively add value compared to Stage 2. In terms of EVA and MEVA, Stage 1 firms are statistically no different from Stage 2 firms. This empirically confirms the commonly held belief that more value creation occurs down chain, as opposed to up chain.

Table 3. Regression results.¹

Variables	(1) EVA	(2) MEVA	(3) CEVA	(4) PEVA
Stage 1	-15.928 (22.532)	-0.601 (1.017)	0.055** (0.028)	0.158*** (0.028)
Stage 3	40.634* (24.768)	1.586* (0.931)	0.088*** (0.025)	0.216*** (0.024)
Stage 4	39.273** (19.805)	4.716*** (0.958)	0.146*** (0.026)	0.218*** (0.026)
LN(Size)	40.346*** (7.133)	2.544*** (0.126)	0.059*** (0.005)	0.088*** (0.007)
Leverage	3.645* (2.133)	0.029 (0.019)	0.001 (0.001)	0.001 (0.001)
Innovation 2	0.045*** (0.011)	0.001*** (0.000)	0.001*** (0.000)	0.001 (0.001)
Innovation 3	1.464*** (0.136)	0.001 (0.002)	0.001*** (0.000)	0.001 (0.001)
COGS	-27.550** (11.316)	-0.113 (0.327)	-0.036*** (0.009)	-0.009 (0.009)
Constant	-8.626 (55.598)	-1.744 (1.232)	0.417*** (0.054)	-0.116* (0.064)
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
P-value Stage 1=Stage 3	0.027	0.005	0.120	0.007
P-value Stage 1=Stage 4	0.010	0.000	0.000	0.008
P-value Stage 3=Stage 4	0.952	0.000	0.002	0.893
R-squared	0.505	0.186	0.264	0.310
Observations	3,466	3,466	3,466	3,466

¹ Robust standard errors in parentheses; *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$; in column 1 and 2, the appropriate econometric model is to use a probit model. Both the probit and the ordinary least squares (OLS) econometric techniques were used: The two methods give essentially identical results, with insignificant differences in the variables. For simplicity, only the results of the OLS regression are shown; COGS = cost of goods sold; EVA = economic value added; MEVA = modified economic value added; CEVA = creation or destruction of value; PEVA = persistence of economic value added.

Both stages have low rates of value creation, with conditional means close to zero of -0.194 and -0.806 for Stage 1 and Stage 2 respectively.

The constant coefficient in the CEVA model though is statistically significant at the 0.01 level, indicating that Stage 2 firms do have a positive probability in any year to add value. However, the added value will be low, and will be swamped by large levels of value destruction in a given year. As hypothesized, the results show differences in the probability to create value across stages, and down-chain stages have higher probabilities for value creation than those up chain.

PEVA, the final value creation metric reflects the persistence of value creation. The dummy variable takes a value equal to 1 if a company uses its capital efficiently for at least five years (half of the period covered by the database) during the study period, and zero otherwise. This variable identifies the proportion of companies that persistently create value within each stage. Stage 4 firms, the retail stage, possess a probability of being persistent that is 21.8 percentage points higher than a Stage 2 firm (production), which has a negative 11.6% probability. The coefficient estimate for Stage 3 is 21.6% and for Stage 1, 15.8% greater than Stage 2. The constant is negative and statistically significant at the 0.10 level and thus indicates a negative probability that a Stage 2 firm will be a persistent value creator. The PEVA model results validate the hypotheses that

value creation levels along the food and agribusiness value chain differ across stages, and levels are higher down chain compared with up chain.

- *Hypotheses III: the lack of coordination and the commercialization of undifferentiated products as well as the condition of being primarily a price taker makes the production stage exhibit the lowest levels of value addition among the four value chain nodes*

We accept the null for Hypothesis III that Stage 2 firms add relatively little value to the food and agribusiness chain, as measured by capital utilization efficiency. In a given year, 52% of Stage 2 firms do create value, which reflects the competitive nature of the stage. The average firm creates \$43 million of added value. Firm performance within Stage 2 is heterogeneous reflected by the high coefficient of variations for EVA (6.96) and MEVA (0.97). It is important to note that there are firm-year pairs in Stage 2 where significant value destruction occurs. Stage 2 firms also lack persistency where only 32% of the firms create value for at least five years of the study period. The low PEVA levels result in a negative and significant constant estimate for PEVA.

- *Hypotheses IV: food manufacturing (Stage 3) will exhibit a relatively high level of value addition, compared to upstream stages, due to strong product differentiation, coordination with retailers, and access to low cost inputs from the production stage*
- *Hypotheses V: the retail firms (Stage 4) with their consumer orientation, need to innovate, and strategic position within the value chain, will be a relatively high value creator, compared to upstream stages*

We accept null hypotheses IV and V that Stages 3 and 4 create significant value. Stage 3 and Stage 4, respectively increase the rate of value adding in terms of returns on invested capital 1.59% and 4.71%, respectively, and the estimates are statistically significant at the 0.10 and 0.01 levels. The empirical analysis shows that Stage 4, the retail stage, most efficiently uses its capital; being the largest contributor to the value creation process along the food and agribusiness value chain. The MEVA metric, as opposed to EVA, accounts for a standardized value creation level without taking into account the nominal quantity of capital invested in the productive process.

CEVA is a dummy variable that takes value equal to 1 if the observation has a positive value creation level in a given year during the study period, and zero, otherwise. Thus the level of value adding, whether in nominal terms (EVA) or in real terms (MEVA) does not factor into the estimation. The coefficient value reflects the probability of creating positive value compared with Stage 2. All stages have a positive and significant probability that a firm creates more value than a firm in Stage 2. Positive probabilities range from the highest being Stage 4 (retail) at 15% to Stage 1 (inputs), at 6%. The probability for a retail firm is 65% higher than Stage 3 (manufacturing), which is 60% more likely than Stage 1.

- *Hypothesis VI: firms with higher levels of intangible assets and goodwill create more value. The coefficient estimate for the goodwill and intangible asset variable should be positive and significantly different from zero*
- *Hypothesis VII: firms with higher levels of research and development expenditures create more value. Similarly, the coefficient estimate for the R&D expenditure variable should be positive and significantly different from zero*

All the regression models include two measures of innovation for testing hypotheses VI and VII: 1) intangible and goodwill assets as percentage of total assets, the Inn 2 variable level; 2) and R&D expenditures, the Inn3 variable. Both are hypothesized to carry a positive sign because they drive innovation, and thus, value creation.

The results support Hypothesis VI. The coefficient estimates for intangibles and goodwill assets (Inn2) are positive for all four models, and significant at the 0.01 level for all but the PEVA model. In real terms, intangibles and goodwill raise MEVA, albeit slightly, and the result is significant at the 0.01 level. Intangible and goodwill assets though effect EVA significantly less than R&D expenditures. A 1% increase in the ratio of intangibles and goodwill to total assets, raises EVA \$45,000 for a firm in a given year.

The coefficient estimates for R&D expenditures (Inn3) are also positive for all four models and are significant at the 0.01 level for all but the MEVA and PEVA models. We accept the null for Hypothesis VII. Increasing R&D expenditures raises annual EVA per firm \$1.5M, which is over 30 times the impact of intangibles and goodwill assets. Both intangibles and goodwill, and R&D lead to persistent value addition. The coefficient estimates in the PEVA model are small but significant at the 0.01 level. The regression results provide empirical evidence of not only a positive relationship between innovation and value creation, but also a measure of their contribution to value creation along the food and agribusiness value chain.

- *Hypothesis VII: firms with higher degrees of product differentiation, a smaller ratio of COGS to sales, create more value*

Hypothesis VIII asserts that the ratio of COGS to sales, which is a measure of product differentiation, drives value creation. The smaller this ratio, the larger is the gross margin. Increasing the ratio of COGS to sales by one unit reduces the firm's EVA by \$27.6 million dollars. The coefficient estimate is significant at the 0.05 level. Similarly, the probability of consistently creating value in any given year decreases by 3.6% when the COGS:sales ratio increases by one unit. Both coefficient estimates are significant at the 0.01 level and confirm Hypothesis VIII. For the CEVA and PEVA models, the regression results are negative but not statistically significant. The regression results for the four models show a positive relationship between product differentiation and value creation.

- *Hypothesis IX: there is a positive relationship between firm size and value creation*

The logarithm of adjusted total assets as a measure of firm size has a positive and statistically significant coefficient estimate, at the 0.01 level, in all four of the regression models. Therefore, firm size is a significant determinant of value creation, which supports Hypothesis IX. An increase of 1% in size increases the EVA level by \$40 million dollars. An increase of 1% in the size of a firm also increases the rate of value creation (MEVA) by 2.5 percentage points. The probability of CEVA increases by 6% for the average company when the firm size increases by 1%. Finally, the probability of persistently adding value increases by 9% when firm size increases by 1%. These results are consistent with previous literature where larger companies, ceteris paribus, create greater value because of their better access to resources, economies of scale and scope, and the greater ability to spread risk.

Finally, leverage is measured as total liabilities divided by total equity. This variable captures the type of capital employed by the firm. Theory is not clear on the effect of leverage on value creation, thus we present no hypothesis. The results were weak on the linkage between leverage levels and value adding. Only one (EVA) of the four models generates a statistically significant (0.10) coefficient for the leverage variable. Firms with higher levels of debt do produce greater levels of EVA. The result is significant at the 0.10 level. Increasing the ratio of debt to equity by one unit increases the level of value creation by \$3.6 million dollars, ceteris paribus. These results though should be cautiously interpreted as none of the validation results support this finding.

4.3 Two short examples

The following two example applications of the EVA methodology demonstrate that while on average up chain stages of the food and agribusiness value chain are relatively poor users of capital, there are exceptions. We compare two Stage 1 firms, a poor performer, Alamo, with a strong performer, Monsanto. The Alamo Group

Inc., manufactures and sells agricultural and infrastructure maintenance equipment, and persistently creates value. However, on average, Alamo Group Inc. destroys \$4.5 million dollars at the average rate of -1.12% below their cost of capital (Figure 6). Thus, value destruction can be extreme in a given year. On the other hand, another Stage 1 firm, Monsanto, annually creates \$1,165 million dollars of EVA at an annual rate of 7.6 percentage points above their cost of capital. Monsanto invests 10% of sales in R&D expenditures and maintains 30% of the adjusted total assets in goodwill and intangible assets. The firm is also a consistent value creator having positive CEVA in all the years under analysis. Furthermore, Monsanto maintains an average COGS of 49.06%, which is 24% lower than the average firm in the input stage.

5. Conclusion

The objectives of this manuscript were threefold: (1) to provide a financial, and thus formal, definition of value added; (2) to measure value addition by firms across the four nodes/stages of the value chain; and (3) to test hypotheses as to the drivers of value creation that differ across the four nodes.

First, the current understanding of value creation or value adding in food and agri-business presents a broad and qualitative definition. The current definition holds that firms create or add value when they introduce or modify a new method or product, or they perform an activity that was previously performed by another member of the chain. Furthermore, the current definition allows for greater coordination as a method for creating or adding value. We advance the definition of value adding by building from the work of Amanor-Boudu (2003) and provide a formal measure of value creation. By explicitly measuring the level of value creation our method effectively formalizes the thinking as to how and when a firm creates value. Specifically, we follow the general finance literature and define value creation as a capital creation process; capital created in excess of the capital used to produce the new capital. Using our more formal definition of value creation adds clarity by showing that Stage 2, the production stage, is inferior across all four of our measures at creating value compared to others along the agri-food value chain. But interestingly, and we argue importantly, Stage 2's profitability levels, as measured in nominal terms, or per asset compares quite favorably with down chain firms, i.e. Stage 4. Though beyond the scope of this research, we show important

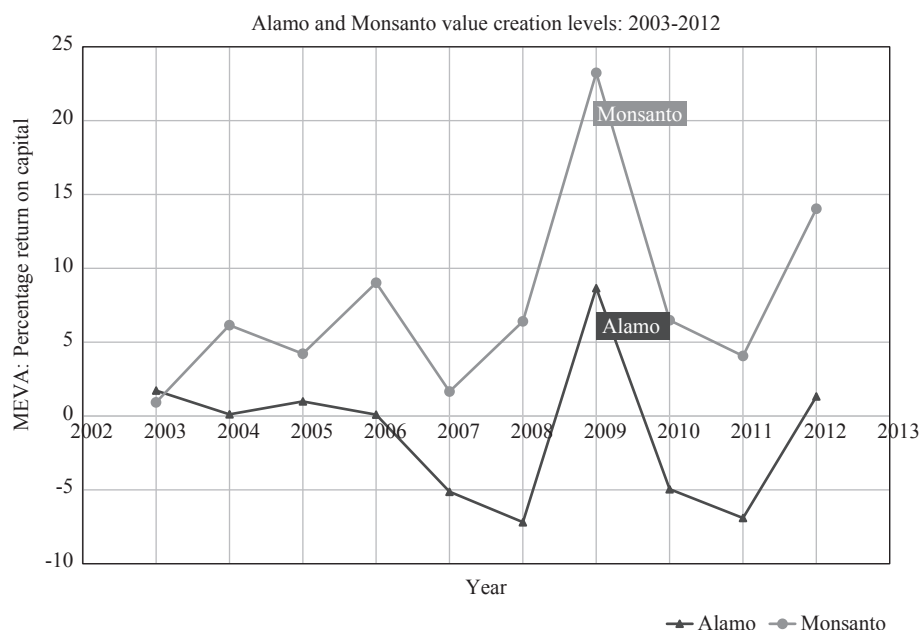


Figure 6. The value creation levels of two different firms within the same stage (1), Alamo and Monsanto: 2003-2012.

differences between value creation and profitability. These differences may be material for explaining the sustainability of the Stage 2 business model that creates and thus captures low levels of value.

Second, extensive research using the Food Dollar or Marketing Bill approaches clearly shows the decline in the share of the consumer dollar accruing to producers. It is unclear what such findings specifically indicate about value creation and capture. But from a policy perspective, producers and policymakers assert that anti-competitive practices along the value chain explain the disproportionately low level of value capture by producers, i.e. see the EU Council (2016). Our analysis using all four metrics, EVA, MEVA, CEVA, and PEVA, adds some specificity to both issues; the linkages between the decline in the Food Dollar capture, and the assertion as to whether producers capture a disproportionate share of value created. In particular, of the 65 Stage 2 firms only 32 are persistent value creators, for example. Thus our findings do not state that Stage 2 firm cannot create value, but on average firms create less capital than they employ. Our findings do not support the premise that anti-competitive forces result in Stage 2 firms' low level of value capture. Instead we indicate that producers on average capture a level of value commensurate with the value they create, especially as compared to the other nodes along the value chain.

Third, our method also allows us to validate these findings by testing nine hypotheses derived from theoretical drivers of value creation. The results of the empirical tests confirm that Stage 2 (and Stage 1) differently employs capital and higher levels of COGS, which explains the causes for low levels of value creation. Stage 2 holds significantly lower levels of innovation assets such as goodwill and an intangible assets, and engages in very little research and development, compared with other nodes along the value chain. One implication of the fact that Stage 2 holds differential levels of capital and innovation assets may reflect an unconventional form of risk sharing along the agri-food value chain. While producers (Stage 2) face many risks such as price and weather, they can rely on chain partners up and down chain to engage in the high risk and costly activities of research and development and intangible asset assembly. Analyses that focus on risk management at the farm gate alone may fail to capture the complete risk sharing that occurs along the agri-food value chain as a whole.

We posit from these findings that there exists intra-stage complementarities across the agri-food value chain, whereby the value chain as a whole employs capital well and creates sufficient levels of value. It is improper to assume that each node must similarly employ capital and create capital at the same rates. Maybe the relatively competitive and uncoordinated Stage 2 production stage supports value creation within other stages along the value chain by, for example, holding down the COGS for down chain firms. There may be tradeoffs across the chain whereby innovation occurs up and down chain away from production, which in turn reduces the burden for Stage 2 firms to deploy innovation capital. This logic suggests that firms in Stage 2 in general focus on productive activities, rather than riskier creative activities. The implication is that all firms along the value chain need not employ the same capital plans, for example involving like levels of goodwill and intangible assets, or research and development, with respect to value chain. Critical though, to Stage 2 sustainability, may be linkages and complementarities within a chain. The policy implication for those seeking to strengthen rural economies is that optimal chain performance may occur when some firms, say in Stage 2, are allowed to specialize, remain independent, achieve economies of scale, and serve a more complementary role, and by doing so, keep raw material prices low and the supply thick.

Finally, this study is restricted insofar as it only uses financial data. Thus neglects the important topic as to whether coordination, as a source of innovation, can also account for the differences across the four stages. An area for further research would be an analysis of the impact of coordination (horizontal and vertical) on value creation. Coordination among value chain actors implies complementarities among the activities of different chain members. The food and agribusiness value chain, is a system whereby vertical linkages may impact the investment decisions of individual firms within the chain. (Hendrikse and Bijman, 2002). Coordination among members in a chain can reduce inventory holding costs, delivery times, transportation costs, levels of loss and damage, and improve customer service (Lee *et al.*, 1997; Simatupang *et al.*, 2002), which may simultaneously improve capital use efficiency and levels of value added. Further work is needed

to determine how best to parameterize coordination and collaboration within the EVA analytical approach. Doing so would clarify the empirical relationship between coordination and value creation.

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