Essays in Corporate Governance and Environmental Risks

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A Thesis

In

The John Molson School of Business

Presented in Partial Fulfillment of the Requirement
For the Degree of
Doctor of Philosophy (Business Administration) at
Concordia University
Montreal, Quebec, Canada

July 2018

CONCORDIA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

This is to certify that the thesis prepared

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Entitled: Essays in Corporate Governance and Environmental Risks

and submitted in partial fulfillment of the requirements for the degree of

Doctor Of Philosophy (Business Administration)

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Abstract

Essays in Corporate Governance and Environmental Risks

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Concordia University, 2018

This thesis consists of two essays focusing on long-term perspective in management.

The first essay (chapter 2) studies how family firms' valuations are affected by the presence of free cash flow and antitakeover provisions. Both free cash flow and anti-takeover provisions are believed to increase the severity of agency conflicts. However, we found that in family firms, the existence of free cash flow and anti-takeover provisions are not perceived as damaging. Our findings indicate that higher levels of free cash flow and higher levels of antitakeover provisions in family firms are associated with higher valuations as measured by the firms' Tobin's Q. Moreover, we find that an increase in strength of anti-takeover provisions or level of free cash flow in family firms positively affects family firms' valuation.

The second essay (chapter 3) uses a unique data set of natural disasters that occurred around the world during the period 1970 to 2015 and study their impact on the price and price volatility of globally traded agricultural commodities. Our results show that natural disasters affect most of the commodities examined in this study by causing an increase in their price volatility whereas prices are only marginally affected. In addition to this, we find that the total damage caused by a natural disaster affects the magnitude of price and price volatility changes of a given commodity.

Finally, natural disasters affecting countries with a higher share of the global production of a commodity have a more significant impact on the price and price volatility of that commodity.

Acknowledgements

First, I would like to thank my supervisor Dr. Thomas Walker for his continuous support and guidance. I benefited greatly from his insightful suggestions and encouraging feedbacks.

I am also grateful to my mentor Dr. Rahul Ravi for all his support throughout my Ph.D. studies. His wisdom and knowledge have and will always guide me.

I would also want to thank Dr. Kuntara Pukthuanthong, Dr. Andrew Chapman, Dr. Maher Kooli, and Dr. Fred Davis for their valuable comments and suggestions.

Finally, I would like to specially thank my family for their unconditional love and support. I dedicate this thesis to them.

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CHAPTER 1

1. Introduction

This thesis consists of two essays focusing on long term perspective in management.

In the first essay, we study how the existence of long term perspective in management impacts the corporate governance practices of the firm. Specifically, we show when management focuses on the long-term performance of the firm, factors believed to increase the severity of agency conflict can be perceived by investors as beneficial to the firm.

In the second essay we focus on emerging environmental risk factors such as natural disasters and their impact on supply chain management. These emerging risk factors are becoming more frequent and larger in magnitude. Therefore, managers focusing on the long-term performance of the firm, specially firms active in food and agricultural industry, should increasingly focus on addressing these emerging risk factors Essay 1, titled 'Agency Conflicts in Family Firms', focuses on corporate governance in the specific context of family firms. Corporate governance in finance is the subject of many studies However, certain aspects of this area are not as thoroughly explored. We focus on family firms and study how their goal of legacy building and focus on long-term performance (Yeh, 2014) can affect the severity of agency conflict in firms. Family firms are common ownership structures around the world and while the concentrated ownership can be a source of agency conflict (Villalonga and Amit, 2006, 2009; Ali, Chen, and Radhakrishnan, 2007), there are certain benefits arising from this particular ownership structure (Schoar, 2006). A family owner holds a significant ownership stake which is likely to remain in the family by being transferred to the next generationand family owners are more likely to hold an undiversified portfolio (Bertrand and Schoar, 2006; Burkart, Panunzi, and Shleifer, 2003).. As a result, family owners are likely to be more concerned about the long-term performance of the firm viewing the firm as a legacy building vehicle rather than a mean to serve their self interest (Jaskiewicz, Combs, and Rau, 2015).

In this essay, we focus on two factors that are known to increase the severity of agency conflict, namely the presence of antitakeover provisions and free cash flow. Presence of antitakeover provisions can lead to a higher entrenchment level in firms and ultimately decrease shareholders' wealth (Masulis, Wang, and Xie, 2007; Bebchuck Cohen, and Ferrell, 2009; Cohen and Wang, 2013).. Existence of free cash flow in firms can also lead managers to pursue their self interest rather than focusing on maximizing shareholders' wealth (Dechow, Richardson, and Sloan, 2008).. We study how family firms are affected by existence of antitakeover provisions and free cash flow. Our results indicate that the existence of antitakeover provisions and free cash flow affect family firm and non-family firms in a different way. We find that that family firms' valuations are positively affected by these two factors that are considered to increase agency conflict in the firm. We attribute this to family firms' main focus on long-term performance and legacy building. Our results indicate that market participants expect family firms' managers to have a long-term perspective. Therefore, investors perceive the existence of free cash flow and antitakeover provisions as beneficial to the firm.

Essay 2, titled 'Environmental Risks and Commodities', focuses on sustainable investments. Emerging global risk factors such as climate change related risks have become increasingly important to consider for both private and institutional investors (Ranger, 2012; Chang, Chang, and Wen, 2014). Our study focuses on the impact of natural disasters on the commodity prices and price volatilities in hope to give investors insight on how to better prepare for these emerging risk factors. As natural disasters are increasing in number and magnitude (Michel-Kerjan, 2010; Ranger, 2012) many researchers have focused on how these disasters affect financial markets and economies. We focus on an area that has not been extensively researched. We use a comprehensive dataset of natural disasters to study how natural disasters affecting production centers of a commodity impact the commodity price and price volatility. Our findings suggest natural disasters have a significant impact on the price volatility of most commodities. Moreover, we find that natural disasters have a marginal effect on price level of commodities. Our results also suggest that natural disasters affecting a country with a larger production share of a particular commodity have more significant impact on the price and price volatility of that commodity.

Our study is an attempt to better identify the impact of natural disasters on agricultural firms' supply chain and our results highlight the increasing importance of supply chain risk management. More importantly, as the frequency and severity of natural disasters is expected to increase for the foreseeable future, managers with focus on long-term performance of the firm need to further hedge their supply chain.

CHAPTER 2

Agency Conflicts in Family Firms

2.1. Introduction

The agency problem proposed by Jensen and Meckling (1976) cites a conflict of interest between managers and shareholders. In their widely cited paper, Jensen and Meckling (1976) suggest that managers or agents should act in the best interest of shareholders. However, managers may deviate from this main role and engage in self-serving behavior. The corporate governance literature has extensively studied the implications of agency conflict. In the core of this line of research lie various factors that can improve or deteriorate the magnitude of agency conflict in the firm. Here, we focus on two widely used measures that have been shown to intensify the severity of agency conflict in corporations; that is, free cash flow and anti-takeover provisions and their impact within the context of family firms. Our study highlights the importance of management perspective in firms and how it can affect how slack resources or managers' entrenched positions are used. Family firms' managers are more likely to focus on the long-term performance of the firm (Jaskiewicz, Combs, and Rau, 2015). While the existence of free cash flow and anti-takeover provisions in firms is shown to be detrimental to firms by increasing the severity of agency conflict, we show market participants react positively to the existence of these factors in family firms. Our study addresses an important issue in corporate governance literature which is management perspective plays an important role in severity of agency conflict in firms and the impact of which on firm valuation.

The existence of free cash flow in a corporation is widely believed to magnify agency problems. Jensen (1986, p. 323) defines free cash flow as "cash flow(s) in excess that required to fund all projects that have positive net present values when discounted at the relevant cost of capital." Richardson (2006) provides an alternative definition of free cash flow as funds in excess of those needed for maintenance and development. The free cash flow hypothesis suggests that in the presence of free cash flow, managers are more inclined to use the free cash flow available in the firm to pursue their own interests and not in the best interests of shareholders deviating from the manager's primary goal of pursuing shareholder interest. Another factor widely believed to have an impact on the agency problem is the existence of antitakeover provisions in a corporation. As defined by DeAngelo and Rice (1983, p. 332) "antitakeover amendments [to] primarily act to increase incumbent management's job protection and decision-making prerogatives at the expense of current shareholders." The extent of adopting antitakeover provisions and their impact on a firm's valuation have been the subject of many studies that conclude that the adoption of antitakeover provisions has a negative impact on firm valuation (Jarrell and Poulsen, 1987; Ryngeart, 1988). In addition, antitakeover provisions can lead to higher entrenchment levels among managers resulting in more severe agency problems and, ultimately, negatively impacting shareholders' wealth (Gompers, Ishii, and Metrick, 2003). This study focuses on agency problems in the context of family firms. Specifically, we examine whether the severity of agency conflicts in family firms is weaker/stronger when free cash flow and antitakeover provisions exist.

Family firms are a common ownership structure around the world. Family ownership on its own is a potential source of agency costs arising from conflict between managers and shareholders (Fama and Jensen, 1983; Villalonga and Amit, 2006). Moreover, the existence of concentrated ownership can also cause agency conflict (Villalonga and Amit, 2006, 2009; Ali, Chen, and Radhakrishnan, 2007). However, an alternative school of thought exists which suggests that family ownership may be a potential source of benefit for firms. Bertrand and

Schoar (2006) argues that family firms tend to maintain their control and ownership of the firm and this tendency of control can potentially benefit the firm as family owners may have a long-term perspective in management. For families, the firm is not only an investment. It is often a vehicle for legacy building (Jaskiewicz, Combs, and Rau, 2015). Because families hold a significant ownership stake in the firm and this ownership stake is likely to be a significant part of their undiversified portfolio, which is likely to transfer to the next generation in the family, they tend to make decisions based on the long-term performance of the firm.

This study is an attempt to resolve the seemingly contradictory arguments on the impact of family ownership on firm valuation. We use the existence of takeover defences in the firm to separate more vs less secured (entrenched) management. Arguably, the existence of antitakeover measures is perceived by investors as a mechanism for management entrenchment. However, a competing theory, called shareholder interest theory (Yeh, 2014), suggests that a more secured position may allow the management to implement their long-term goals which ultimately benefits shareholders. We propose that if managers in family firms have a long-term perspective then, they are more likely to use antitakeover provisions to shed myopia and make decisions in the interest of long term goals. This can be particularly important when a firm is active in a high-tech industry. High-tech firms invest heavily in innovative technology and stability in management is essential to assure the success of the firm. We use Free Cash Flow as an alternative measure to takeover defences. Arguably, if family firms are committed to legacy building and ensuring the long-term success of the firm, they are less likely to engage in value destroying activities when free cash flow is available to them. Our results indicate that the existence of antitakeover provisions and the presence of free cash flow in family firms do not have the same impact on firm valuation as they do in non-family firms. We employ both the

Entrenchment Index and the Governance Index and find that while antitakeover provisions have a negative effect on valuation in non-family firms, these provisions are positively perceived in family firms. Our results also show that the presence of free cash flow in non-family firms has a negative impact on firm valuation. However, free cash flow affects family firm valuation in a positive manner. The results using both, the Entrenchment Index and the Governance Index find that an increase in adopting anti-takeover provisions positively affects family firms' valuation supporting the arguments that family firm managers are more likely to use their entrenched positions as well as slack resources such as free cash flows towards building shareholder value. Our results also indicate that family firms in high-tech industries further benefit from the excess free cash flow and more entrenched management compared to family firms in low-tech industries.

This study focuses on the important issue of management perspective in studying the agency conflict in firms. Our results indicate that within the context of family firms the existence of free cash flow and antitakeover provisions are perceived as beneficial to the firm and have a positive impact on firm valuation. We show investors perceive higher levels of free cash flow or antitakeover provisions as positively but only for family firms. As a result, market participants react accordingly to these measures and we observe this reaction in higher valuation for the firm as measured by Tobin's Q.

Our findings highlight the importance of management perspective in the corporate governance research. In other words, our findings suggest that in order to better identify the impact of corporate governance practices in firms researchers have to focus more, among other factors, on the role management perspective can play.

2.2. Literature Review

The free cash flow hypothesis was developed by Jensen (1986, 1989, 1993) and relies heavily on the agency problem proposed by Jensen and Meckling (1976). Managers' self-serving decisions can include undertaking projects that have no value to the firm or project negative NPV (Jensen, 1986; Jensen and Meckling, 1976) and are more likely to continue investing in negative NPV projects in the presence of free cash flow (Lang, Stulz, and Walkling, 1991). Managers may also use excess funds to engage in unnecessary acquisitions with no regard as to whether these acquisitions generate wealth for shareholders (Opler, Pinkowitz, Stulz, and Williamson, 1999; La Porta, Lopez-de-Silanes, Shleifer, and Vishny, 2000). Moreover, managers may use the free cash flow available to them other expenditures deemed unnecessary to firm operation and value creation (Amihud and Lev, 1981; Jensen, 1986; Christie and Zimmerman, 1994; Rediker and Seth, 1995). Chen, Hope, Li, and Wang (2011) find that free cash flow signals excessive investment and not necessarily investment efficiency. In addition to taking on negative NPV projects, unnecessary acquisitions, or wasteful spending, managers of firms with free cash flow are less dependent on outside funding. This allows managers to avoid common checks from lenders and engage in activities that are not in line with their primary shareholders' wealth maximizing goal. This self-serving behavior, along with investment in negative NPV projects, can have a negative impact on the stock returns of firms as demonstrated in Fairfield, Whisenant, and Yohn (2003) and Titman, Wei, and Xie (2004). As a result, while the existence of cash flow can have a positive impact on performance (Brush, Bromiley, and Hendrickx, 2000; Deb, David, and O'Brien, 2017), the presence of free cash flow can be detrimental to firm performance (Dechow, Richardson, and Sloan, 2008). Similarly, Kadioglu, Kilic, and Yilmaz (2017) use Tobin's Q as a measure of valuation and find a significant and negative relationship between free cash flow and firm valuation. This negative relationship between free cash flow and firm valuation persists even in highly regulated industries such as Asian REITs as found by Wei, Kien, and Fan (2017).

The impact of antitakeover provisions on governance and firm valuation has been the subject of many studies. The existence of antitakeover provisions is known to negatively affect firm's valuation and shareholders' wealth as these provisions result in management entrenchment and more severe agency problem.(Masulis, Wang, and Xie, 2007; Bebchuck Cohen, and Ferrell, 2009; Cohen and Wang, 2013).

Gompers, Ishii, and Metrick (2003) developed a Governance Index or G-Index using 24 governance provisions. The G-Index has been employed in many studies as a proxy for management entrenchment (cf., Masulis et al., 2007; Bebchuck et al., 2009; Cohen and Wang 2013; Giné, Moussawi, 2017; Chen, King, and Li, 2018). While the G-Index has been widely used, some researchers believe that all 24 provisions used in Gompers et al. (2003) do not matter when measuring shareholders' rights. Bebchuk, Cohen, and Ferrell (2009) employ only six governance provisions (poison pills, golden parachutes, limits to shareholder bylaw amendments, staggered boards, and supermajority requirements for mergers and charter amendments) and find that only this subset of governance provisions matter. Entrenchment Index has also widely been used by researches to measure the quality of corporate governance in firms and the results mainly support a negative relationship between firm performance and higher level of entrenchment (El-Khatib, Fogel, and Jandik, 2015). While the impact of implementing antitakeover provisions is potentially harmful to shareholders' wealth as it is likely to increase management entrenchment, antitakeover provisions can have different effects on shareholders' and debtholders' wealth. Few studies have focused on implementing antitakeover provisions and their impact on debtholders. These studies generally conclude that implementing antitakeover provisions alleviates debtholders' concerns about potential takeover threats resulting in a lower cost of debt and, consequently, better performance (Klock, Mansi, and Maxwell, 2005, Chava, Livdan, and Purnanandam, 2009; Francis, Hasan, John, and Waisman, 2010).

In summary, while it is well established in the literature that antitakeover provisions can lead to management entrenchment and poor performance, under certain circumstances, it has been determined that the existence of these provisions may be perceived as beneficial or, at the very least, not as damaging.

Here we focus on the severity of agency conflict that arises from the existence antitakeover provisions and free cash flow and in the context of family firms

Family firms are a relatively common ownership structure in the world (La Porta, Lopez-De-Silanes, and Shleifer, 1999; Claessens, Djankov, and Lang, 2000; Faccio and Lang, 2002). About half of publicly traded firms in U.S and close to one-third of S&P 500 firms are family firms (Villalonga and Amit, 2010; Anderson and Reeb, 2003). Family shareholders are the most common form of block holders and are primarily undiversified. Consequently, they have a strong tendency to hold ownership and control of the firm considering that ownership transfers through generations (Bertrand and Schoar, 2006; Burkart, Panunzi, and Shleifer, 2003).

Additionally, concentrated controlling ownership in family firms can be a source of agency costs for minority shareholders (Villalonga and Amit, 2006, 2009; Ali, Chen, and Radhakrishnan, 2007).

2.3. Hypotheses Development

Our goal is to test how the existence of free cash flow and antitakeover provisions affect family firm valuation. Free cash flow and antitakeover provisions are widely known to increase the severity of agency problem in firms and hence negatively affect firm valuation. We focus on family firms because of their unique ownership structure and management perspective (Bandiera, Lemos, Prat, and Sadun, 2018). We conjecture that antitakeover provisions in family firms deter hostile takeover threats allowing the value and legacy building vision of family owners to be implemented. Thus, the existence of these provisions in family firms may not cause agency conflicts or management entrenchment in the same fashion as it does in non-family firms. Rather, it may result in firm stability and releases managers from takeover threats allowing them to focus on achieving the long-term goals of the firm. In contrast, it is also possible that family firms implement antitakeover provisions for the sole purpose of maintaining ownership and control of the firm to personally benefit from the firm, which can be a substantial source of agency costs. In such a case, the existence of these provisions in family firms can result in diminishing shareholders' wealth even more significantly. Thus, the existence of antitakeover provisions may actually cause a more severe decline in shareholders' wealth within family firms. To test these competing theories, we propose our first hypothesis:

H1a: Antitakeover provisions are detrimental to family firm valuation.

H1b: Antitakeover provisions are beneficial for family firm valuation.

Moreover, to further investigate how antitakeover measures affect family firms, we test if changes in the extent of adopting of antitakeover provisions also affect family firms differently.

We conjecture that if the existence of antitakeover provisions in family firms are perceived as beneficial, market participants would react positively if these measures come to existence or become more prevalent in family firms. Conversely, if antitakeover provisions are detrimental to both family and non-family firms, an increase in the extent of adopting these measures would be perceived negatively for all firms. To test this, we propose the following hypotheses:

H2a: An increase in adopting antitakeover provisions is detrimental to family firm valuation.

H2b: An increase in adopting antitakeover provisions is beneficial to family firm valuation.

As previously mentioned, the long-term perspective of family firms can be a determining factor as to how antitakeover provisions are effectively used. This is in line with the efficient use of cash flow that can have a positive impact on valuation (Brush et al., 2000). Alternatively, family firms may not differ in their use of free cash flow and can engage in unnecessary and wasteful spending. Consequently, the presence of free cash flow in family firms can adversely affect firm valuation. To test these two notions, we propose our third set of hypotheses:

H3a: The presence of free cash flow is detrimental to family firm valuation.

H3b: The presence of free cash flow is beneficial for family firm valuation.

Furthermore, if higher levels of free cash flow in family firms are perceived positively, market participants would react favorably to an increase in the level of free cash flow in family firms. Conversely, if free cash flow in family firms is perceived detrimental as is in non-family firms, an increase in free cash flow level will be received negatively by market participants. To test this, we propose the following hypotheses:

H4a: An increase in free cash flow is detrimental to family firm valuation.

H4b: An increase in free cash flow is beneficial for family firm valuation.

The remainder of this paper is organized in the following way. In Section 2.4, we explain the data used in the study. Section 2.5 focuses on the model used. Section 2.6 presents summary statistics, Sections 2.7 presents our results, and Section 2.8 presents our robustness tests. Section 2.9 describes our conclusions.

2.4. Data

Our sample consists of firms that are part of the S&P 500 Index from 1993-2014. To identify family firms, we use the data available on Ron Anderson's website used in Anderson, Duru, and Reeb (2009) and Anderson, Reeb, and Zhao (2012). We employ the same methodology and manually update the data using the ownership structure listed on Bloomberg. Financial data, including valuation and free cash flow, is extracted from Compustat. Finally, we use Institutional Shareholder Services (ISS), formerly known as RiskMetrics, to retrieve governance data. We construct the E-Index following Bebchuk et al. (2009). The G-Index is only used for years prior to 2007 as the components of the G-Index were not entirely reported after that.

2.5. Method

The purpose of our research is to study whether and how factors that are typically associated with agency conflicts have a differential impact on family firms. We use multiple measures to proxy for the level of agency conflict in the firm. In the first set of tests, we use the Entrenchment Index and the Governance Index as proxies. The Entrenchment Index (E-Index) was introduced by Bebchuk et al. (2009) who use six governance provisions in their index construction. The Governance Index (G-Index) was developed by Gompers et al. (2003) and draws on 24 governance provisions. The underlying data for the G-Index is only available prior to 2007. As such, our tests related to the G-Index only represent a portion of our data prior to 2007.

We define Equation (2.1) and employ panel regressions to examine how the two indices affect a firm's valuation for both family and non-family firms (thereby testing Hypotheses H1a and H1b):

$$Tobin's\ Q_{it} = \alpha + \beta_1 * Index_{it} + \beta_2 * Index_{it} * FamilyFirm_{it} + \beta_3 * FamilyFirm_{it} + \sum_{j=4}^{8} \beta_{jt} * C_{jt} + \varepsilon_{it} \qquad (2.1)$$

where the dependent variable is $Tobin's\ Q_{it}$, which we use as the measure of valuation to test how various sources of agency conflict and family firms impact firm valuation. $Tobin's\ Q_{it}$ is Tobin's Q for firm *i* at year *t*. $Index_{it}$ is the value of the E-Index or the value of the G-Index for firm *i* at year *t*. $FamilyFirm_{it}$ is a dummy variable that takes a value of one if firm *i* at year *t* is a family firm and zero otherwise . We use the interaction variable $Index_{it}*FamilyFirm_{it}$ to determine the impact of the Entrenchment Index and the Governance Index on family firm valuation. Specifically, β_1 captures the impact of our two governance indices on non-family firm valuation. β_3 captures the impact of a family firm on valuation. β_2 captures the incremental impact of the Entrenchment Index and the Governance Index on a family firm's valuation. C_{jt}s are the control variables in our model and include ROA, the natural log of total assets, a dummy variable that measure if the firm is incorporated in the state of Delaware, the ratio of capital expenditures to total assets, and leverage, all of which are extracted from Compustat. Leverage is calculated as:

$$Leverage = \frac{Long\ Term\ Debt + Debt\ in\ Current\ Liabilities}{Total\ Stockholders'Equity}$$

We also use free cash flow as a proxy for the level of agency conflict in the firm. Free cash flow is calculated using the method outlined in Lehn and Poulsen (1989) as:

Cash Flow = Operating Income - Tax - Interest - Preferred Dividend - Common Stock Dividend

We scale the cash flow by the book value of assets and sales to calculate two measures for Free Cash Flow (Lehn and Poulsen, 1989; McLaughlin, Safieddine, and Vasudevan, 1996; Gul and Tsui, 1997, 2001).

$$FCFAssetScale_t = \frac{Cash\ Flow_t}{Book\ Value\ of\ Asset_t}$$

and

$$FCFSaleScale_t = \frac{Cash\ Flow_t}{Sales_t}$$

We define Equation (2.2) and employ panel regressions to test how free cash flow affects the valuation of family and non-family firms (thereby also testing Hypotheses H3a and H3b):

$$Tobin's\ Q_{it} = \alpha + \beta_1 * FCF_{it} + \beta_2 * FCF_{it} * FamilyFirm_{it} + \beta_3 * FamilyFirm_{it} + \sum_{j=4}^{8} \beta_{jt} * C_{jt} + \varepsilon_{it} \qquad (2.2)$$

where FCF_{it} is a dummy variable that takes on a value of one if the free cash flow value for firm *i* at time *t* is in the top quartile of the free cash flow values in our sample. FCF_{it} takes a value of zero if the free cash flow value for firm *i* at time *t* is in the bottom quartile of the free cash flow values in our sample. To ensure the robustness of our results, we use median as a cut off point. In other words, we define FCF_{it} as a dummy variable that takes a value of zero if the free cash flow value for firm *i* at time *t* is below the median of the free cash flow values in our sample. Our results remain unchanged. All of the other variables are as previously defined.

We define equation (2.3) and employ panel regressions to test how changes in antitakeover provisions affect the valuation of family and non-family firms (thereby also testing Hypotheses H2a and H2b):

$$\Delta Tobin's\ Q_{it} = \alpha + \beta_1 * \Delta Index_{it} + \beta_2 * \Delta Index_{it} * FamilyFirm_{it} + \beta_3 * FamilyFirm_{it} + \sum_{j=4}^{8} \beta_{jt} * C_{jt} + \varepsilon_{it} \qquad (2.3)$$

where the dependent variable is $\Delta Tobin's\ Q_{it}$, which we use as the measure of change in firm valuation to test how changes in the extent of adopting antitakeover measures affect family and non-family firm valuations. We define $\Delta Tobin's\ Q_{it}$ as;

$$\Delta Tobin's\ Q_{it} = Tobin's\ Q_{it} - Tobin's\ Q_{it-1}$$

where $Tobin's\ Q_{it}$ is Tobin's Q for firm i at year t and $Tobin's\ Q_{it-1}$ is Tobin's Q for firm i at year $t-1$ or the previous year.

We also define $\Delta Index_{it}$ as:

$$\Delta Index_{it} = Index_{it} - Index_{it-1}$$

where $Index_{it}$ is the value of the E-Index or the value of the G-Index for firm i at year t and $Index_{it-1}$ is the value of the E-Index or the value of the G-Index for firm i at year $t-1$ or previous year. All of the other variables are as previously defined.

Furthermore, we define equation (2.4) and employ panel regressions to test how changes in level of free cash flow in a firm affect the valuation of family and non-family firms (thereby also testing Hypotheses H4a and H4b):

$$\Delta Tobin's\ Q_{it} = \alpha + \beta_1 * \Delta FCF_{it} + \beta_2 * \Delta FCF_{it} * FamilyFirm_{it} + \beta_3 * FamilyFirm_{it} + \sum_{j=4}^{8} \beta_{jt} * C_{jt} + \varepsilon_{it} + \qquad (2.4)$$

where ΔFCF_{it} is a dummy variable that takes on a value of one if the change in free cash flow value (sales-scaled or assets-scaled) for firm i from year $t-1$ to year t ($FCF_{it} - FCF_{it-1}$) is in the top quartile of changes in free cash flow values in our sample from year $t-1$ to year t. In other words, ΔFCF_{it} measures the level of change in free cash flow level of a firm (high or low level of change in free cash flow) during the prior year relative to all the firms in the sample. We also define ΔFCF_{it} as a dummy variable that takes on a value of one if the change in free cash flow value for firm i between year $t-1$ and year t ($FCF_{it} - FCF_{it-1}$) is above the median of changes in free cash flow values in our sample between year $t-1$ and year t. Our results remain qualitatively similar.

2.6. Summary Statistics

Table 2.1 provides summary statistics for the data we use for our study. We classify 25.16% of the observations in our sample as family firms. For each firm in our sample, we calculate the Entrenchment Index ranging from zero to six. While our full sample contains 6,114 observations, we could not find a match for the E-Index for 182 observations when we collected the data from RiskMetrics. Consequently, for the tests including the E-Index variable, our sample is slightly smaller. The results in Tables 2.6 and 2.7 remain qualitatively unchanged once we remove the observations with missing data on the E-Index. The Governance Index can range from 0-24. However, our sample only includes firms with G-Indices ranging from 3-16. Moreover, since the G-index is only reported for a portion of our data prior to 2007, we only have 4,279 observations containing the G-Index.

Insert Table 2.1 about here.

Table 2.2 presents a correlation matrix for the variables used in our regressions. It is worth noting that the variables *Free Cash Flow - Sales Scaled* and *Free Cash Flow - Asset Scaled* have a correlation of 0.5521. Similarly, the Governance Index and Entrenchment Index have a correlation of 0.7156. While we also observe a high correlation between *Return on Assets* and *Free Cash Flow-Assets Scaled* (0.7731) and between *Market Value of Total Leverage* and *Assets* (*Natural Log*), these pairs are included in our regressions since the Variance Inflation Factors (VIF) were below four.

Insert Table 2.2 about here.

2.7. Results

2.7.1. Univariate Analysis

Table 2.3 presents the results of our univariate analysis for the difference in mean and median of Tobin's Q. Family firms have a lower mean and median Tobin's Q compared to non-family firms. We divide our sample based on firms with a low (0-3) and high (4-6) Entrenchment Index. We used the cut-off point of three for the E-Index because the median E-Index in our sample is three. The results indicate that the low Entrenchment Index firms in our sample have a higher mean and median Tobin's Q. We also divide our sample based on the G-Index using the G-Index median (median = 10) as the cut-off point. Consistent with our results with the Entrenchment Index, we find that firms with a low Governance Index have a higher mean and median Tobin's Q. Our results also indicate that firms with a Return on Assets above the median have higher mean and median Tobin's Q. Moreover, firms with assets below the median have higher mean and median Tobin's Q. Similarly, firms with capital expenditures below the median have higher mean and median Tobin's Q. Firms incorporated in the state of Delaware have higher mean and median Tobin's Q. Finally, firms with free cash flow below the median, both sales scaled and asset scaled, have higher mean and median Tobin's Q.

Insert Table 2.3 about here.

2.7.2. Panel Regressions

Table 2.4 reports the summary results of the panel regression demonstrating how the Entrenchment Index impacts Tobin's Q. Model (1) only reports the effect of the E-Index on Tobin's Q for all of the firms in our sample regardless as to their classification as family or non-family firms. As expected, higher E-Index results are associated with lower Tobin's Q. This suggests that a higher Entrenchment Index has a negative impact on firm valuation. Model (3) in Table 4 includes *Family Firm* and the interaction term of *Family Firm * E-Index*. The results for the Entrenchment Index are consistent with Model (1). However, the interaction term is positively and significantly related to Tobin's Q. This implies that while a higher Entrenchment Index has a negative impact on firm valuation, a higher Entrenchment Index in family firms has a positive impact on firm valuation.

Insert Table 2.4 about here.

Table 2.5 reports summary results of the panel regressions for the Governance Index and its impact on firm valuation. The results are in line with those we reported in Table 2.4 for the Entrenchment Index. Model (1) only includes the Governance Index and indicates that a higher Governance Index is associated with lower Tobin's Q. Consistent with our results in Table 2.4, Model (3) suggests that while higher levels of the Governance Index are negatively associated with firm valuation, higher levels of the Governance Index in family firms has a positive and significant relationship with valuation.

Insert Table 2.5 about here.

In summary, the results in Tables 2.4 and 2.5 are consistent and demonstrate that higher E-Indexes and higher G-Indexes are be associated with a lower Tobin's Q. However, contrary to non-family firms, higher E-Indexes and G-Indexes in family firms are associated with higher valuation.

Tables 2.6 and 2.7 report the results of panel regressions for free cash flow and its impact on firm valuation. In line with the existing literature, we find that higher free cash flow levels are associated with lower valuation. Model (1) in Table 2.6 indicates that firms with free cash flow (assets scaled) in the top quartile have lower Tobin's Q. Model (2) in Table 2.6 suggests that while non-family firms with free cash flow (assets scaled) in the top quartile are negatively associated with firm valuation, family firms with free cash flow (assets scaled) in the top quartile have better valuation.

Insert Table 2.6 about here.

We find similar results using a different measure of free cash flow: free cash flow - assets scaled. Our results in Table 2.7, Model (1) indicate that higher levels of free cash flow - assets scaled are associated with lower valuation for all firms. Once family firms are separated from non-family firms, Model (2) demonstrates that the impact of higher free cash flow for family firms is in contrast to their impact on non-family firms.

Insert Table 2.7 about here.

In summary, the results in Tables 2.6 and 2.7 indicate that higher levels of free cash flows are associated with poor valuation for non-family firms. However, family firms with higher levels of free cash flows demonstrate better valuation.

Table 2.8 reports the summary results of the panel regression showing how change in the Entrenchment Index affects Tobin's Q. Model (1) only reports the effect of change in the E-Index on change in Tobin's Q for all firms. As expected, a change in E-index is negatively associated with change in Tobin's Q. In other words, an increase in E-index is associated with a decrease in Tobin's Q for all firms. Model (3) includes *Family Firm* and the interaction term of *Family Firm * ΔE-Index.* The results are consistent with model (1) in that the change in E-index is negatively associated with change in Tobin's Q. However, the interaction term in model (3) is positively and significantly related to change in Tobin's Q. This implies that while an increase (decrease) in E-index is associated with a decrease (increase) in Tobin's Q, for family firms, an increase (decrease) in E-index is associated with an increase (decrease) in Tobin's Q. This is in line with our previous results shown in Table 2.4. An increase in adopting antitakeover measures is interpreted as detrimental to firm valuation when we use a sample of all firms. However, an increase in adopting antitakeover measures in family firms is perceived as positive and is positively associated with Tobin's Q.

Insert Table 2.8 about here.

Table 2.9 reports the summary results of panel regression depicting how change in the Governance Index affects firm valuation. Model (1) only shows the effect of change in G-Index on change in Tobin's Q. Consistent with our results for change in E-index from Table 2.8, we find a negative and significant association between change in G-Index and change in Tobin's Q. In other words, an increase (decrease) in G-index is associated with a decrease (increase) in Tobin's Q for a sample of all firms. However, model (3) in Table 2.9 that includes the interaction term *Family Firm * ΔG-Index* shows that while change in the G-Index is negatively associated with change in Tobin's Q for non-family firms, change in G-index is positively associated with change in Tobin's Q for family firms.

Insert Table 2.9 about here.

In summary our results in Tables 2.8 and 2.9 show that change in the E-Index or the G-Index is negatively associated with firm valuation. However, for family firms such increase in the E-Index or the G-Index is positively associated with firm valuation which supports our hypothesis H2b.

Tables 2.10 and 2.11 report the results of panel regressions for change in level of free cash flow and its impact on firm valuation.

Insert Table 2.10 about here.

Our results from models (3) in Tables 2.10 and 2.11 indicate a positive and significant relation between change in level of free cash flow (sales scaled and asset scaled respectively) for family firms. However, for a sample of all firms referring to model (1) in both tables, we only find a negative and significant relation between change in free cash flow (asset scaled) and Tobin's Q as shown in Table 2.11.

Insert Table 2.11 about here.

In summary, our results in Tables 2.10 and 2.11 show that a positive change in free cash flow level is perceived as positive for family firms. However, such a change is perceived negatively by market participants for a sample of all firms.

2.8. Robustness Tests

We include two sets of robustness tests. We split our sample by date and by industry and run panel regressions to test the impact E-index and free cash flow (sales scaled) along with family firms on Tobin's Q.

Table 2.12 shows our robustness tests results for the effect of E-index and family firm on Tobin's Q. Model (1) and (2) show our result using two sub samples. Model (1) only includes observations prior to year 2000 and Model (2) includes observations post year 2000. As shown in Table 2.12, our results remain robust and similar to our results shown in table 4 using these two sub-samples in that E-index in both models is negatively associated with Tobin's Q and the interaction term *Family Firm * E-Index* remains positively associated with Tobin's Q. In other words, existence of antitakeover provisions is perceived as positive for family firms and this holds before and after year 2000.

Models (3) and (4) in Table 2.12 use two sub-samples that are split based on industry. Model (3) uses observations that are considered 'High Tech' firms. We identify a firm as high-tech firm if its sic code is 283, 357, 366, 367, 382, 384, or 737 (Kim et. al, 2008; Pukthuanthong and Walker, 2008). Other firms are considered 'Low Tech' and model (4) uses only these observations. It is worth noting that in our panel regression we control for industry fixed effect as well as separating High-Tech and Low-Tech industry firms. The reason for including both is to control for in-group variation within High-Tech and Low-Tech groups. Our results remain robust across high-tech and low-tech industries in that E-Index remains negatively associated with Tobin's Q and the interaction term remains *Family Firm * E-Index* positively associated with Tobin's Q. Furthermore, the interaction term is significantly higher using a sample of high-tech firms relative to the sample of low tech firms. This can be interpreted as family firms that are in a high-tech industry are perceived to benefit more from higher E-Index. This can be due to perceived stability that can ensure persistence in perusing innovative technology which ultimately can benefit a high-tech firm significantly.

Table 2.13 shows the results of our robustness tests for the impact of free cash flow and family firm on Tobin's Q. We use the same sub-samples and our results remain robust. Model (1) only includes observations prior to year 2000 and Model (2) includes observations post year 2000. Similar to our results in table 6, we observe that free cash flow is negatively associated with Tobin's Q. However, the interaction term *Family Firm * ΔFCF* is positively and significantly associated with Tobin's Q.

Furthermore, Model (3) uses observations that are considered 'High Tech' firms and Model (4) uses observations that are considered 'Low Tech' firms. Our results also remain robust using these sub-samples in that the interaction term *Family Firm * FCF* remains positive and significant. Interestingly, similar to our result in Table 2.12, the interaction term is significantly higher in model (3) relative to model (4). In other words, free cash flow in high-tech family firms seem to be perceived more beneficial compared to high-tech family firms.

2.9. Conclusions

Our study contributes to the literature of corporate governance by attempting to answer this important question: how long-term management perspective can affect corporate governance practices of the firm and how this would affect firm valuation y focusing on agency conflict within the context of family firms. Specifically, we examine how family firms' valuation differ from non-family firms in the presence of factors known to increase the severity of agency conflict. For this purpose, we use two measures that are widely known to increase the severity of agency conflict: the presence of antitakeover provisions and free cash flows in the firm. We used the Entrenchment Index and the Governance Index to measure the extent to which antitakeover provisions are implemented in the firm. Additionally, we follow Lehn and Poulsen (1989) to calculate free cash flow and scaled it by both assets and sales to account for the level of free cash flow in the firm. Our results are consistent with the existing literature in that the presence of antitakeover provisions and free cash flow in firms is negatively associated with firm valuation. However, within the context of family firms, our results consistently present the opposite impact. In particular, the presence of antitakeover measures negatively impacts the valuation of non-family firms and a sample of family and non-family firms. However, the presence of antitakeover measures is positively associated with family firm valuation. Moreover, we find that implementing additional antitakeover provisions has a positive impact on family firm valuation but has a negative impact on non-family firm valuation. Our results remain robust when we use two widely used measures of antitakeover provisions, the Entrenchment Index and the Governance Index and when we use two sub-samples prior and post year 2000. Moreover, while our results remain unchanged for high-tech and low-tech firms, we find a stronger relation between antitakeover provisions and Tobin's Q for high-tech family firms which suggest market participants perceive the higher levels of free cash flow and higher levels of adopting antitakeover provisions to be more beneficial to high-tech family firms which further highlights the importance of management stability to pursue innovation.

We also use free cash flow as another factor known to magnify the severity of agency conflict. Our results are in line with the existing literature and we find that the presence of free cash flow has a negative impact on valuation for non-family firms and a sample of family firms and non-family firms. We also determine that while higher levels of free cash flow have a negative impact on firm valuation for non-family firms, this impact is positive for family firms. Specifically, family firms with higher levels of free cash flow demonstrate higher valuation. Furthermore, we find that change in free cash flow is negatively associated with firm valuation for a sample of family firms and non-family firms but is positively associated with family firm. Our results are consistent for both measures of free cash flow employed namely free cash flow-sales scaled and free cash flow-asset scaled and when we split our sample to prior and post year 2000 observations. Moreover, our results remain unchanged for high-tech and low-tech firms but we find high-tech family firms are perceived to benefit more from free cash flow than are low-tech family firms.

Our study attempts to fill an important gap in corporate governance literature which is the importance of long-term management perspective and how it can affect the corporate governance practices in the firms. While many studies have focused on factors that can increase or decrease the severity of agency conflict, there needs to be more research on how long-term management perspective along with other factors can have an impact on severity of agency conflict.

CHAPTER 3

Environmental Risks and Commodities

3.1. Introduction

In the past, environmental risk factors may not have been perceived as important as they are today. These risk factors, such as natural disasters, are becoming more and more prevalent and larger in magnitude and their impact and our daily lives will only become more significant. The long-term success of firms and the long-term effectiveness of their risk management and supply chain risk management, specially for firms active in agricultural and food industry, depends on how well the impact of these emerging risk factors are addressed. This study is an attempt to better identify the impact of these risk factors on individual commodities. We contribute to literature of supply chain risk management specifically firms active in agricultural and food industry by addressing how agricultural natural disasters impact the price and price volatility of commodities that are the base of these firms' supply chain. Our study aims to be a starting point to better assess the impact of emerging environmental risks on supply chain risk management.

Natural disasters can cause significant disruption in production of an agricultural commodity when occurring in a country that produces that commodity. This disruption in production can be caused when the disaster directly affects the crop production. Furthermore, a natural disaster can affect the infrastructure of the producing country and hence indirectly have an adverse effect on commodity production (Noy and Nualsri, 2011; Nakamura et al., 2013) as there exists ample evidence in the literature that natural disasters are capable of adversely affecting the entire economy of the affected country (Strobl, 2012).

Both private and institutional investors are increasingly aware that their portfolio firms are subject to emerging risk factors such as water and climate change risks (Ranger, 2012; Chang, Chang, and Wen, 2014), particularly if those firms operate in the agricultural and resource extraction sector or if their supply chains are based on the associated agricultural and natural resource commodities (Michel-Kerjan, 2010).

Recently, a number of studies have concluded that extreme weather events will be more prevalent (Francis and Vavrus, 2012) and a surge in the number and magnitude of natural disasters such as floods and hurricanes is expected in the future (Michel-Kerjan, 2010; Ranger, 2012). There is also ample evidence that climate change will in fact increase the occurrence of natural disasters (Rahmstorf and Coumou, 2011), causing a riskier business environment (Ranger, 2012; Chang, Chang, and Wen, 2014). As climate change related events and natural disasters become more frequent and more severe, these studies magnify the necessity of research to identify the possible impacts of natural disasters and how to be prepared for them.

There is ample evidence that natural disasters can affect many aspects of modern life, from their impact on economies and financial markets to specific industries. However, there is conflicting evidence on how natural disasters actually affect specific sectors and economies around the world.

A number of studies have focused on the impact of natural disasters on economies, but there is little consensus among academics on this issue. For this purpose, researchers have focused on various economic factors. Noy and Nualsri (2011) find a reduction in governments' spending following a natural disaster. Similarly, Nakamura et al. (2013) find a lasting decline in national consumption after disasters and Strobl (2012) finds a decline in the gross domestic product of affected countries. Because natural disasters can cause ample damage to various infrastructures and production centers in affected areas, they have been associated with slowing down the economies of affected areas. Many studies find that natural disasters can negatively affect the economies at both the local and national level (Noy and Nualsri, 2011; Nakamura et al., 2013). For example, at the local economy level, one of the most devastating hurricanes in recent years, Katrina, has been the subject of numerous studies. Kirgiz, Burtis, and Lunin (2009) find that Katrina affected the local economy by adversely affecting the profitability of refineries in the affected areas. The authors attribute the negative impact of Katrina to the significant damage it caused to local refineries and the associated adverse effect on refineries' production.

Natural disasters are also capable of adversely affecting economies at a larger scale. If the damage caused by natural disasters is significant, it is likely that its effects do not remain at the local level. In other words, large natural disasters are likely to have a negative impact on affected states or countries and possibly on the world economy. A number of studies have focused on the impact of natural disasters at the national level and have found that disasters can negatively affect the gross domestic product (GDP) of affected countries. Hochrainer (2009) attributes the impact of natural disasters to the significance of their shock. The author concludes that more damaging natural disasters have a more significant negative impact on economies. Raddatz (2009) studies the short and long-term effect of natural disasters on the GDP of countries. He finds a significant negative impact of natural disasters on economies, which is more pronounced in lower income countries.

On the contrary, several studies have found no impact on the economies of affected areas or even a positive impact (Skidmore and Toy, 2002). For example, Baker and Bloom (2013) show that shocks to the economy, including natural disasters, can have a positive impact on economic growth, and Leiter, Oberhofer, and Raschky (2009) show that firms in areas hit by natural disasters demonstrate higher levels of growth. This positive impact can arise even from localized disasters, as Bernile et al. (2015), using a sample of US firms, show that even localized disasters can positively impact the national economy. This positive impact arises from an increase in recovery expenditures in states with economic ties to affected area.

In addition to natural disasters affecting economies at a macroeconomic level, they have the potential to affect industries and financial markets, too (Arin, Ciferri, and Spagnolo, 2008; Altay and Ramirez, 2010). Natural disasters such as droughts and hurricanes have been known to significantly negatively affect a multitude of industries including the agricultural sector, the food and beverage industry, mines and metal producers, as well as the tourism, construction, and insurance industries (Thomann, 2013).

Cao, Xu, and Guo (2015) study the impact of climatic events occurring in China and the United States on the Chinese stock market. They conclude that domestic natural disasters have a more significant impact on the Chinese stock market compared to foreign natural disasters. Similarly, Worthington and Valadkhani (2004) find that stock market returns are adversely affected by natural disasters. Conversely, some studies find that natural disasters have little or no impact on stock market returns (Luo, 2012). Wang and Kutan (2013) find no wealth effect on financial markets using a sample of firms in the United States and Japan.

Worthington (2008) uses a sample of firms in Australia and finds that at the market level, natural disasters do not have an impact and that different types of disasters may have different effects across industries. For example, the insurance industry can be affected very significantly by natural disasters and especially by frequent occurrences of natural disasters (Michel-Kerjan and Morlaye, 2008).

While a number of studies have focused on the impact of natural disasters on economies and financial markets, there exists limited empirical research focusing on the impact of natural disasters on individual commodities. Researchers, however few, have mainly focused on the impact of weather conditions rather than natural disasters on a particular commodity such as oil and oil products (Girma and Paulson, 1998; Kilian and Vega, 2011; Ji and Guo, 2015). For example, Fink and Fink (2014) show that hurricanes have an impact on refined oil products. Roll (1984) studies the impact of weather and weather-related events on orange juice concentrate. Gebregewergs and Hadush (2017) study the impact of weather conditions on potato and onion prices in Ethiopia, and Baviera and Mainetti (2017) study the impact of weather conditions on natural gas prices.

Our study attempts to address this gap by focusing on the agricultural commodity sector and its production process, thus contributing to the literature on supply chain management and financial risk management. Specifically, it provides a first-of-its-kind investigation into the effect of emerging environmental risks, such as water- and climate change-related natural disasters, on commodity prices and their volatility.

While the effect of natural disasters on economies and financial markets has been the subject of many studies, only few of them have focused on how commodity prices are affected by natural disasters occurring in producer countries. Our work aims to fill this gap. To our knowledge, our study is the first to use a comprehensive database of natural disasters and to study the impact of these disasters on the price and price volatility of multiple commodities.

3.2. Hypothesis Development

Our study examines how natural disasters affecting the production centers of selected agricultural commodities impact the price and price volatility of those commodities. Specifically, our study focuses on including coffee, wheat, soybeans, rice, cocoa, and sugar. We choose these commodities because they exhibit a high regional concentration in production. The underlying assumption is that a natural disaster that hits a country which produces a certain commodity will cause disruption in the production of said commodity, and that this can impact the commodity's price and price volatility. The disruption in production can occur because the disaster affects the actual production of the commodity or adversely impacts the infrastructure required in production. In either case, the natural disaster is expected to disrupt the supply chain of the commodity and hence affect its price and/or its price volatility.

While natural disasters may all have an impact on production, we focus on more significant disasters because their impact is more pronounced (Hochrainer, 2009). For this purpose, we only include *major disasters* in our study. In the methodology section of our paper, we explain how we identify a major disaster and the steps we take to ensure the robustness of our results.

Moreover, various countries produce certain commodities at different capacities. A natural disaster in a country that is considered a major producer of a commodity may cause a more significant disruption in that commodity's supply chain. On the contrary, a natural disaster in a country that has a small portion of global production of a certain commodity may not have as significant an impact. Consequently, in our study we focus on countries that are considered *major producers* of a commodity. Again, we explain how we identify a major producer country and the steps we take to ensure the robustness of our results in our methodology section.

In the first part of our study, we focus on testing if natural disasters do in fact have an impact on the price and price volatility of commodities. If natural disasters significantly disrupt the production of a commodity, we expect this disruption to be reflected in the price and price volatility of said commodity. Specifically, a disruption in production would mean a decline in production of the commodity resulting in a decrease in supply and consequently a price increase. We thus postulate the following null hypotheses:

> *H1a: A major natural disaster occurring in a major producer country for a given commodity will significantly increase the price of that commodity.*

Moreover, an unforeseen disruption in production causing a possible decrease in supply would add to uncertainty surrounding the production level and the commodity price. This uncertainty should be reflected in a higher price volatility of the affected commodity. We thus postulate the following hypothesis:

> *H1b: A major natural disaster occurring in a major producer country for a given commodity will significantly increase the price volatility of that commodity.*

While major natural disasters occurring in major producer countries can affect the price and price volatility of commodities, the level of impact can vary depending on numerous factors. In the following section we discuss the factors that we expect to affect the magnitude of price or price volatility changes.

The first factor that should impact the level of price and price volatility changes is the significance of the disaster. A more significant natural disaster causes a larger shock in the affected areas and consequently should have a more significant impact on locally produced commodities (Hochrainer, 2009). Here, we measure the strength of a disaster by the total dollar value damage it has caused. Specifically, we test the following hypotheses:

H2a: The level of damage caused by a natural disaster affects the magnitude of commodity price changes.

H2b: The level of damage caused by a natural disaster affects the magnitude of changes in a commodity's price volatility.

We also use the number of casualties caused by a natural disaster as an additional measure of damages to test hypotheses H2a and H2b.

In addition to the damage a natural disaster can cause, the level of production of a commodity in the affected country should play an important role. If a country with a larger share of global production of a commodity experiences a disruption in production, the effects on price and price volatility should be more severe compared to disruptions in production happening in countries with a lower share of global production. To explain this issue, we test the following hypotheses:

H3a: The production share of the affected country affects the magnitude of commodity price changes caused by a major natural disaster occurring in a major producer country.

H3b: The production share of the affected country affects the magnitude of commodity price volatility changes caused by a major natural disaster occurring in a major producer country.

Control variables

Another possible country factor that can have an impact on the impact of natural disasters is how strong the infrastructure of the country and how developed the country is (Raddatz, 2009). We use the GDP of a country as a proxy for its level of development and the strength of their infrastructure (Asiedu, 2002; Toya and Skidmore, 2007). We expect that a stronger infrastructure will limit the negative impact of natural disasters.

Finally, we expect a natural disaster to have a more significant impact commodities that experience demand pressures. We assume that the price and price volatility of a highly demanded commodity are more sensitive to any disruptions in the supply chain of that commodity. We use the recent increase in price as a measure of demand pressure and expect a stronger effect of natural disasters on commodities that had a recent increase in demand.

The remainder of this paper is organized as follows. Section 3.3 describes the data we used. Section 3.4 explains the steps we took in constructing our sample. Section 3.5 describes our methodology. Section 3.6 presents our results and Section 3.7 concludes the essay.

3.3. Data

Our data comes from four separate sources.

As noted earlier, we include six commodities in our study: coffee, wheat, rice, soybeans, sugar, and cocoa. We use Bloomberg to access the historical prices of each commodity.

We use the International Disaster Database from Center for Research on Epidemiology of Disasters (CRED) database to compile our natural disaster dataset. We include all available agricultural natural disasters listed in the CRED database—namely landslides, wildfires, floods, storms, and droughts—in our sample. CRED also reports technological disasters and nonagricultural disasters such as earthquakes. Those are not included in our sample as they are not relevant to our study. For every agricultural disaster listed in CRED, we manually extract the start date of the disaster, the country that the disaster affected, the total damages in US dollars caused by the disaster, and the total deaths caused by the disaster.

Each countries' production share of a given commodity is collected from historical data and statistics provided by FAOSTAT. For every commodity, we gather historical data on the production levels of individual countries. Annual global individual production figures are then used to calculate the historical production share of each country for every commodity.

Finally, we use the World Bank and the Organization for Economic Co-operation and Development (OECD) national accounts to retrieve information on each country's historical GDP per capita.

3.4. Sample Construction

Table 1 illustrates our sample construction, starting with our natural disaster dataset from CRED. The CRED database contains data for 22,164 disasters during the period of 1970-2015, including both agricultural and nonagricultural disasters. We identify 8,747 natural disasters including landslides, wildfires, floods, storms, and droughts that affected a country that produces, however little, at least one of the commodities we use in our study. We exclude disasters affecting countries with a production share of a commodity that is less than 5% of global production. Moreover, a particular disaster can affect a country that produces more than one of the commodities in our study. In such cases, we include separate observations for the impact on each commodity. We identify 1,577 observations for disasters affecting the production centers of commodities. Seven hundred seventeen of these observations include disasters causing damages of less than $5 million but more than zero, which we identify as small disasters. The remainder 860 observations, are disasters with damages in excess of $5 million. We label these disasters major disasters. These observations are used in the event study part of our study. The results of our event study analyses do not change when we exclude the 112 observations we did not use in our regression analyses due to missing data.

Insert Table 3.1 about here.

For the second part of our empirical analysis, we use 748 observations because 112 of our observations have at least one missing data point necessary for the regression model. These 748 observations represent 507 unique natural disasters. As previously mentioned, some disasters affect a country that is considered a major producer of more than one commodity thus explaining the discrepancy.

Table 2 shows the breakdown of natural disasters used in our sample by country and by time. The number of major disasters exhibits an increase over time, which signifies the importance of our study. China has the largest number of disasters in our sample, which mainly consists of developing countries.

Insert Table 3.2 about here.

3.5. Methodology

3.5.1. Event Study Analysis

We employ standard event study methodology to measure abnormal returns and abnormal volatilities around the occurrence of natural disasters. Event study methodology is widely used in finance research as well as other areas of the social sciences. The method is based on the efficient market hypothesis developed by Fama et al. (1969) who state that asset prices reflect all available information, and that markets establish a new equilibrium as soon as new information becomes available. In finance, numerous published articles before the year 2000 have used event study methodology (Kothari and Warner, 2008). Event study methodology has also been widely used to measure the impact of disasters. These studies mostly include the impact of natural disasters on economies and financial markets (Hochrainer, 2009; Raddatz, 2009; Noy and Nualsri, 2011; Nakamura et al., 2013), whereas other studies have focused on other types of disasters such as aviation disasters or terrorist attacks (Flouris and Walker, 2005; Walker, Thiengtham, and Lin, 2005; Charles, Darne, 2006; Brounen and Derwall, 2010; Kaplanski and Levy, 2010; Kollias, Manou, Papadamou, and Stagiannis, 2011; Kawashima and Takeda, 2012).

Our use of event study analysis is inspired by Kothari and Warner (2008) and Brown and Warner (1980). The first part of our event study analysis focuses on commodity prices and their possible abnormal returns around the occurrence of natural disasters. For this, the first step is to estimate the commodity prices conditional on the fact that the event had not happened. For this purpose, the commodities' expected returns are estimated using equation (3.1):

$$R_{i,t} = \beta_0 + \beta_1 * R_{m,t} + \epsilon_{i,t} \tag{3.1}$$

where $R_{i,t}$ is the return on each commodity impacted by disaster *i* at time *t*, $R_{m,t}$ is the return on market index m at time *t*, and $\epsilon_{i,t}$ is the random error term. β_0 and β_1 are estimated coefficients. In our event study, we use the Bloomberg Commodity Index (BCI) as the market index. For robustness purposes, we also use the S&P 500 Goldman Sachs Commodity Index (GSCI), with little effect on our results. In our estimation of β_0 and β_1, the event date is marked at $t = 0$. The β_0 and β_1 coefficients are estimated using a prior-to-the-event-date estimation window of [–60, –30]. Our results remain unchanged when we also use longer estimation periods such as an estimation window of [–250, –30].

The abnormal returns of commodities then calculated using equation (3.2):

$$AR_{i,t} = R_{i,t} - (\beta_0 + \beta_1 * R_{m,t}) \tag{3.2}$$

where AR_{it} denotes the abnormal return of each commodity impacted by natural disaster *i* at time *t*. Our model assumes that the abnormal return is the result of an occurrence of a natural disaster in a production center.

We use equation (3.3) to calculate cumulative abnormal returns (CARs) for a period of τ days:

$$CAR_{it} = \sum_{t=1}^{\tau} AR_{i,t} \tag{3.3}$$

Similarly, the variance of CARs is calculated using equation (3.4).

$$var(CAR_{i\tau}) = \sum_{t=1}^{\tau} var(AR_{i,t}) \tag{3.4}$$

An average of the CARs and of the variance of CARs across all natural disasters impacting the production centers of each commodity are calculated using equations (3.5) and (3.6):

$$\overline{CAR_\tau} = \frac{1}{N}\sum_{i=1}^{N} CAR_{i,t} \tag{3.5}$$

$$var(\overline{CAR_\tau}) = \frac{1}{N^2}\sum_{i=1}^{N} var(CAR_{i,t}) \tag{3.6}$$

We use Student's *t*-tests to test for the null hypothesis of mean excess returns during an event window being equal to zero.

Moreover, we estimate the expected return of commodities using mean-adjusted returns following Brown and Warner (1980). For this part, we use an estimation window of [–60, –30] around the event date (t=0) to calculate the expected return. The abnormal return is then calculated using equation (3.7):

$$AR_{i,t} = R_{i,t} - \frac{1}{31}\sum_{t=-60}^{-30} R_{i,t} \tag{3.7}$$

where $R_{i,t}$ is the return for each commodity affected by disaster *i* at time *t*. CARs and the Student's *t*-statistics are calculated using equations 3.3 through 3.6.

To calculate the abnormal variance of returns around the occurrence of natural disasters in production centers, we use a generalized autoregressive conditionally heteroskedastic (GARCH) model, which was initially developed by Engle (1982) and Bollerslev (1986). The underlying assumption of GARCH-type models is that there exists a time-varying component of variance, and consequently volatility can change over time. Here, we use a GARCH(1,1) model (Bollerslev, 1986) to estimate the conditional volatility of commodity returns. While the GARCH model has been used extensively in the literature, other extensions of this model are also used in various studies but these extensions do not necessarily outperform the GARCH(1,1) model (Hansen and Lunde, 2005) hence making it a strong choice in empirical studies. To ensure the robustness of our results, we also use an exponential generalized autoregressive conditional heteroskedastic (EGARCH) model (Nelson, 1991; Nelson and Cao, 1992) to estimate conditional volatility. Specifically, we use the EGARCH model to allow for the return sign (positive or negative) to have a separate effect from the return magnitude. In the event study part of this paper, we only report the results of abnormal volatility using conditional volatility estimates of the GARCH model. Our results remain qualitatively unchanged when we use conditional volatility estimates of the EGARCH model to measure abnormal variance.

Once we estimate the conditional volatility of a given commodity, we use a similar approach as that for mean-adjusted abnormal returns (Brown and Warner, 1980) to measure abnormal return variance using equation (3.8):

$$AV_{i,t} = CV_{i,t} - \frac{1}{31}\sum_{t=-60}^{-30} CV_{i,t} \tag{3.8}$$

where AV_{it} denotes the abnormal volatility of returns for each commodity affected by natural disaster *i* at time *t*. $CV_{i,t}$ is the conditional volatility estimated by the GARCH model (or the EGARCH model for robustness) for each commodity affected by natural disaster *i* at time *t*.

We then measure the cumulative abnormal variance (CAV) and the relevant *t*-statistic using an approach that is similar to the one we used for our estimation of abnormal returns.

We use equation (3.9) to calculate the cumulative abnormal variance for a period of τ days:

$$CAV_{i\tau} = \sum_{t=1}^{\tau} AV_{i,t} \tag{3.9}$$

In addition, we use equation (3.10) to measure the variance of cumulative abnormal returns:

$$var(CAV_{i\tau}) = \sum_{t=1}^{\tau} var(AV_{i,t}) \tag{3.10}$$

We estimate the average CAVs and the variance of the CAVs across all natural disasters affecting the production centers of each commodity using equations (3.11) and (3.12):

$$\overline{CAV_{\tau}} = \frac{1}{N} \sum_{i=1}^{N} CAV_{i,t} \tag{3.11}$$

$$var(\overline{CAV_{\tau}}) = \frac{1}{N^2} \sum_{i=1}^{N} var(CAV_{i,t}) \tag{3.12}$$

Finally, we perform a Student's *t*-test to test the null hypothesis if the mean excess variance is equal to zero in a given event window.

We perform our event study analysis separately for each commodity. We do so because we expect the price and price volatility of certain commodities to be more sensitive to natural disasters than those of other commodities. We identify a natural disaster as "significant" if the natural disaster has caused significant damage and has occurred in a country that is considered a major producer of a given commodity. We conjecture that the more damaging the natural disaster, the greater its impact on price and price volatility. The damage of a natural disaster is measured by the total damage it caused. Specifically, we used the "Total Damage" available from the Centre for Research on the Epidemiology of Disasters (CRED) for this purpose. Moreover, as noted above, we conjecture that a natural disaster has a more significant impact on the price and price volatility if it occurs in a country that is considered a major producer of the commodity in question. Our data from the Food and Agriculture Organization of the United Nations (FAOSTAT) allows us to identify such countries. In our main analyses, we define a natural disaster as a "significant" disaster if said natural disaster has caused a total damage greater than \$5 million, adjusted for inflation, and has occurred in a country with a production share greater than 5% of global production of the affected commodity.

To ensure the robustness of our results, we also consider three other categories of "significant" disasters:

1. Natural disasters causing a total damage greater than \$5 million that occurred in countries with a production share greater than 10% of the global production of the commodity
2. Natural disasters causing a total damage greater than \$10 million that occurred in countries with a production share greater than 5% of the global production of the commodity
3. Natural disasters causing a total damage greater than \$10 million that occurred in countries with a production share greater than 10% of the global production of the commodity

Our results are not qualitatively different when we use alternative categories of "significant" disasters.

For the event study analysis, we use six event windows before (event windows [–5, –1] and [–7, –1]), during (event windows [–1, +1] and [–7, +7]), and after (event windows [+1, +5] and [+1, +7]) the disaster to capture the possible impacts of the natural disasters. We also explore various other event windows for robustness purposes, and our results remain unchanged.

3.5.2. Ordinary Least Squares (OLS) Analyses

In the second part of our empirical analysis, we study the possible impact of various factors on the magnitude of abnormal return and abnormal variance. For this purpose, we use equation (3.13) to measure the impact of various factors on a commodity's CAR:

$$
\begin{aligned}
CAR.BCI_{t1,t2,i,j} &= \alpha + \beta_1 * Demand.Pressure_i + \beta_2 * Damage_j + \beta_3 * Deaths_j \\
&+ \beta_4 * Share_i + \beta_5 * GDPPerCapita_j + \sum_{h=1}^{5} \beta_i * Commodity_h \\
&+ \sum_{m=1}^{4} \beta_m * Disaster.type_m + \varepsilon_{i,j,t_1,t_2}
\end{aligned}
\tag{3.13}
$$

where $CAR.BCI_{i,j,t_1,t_2}$ is the cumulative abnormal return using the Bloomberg Commodity Index (BCI) as the bench mark for the event window of $[t1, t2]$ for commodity i and disaster j.

$Demand.Pressure$ is a proxy of the demand pressure for a given commodity (Trostle, 2010). We define this measure as

$$
Demand.Pressure_{i,t} = \frac{1/30 \sum_{j=t-60}^{t-31} Price_{i,t} - 1/500 \sum_{j=t-560}^{t-61} Price_{i,t}}{1/30 \sum_{j=t-60}^{t-31} Price_{i,t}} \tag{3.14}
$$

where $Price_{i,t}$ is the price of commodity *i* at time t. This variable simply measures the price increase of commodity *i* prior to the natural disaster occurring at time *t*. We conjecture that commodities that are in high demand have experienced a relatively recent increase in price. Consequently, a disruption in their production caused by a natural disaster affecting a production center may have a more significant impact on their price and price volatility.

$Damage$ is the natural log of “total damage” in US dollars caused by a natural disaster as reported by CRED.

$Deaths$ is the number of casualties caused by a natural disaster. This information is also reported by CRED. While we use the total damage as a measure of significance of a natural disaster, total deaths may provide additional information on the severity of a natural disaster.

$Share$ is a country’s production share of a certain commodity in the year prior to the occurrence of a natural disaster. We use the previous year information because a disaster can affect the commodity’s production in the current year.

$GDPPerCapita$ is the natural log of the gross domestic product per capita of the affected country.

$Commodity_i$ is a dummy variable that identifies our sample’s commodities: cocoa, coffee, rice, soybeans, and wheat (with sugar as excluded category).

Similarly, $Disaster_j$ is a dummy variable that identifies the disasters: storms, droughts, wildfires, and landslides (with floods as the excluded category).

We also use an extension of equation (3.13) in which we replace the dependent variable with $CAR.GSCI_{t1,t2}$ for robustness purposes. $CAR.GSCI_{t1,t2}$ is the cumulative abnormal return using the Goldman Sachs Commodity Index (GSCI) as the bench mark for the event window of $[t1, t2]$.

We use equation (3.15) to test the possible impact of various factors on the cumulative abnormal price volatility of a given commodity:

(3.15)

$$
\begin{aligned}
CAV.GARCH_{i,j,t_1,t_2} \\
&= \alpha + \beta_1 * Demand.Pressure_i + \beta_2 * Damage_j + \beta_3 * Deaths_j + \beta_4 \\
&* Share_i + \beta_5 * GDP_j + \sum_{h=1}^{5} \beta_i * Commodity_h \\
&+ \sum_{m=1}^{4} \beta_m * Disaster.type_m + \varepsilon_{i,j,t_1,t_2}
\end{aligned}
$$

where $CAV.GARCH_{i,j,t1,t2}$ is the cumulative abnormal variance for commodity i affected by disaster j using the conditional variance calculated by a GARCH(1,1) model for the event window of $[t1, t2]$. All other variables are similar to equation (3.13) and are defined previously. We also use an extension of equation (3.15) for robustness with $CAV.EGARCH_{i,j,t1,t2}$ as the dependent variable. $CAV.EGARCH_{i,j,t1,t2}$ is the cumulative abnormal variance using the conditional variance calculated by an EGARCH(1,1) model for the event window $[t1, t2]$. We include all major disaster observations in our event study but only include a major disaster in our OLS regressions if all available data points needed in our regression model are available for that particular observation. Our event study results do not qualitatively change if the smaller OLS regression sample is used.

3.6. Empirical Results

3.6.1 Event studies

Tables 3.3–3.8 present our event study analyses for each commodity examined in this paper. Specifically, Table 3.3 examines coffee, Table 3.4 examines wheat, Table 3.5 examines soybeans, Table 3.6 examines rice, Table 3.7 examines cocoa, and Table 3.8 examines sugar, respectively.

We start our discussion with Table 3.3 which presents the event study analyses for the impact of natural disasters on the price and price volatility of coffee. Specifically, we find a positive and significant abnormal variance for all event windows prior, during, and after the event date. All our event study results are significant at the 1% level except for the event window (+1,+5) which is significant at the 5% level. In other words, our results show that the occurrence of a natural disaster in a major producer country of coffee has a significant and positive impact on the price volatility of coffee prior, during, and after the occurrence of the natural disaster. Moreover, we find a positive abnormal return for the event window (-7,-1) with both a mean-adjusted return (CAR = 1.1509%) and a market adjusted return (CAR=0.9615%) that are significant at the 5% significance level. The results suggest an increase in coffee prices prior to the event date given that many natural disasters such as hurricanes can be anticipated before their landfall, this result is not surprising. Our results also show larger abnormal variance increases after the occurrence of natural disasters compared to the period prior to the disasters, likely reflecting market uncertainty after initial news revelations.

Insert Table 3.3 about here.

Table 3.4 shows the results of our event study analysis for wheat, which are very similar to our results for coffee. Our results again show that natural disasters have a significant impact on the price volatility of wheat. This positive and significant impact is robust across all event windows prior, during, and after the event date. All results are significant at the 1% level and are similar in magnitude for the event windows prior to and after the event. While we observe that natural disasters have a positive and significant impact on the price volatility of wheat, we do not observe any significant impact on the price of wheat.

Insert Table 3.4 about here.

Table 3.5 presents the results for the impact of natural disasters on the price and price volatility of soybeans. Our results show a consistent positive and significant impact of natural disasters on the price volatility of soybeans. Using multiple event windows prior, during, and after the event date, we observe a positive and significant abnormal variance increases for soybeans in all event windows. The cumulative abnormal variances are positive and significant at the 1% level but we observe a larger increase in variance after the occurrence of a natural disaster. Moreover, our results show that natural disasters have a positive impact on the price of soybeans. Specifically, for the event window (-7,+7), both of our CAR measures are positive and significant (mean-adjusted CAR = 2.2011%, p-value = 0.0186 and market-adjusted CAR = 2.5213%, p-value = 0.0015). Moreover, using a shorter event window of (-1,+1), our result remain partially the same as the market-adjusted CAR remains significant (market-adjusted CAR = 0.6726%, p-value = 0.0728) whereas the mean-adjusted return CAR is positive and marginally insignificant (mean-adjusted return CAR = 0.6362, p-value = 0.1471). Our results show a similar pattern for event windows after the event date. Specifically, for event window (+1,+5) we find a positive and significant market-adjusted CAR (CAR = 0.8664%, p-value = 0.0651). Moreover, for event window (+1,+7) we a find positive and significant market-adjusted CAR (CAR = 1.3560%, p-value = 0.0135). Although the mean-adjusted CARs for these event windows are positive, they are not significant. Our results for event window (-7,-1) show a positive and significant mean-adjusted CAR (CAR = 1.0758%, p-value = 0.0924) and show a positive and marginally insignificant market-adjusted CAR (CAR = 0.8122%, p-value = 0.1360). In summary, our results show a significant increase in abnormal variance before, during, and after the event date. Similarly, our results suggest an significant increase in abnormal returns around the event date that is significant in most event windows.

Insert Table 3.5 about here.

Table 3.6 provides the event study results for the impact of natural disasters on price the and price volatility of rice. Our event study results for abnormal variance remain consistent across all tested event windows prior, during, and after the occurrence of a natural disaster. Specifically, in all event windows, we find an increase in abnormal variance that is significant at the 1% level. This increase in abnormal variance remains robust for all tested event windows although we observe a larger magnitude of cumulative abnormal variances prior to the event. Our results also indicate an increase in abnormal returns around the event, i.e. for the event window (-7,+7), using both mean-adjusted and market-adjusted benchmarks (mean-adjusted CAR = 1.0453%, p-value = 0.0658; market-adjusted CAR = 1.0240%, p-value = 0.0734). In addition, our results show a positive abnormal return prior to the event for event window (-7,-1). For this event window, the mean-adjusted CAR is positive and weakly significant (CAR = 0.6720%, p-value = 0.0863) whereas the market-adjusted CAR is positive and marginally insignificant (CAR = 0.6173%, p-value = 0.1172). In summary, our result show that around the occurrence of natural disasters, the price volatility of rice increases significantly. Moreover, during the same event windows, the price of rice is affected positively but not significantly in all cases.

Insert Table 3.6 about here.

Table 3.7 presents the results for the impact of natural disasters on the price and price volatility of cocoa. Specifically, we find no significant impact on the price of cocoa prior, during, and after the occurrence of a natural disaster with both mean-adjusted return and market-adjusted return. Moreover, we find a small but statistically significant decrease in abnormal variance prior and during the event and only an increase in abnormal variance for the event window (+1,+7). We conjecture that the significant long time from planting to harvesting cocoa beans, as shown in Table 3.9, is the cause as affected crops will take significantly longer to enter the market and the actual impact on the production will only be realized after a significant time. Consequently, price volatility of cocoa only experiences an increase post event date when possible damage is estimated more accurately.

Insert Table 3.7 about here.

Table 3.8 presents the event study results for the impact of natural disasters on the price and price volatility of sugar. Our results show a price increase during the occurrence of natural disasters for the event window (-1,+1) with both a mean-adjusted return (CAR = 0.9585%, p-value = 0.0381) and a market-adjusted return (CAR = 0.9023%, p-value = 0.0321) that are significant at the 5% significance level. Moreover, our results show a similar increase (although marginally insignificant in some cases) in price of cocoa prior to the occurrence of natural disasters (event windows (-7,-1) and (-5,-1)). For event window (+1,+5), we find a significant increase in the price volatility (abnormal variance=0.0058, p-value=0.0000) and for event window (+1,+7), we find a similar significant increase in the price volatility (abnormal variance=0.0058, p-value=0.0000). our results indicate that an increase in price volatility of sugar is only present after the occurrence of a natural disaster. This can suggest that market participants' reaction to natural disasters vary prior and after the occurrence of a natural disasters. In other words, after the occurrence of natural disaster the price volatility increases but there is not an increase in the price. However, before and during the occurrence of a natural disaster the price of sugar increases and the price volatility of sugar decreases.

Insert Table 3.8 about here.

In summary, our event study analyses show a significant increase in price volatilities around natural disasters for coffee, wheat, soybeans, and rice whereas sugar and cocoa appear less affected and, in some cases, even experience variance declines. Both of the latter, however, exhibit a rise in abnormal variance after the disaster, i.e. during the (+1,+7) event window. Moreover, our results show that commodities tend to experience price increases around the occurrence of natural disasters although the results are generally less consistent than our volatility results.

To explore why natural disasters affect some commodities more than others (see our results in Tables 3.3 – 3.8), we examine the production share concentration of our sample commodities in Table 3.9. We use three methods to calculate the production share concentration. Our first measure calculates the combined production share of the top five producers. We calculate this combined production share for every year and calculate the historical average for each commodity. Our second measure calculates the number of countries whose combined production surpasses 70% of the global production every year for our entire sample. We then calculate the historical average of this measure for each commodity. Finally, we calculate the Herfindahl indices for production share of each commodity. Specifically, we calculate the Herfindahl Index for commodity k for year t as the $HI_{kt} = \sqrt{\sum_{i=1}^{n} {P_{ikt}}^2}$. Where HI_{kt} is the Herfindahl Index for commodity k in year t and P_{ikt} is the production share of country i for commodity k in year t. We then calculate the historical average of the Herfindahl Index for each commodity. The final column of Table 3.9 shows the average time from planting to harvest for each commodity. As shown in Table 3.9, soybeans have the largest production concentration and sugar has the lowest concentration. The low concentration of production for sugar can explain the somewhat inconsistent results we observed in Table 3.8. When we compare the economic significance of natural disasters across different commodities using event window (-7,+7), we find that soybeans experience the highest price increase (2.20% mean-adjusted return and 2.52% market-adjusted return) compared to all other commodities in our sample. This finding is in line with our results in Table 3.9 which show that soybeans also have the highest production concentration among all commodities in our sample and consequently a natural disaster is more likely to impact a significant producer. Moreover, soybeans show the highest Herfindahl Index among the commodities in our sample showing a very high production concentration for soybeans. We conjecture this high production concentration along with short planting to harvest time (second shortest time among the commodities in our sample) is the reason soybeans experience the highest price change around the natural disasters.

Insert Table 3.9 about here.

In the next section, we focus on the results of a series of OLS regressions in which we explore the impact of various factors on the magnitude of price and price volatility changes around the time of a natural disaster.

3.6.2. OLS Regressions

Table 3.10 provides correlation matrix for the variables used in our regression analyses. The dummy variables for storm and flood have a high negative correlation, thus we only include storms in our regression analyses. Total death and total damage are two variables used to measure the relative damage of a natural disaster. Despite potential collinearity concerns, the two variables only have a correlation of 0.1010.

Insert Table 3.10 about here.

Table 3.11 provides OLS regression results for the impact of major natural disasters on the price change of commodities. When we compare the factors that influence the market adjusted CARs in Table 3.11, we observe that demand pressure is one of the most influential variables across all event windows. Specifically, the higher the past demand pressure, the higher the price increase across a given commodity.

Insert Table 3.11 about here.

In addition, our production share variable has a positive influence in our post event windows suggesting that the higher the regional concentration of a given commodity, the stronger the price impact of a disaster. The results for the different commodity dummies are largely insignificant. Only the wheat dummy appears to have a positive impact on CARs in the (-1,+1) event window. This is reasonable considering the wide-spread cultivation of wheat which should make it less susceptible to natural disasters than, e.g., sugar (the excluded commodity dummy).

Similarly, we observe little significance across the different disaster types with the exception of the landslide dummy in the same (-1,+1) event window. Specifically, we find a positive coefficient of 0.0103 on the landslide dummy (significant at the 5% level) suggesting that landslide cause lower abnormal returns compared to the excluded category (floods). This is sensible given that landslides only affect a small area relative to other disasters.

Table 3.12 presents the results for a series of regressions in which we explore the impact of various factors on the cumulative abnormal variance of commodity prices. We observe significant negative coefficients for the demand pressure variable in three out of our six regressions. This result is as expected given that commodities that already underwent turmoil in the past (as measured by prior price increases) are likely to be less affected relative to commodities whose prices were more stable. In other words, the price volatility increase of commodities that had stable prices before a disaster is higher during a natural disaster period, compared to commodities that have experienced prior demand pressure.

Insert Table 3.12 about here.

The total damage variable is only positive and significant in the post event period which is expected as damages can only be observed after the occurrence of a natural disaster.

Moreover, the production share variable is significantly positive across all regression models, suggesting that when a natural disaster hits a country with a higher production share, the agricultural commodities produced by that country will experience a significant increase in price volatility. This increase in price volatility is observed across all event windows regardless whether they measure abnormal variance changes before, during, or after the natural disaster.

We also compare different commodity and disaster types. We find that wheat exhibits a positive volatility increase in the (+1,+5) post event window. Although initially surprising, the results can be explained by the fact the excluded comparison group (sugar) exhibited negative volatility changes in Table 3.8.

With respect to disasters types, we observe a significant negative volatility change during the (-1,+1) event window for landslides. This suggests that landslides, which are typically bound to a small area, have a significant lower volatility increase than the excluded category, floods. Similarly, storms lead to lower volatility increases than floods during one of the (-5, -1) event windows and both (-1,+1) event windows. Again, this suggests that storms lead to a lower volatility increase relative to excluded category, floods.

3.6.3 Robustness Tests

Tables 3.13 and 3.14 provide results for a series of regression models using various samples for our abnormal return and abnormal variance regression models. Model (1) in Table 3.13 includes all disasters that incurred damages greater than zero affecting a major production country with a production share in excess of 5% of the global production share. Model (2) uses a sample that includes natural disasters that caused a high level of damage in excess of 50 million US$ but did not necessarily affect major producing countries. Model (3) uses a sample that includes all natural disasters regardless of the damage they caused that affected a major production country with a production share in excess of 10% of the global production share. Model (4) uses a sample that includes natural disasters that caused a high level of damage in excess of 50 million US$ and affected a major producing country with a production share in excess of 10% of the global production share. Models (5) and (6) use a sample that includes natural disasters that caused damages in excess of 5 million US$ and affected a major producing country with a production share in excess of 5% of the global production share for two time periods prior and after year 2000.

Table 3.13 shows that demand pressures have a positive impact on the magnitude of abnormal returns across all levels of damage caused by natural disasters and across all models (except for the period before the year 2000).

Insert Table 3.13 about here.

Moreover, production share has a positive and significant impact on the magnitude of abnormal returns for both periods prior to and after the year 2000. Production share also has a positive and significant impact on abnormal return if costly disasters affect countries with larger production shares compared to our original sample. This is reasonable given that disasters that affect regionally concentrated commodities should drive up prices more than if they affect wide-spread commodity

Table 3.14 provides results of our robustness tests for abnormal variance. Demand pressure continues to negatively affect abnormal variance when a sample of more significant disasters affecting countries with larger production share compared to our original sample is used. Our results for the post-2000 sample do not show the same significant negative impact of demand pressure on abnormal variance which may simply be due to the lower sample size used for this test. Moreover, a country's production share has a positive and significant impact on magnitude of abnormal variance when more significant disasters affect countries with a larger production share compared to our original sample and for both periods prior and after year 2000.

Insert Table 3.14 about here.

3.7. Conclusion

As natural disasters become more severe and common across the globe their impact on our lives become more significant. As these emerging risk factors become more common and severe, Managers, specially managers of firms in agricultural and food industry, with focus on long-term performance of their firms need to better identify and address the impact of these risk factors on the supply chain of the firms. In this study we use a unique, hand-collected sample of large-scale natural disasters around the globe to study how they affect the price and price volatility of commodities. Our study focuses on the occurrence of natural disasters in countries producing larger production of a given commodity. The underlying assumption of our study is that major natural disasters will cause damage not only to the production of a commodity but also to the production infrastructure, consequently disrupting the supply chain of the commodity. We test if these disruptions in the supply chain are reflected in the market via price changes and price volatility changes.

Our results show that most commodities react similarly to the occurrence of natural disasters in their production centers. Commodities, with the exception of cocoa, experience a significant increase in price volatility around the occurrence of natural disasters in their production centers. In addition, most commodities experience a significant price increase around the occurrence of natural disasters in their production centers.

Our empirical study also examines which factors drive the magnitude of price and price volatility changes when a natural disaster occurs. we observe that the production share of an affected country has a major impact on the magnitude of price and price volatility changes. Specifically, higher production shares of specific commodity producing countries are positively related to the magnitude of price changes and price volatility changes after the occurrence of a natural disaster. This result is not surprising given that several disasters (e.g, landfall of a hurricane) can be anticipated prior to the first recorded date and that agricultural production shares are well known and exhibit little time variation. The impact of production share on the price volatility is not limited to the time after the disaster. Rather, production share is positively related to the magnitude of price volatility changes even prior to the occurrence of disaster.

Agricultural commodities are used in the supply chain of many companies and any impact on their price can have significant impact on global food production and consequently can affect many across the globe. Our study focuses on part of the economic significance of one the pressing matters in our time which is the various impacts of natural disasters. As natural disasters become more frequent and damaging as a result of climate change their inevitable impact on commodities and food supply and how to address and cope with such changes in commodities' market will become an increasingly important issue.

CHAPTER 4

Conclusion

The thesis is mainly focused on long-term perspective in management. The first essay focuses on the management long-term performance and firm valuation. The second essay focuses on emerging environmental risk factors and their impact on commodities which is vital to address by managers aiming to assure long-term success of their firms.

In the first essay we study the impact of antitakeover provisions and existence of free cash flow on family firms' valuation. We focus on family firms since family firm managers are more likely to have a long-term perspective in management. We test how the existence of long-term perspective in management is perceived by market participant and how it affects firm valuation. Both the presence of antitakeover provisions and free cash flow are widely known to increase the severity of agency conflict in firms leading to decrease in shareholders wealth. However, our findings suggest that the existence of these measures are perceived positively or not as damaging for family firm. We attribute this to family firms' managers' long-term perspective as they are more focused on building a legacy and assure the long-term goals of the firm are achieved. We conclude that market participants believe family firms' managers do not use antitakeover provisions or free cash flow to serve their self interest. Rather, they use these measures to assure their long-term goals of the firm are achieved which ultimately benefits the shareholders and this is shown in by an increase in firm valuation.

In the second essay we study the impact of natural disasters on price and price volatility of commodities. While many studies in this area have focused on how natural disasters affect financial markets and economies, we provide a first-of-its-kind study on how natural disasters can affect commodity prices and price volatility contributing to the literature on supply chain risk management. Our findings suggest that climate related natural disasters significantly affect the commodity price volatility and marginally affect the commodity price. Moreover, we find that natural disasters occurring in a country with higher production share of a certain commodity have a more significant impact on price volatility of said commodity.

References

Ali, A., T.-Y. Chen, and S. Radhakrishnan, 2007. Corporate Disclosures by Family Firms. *Journal of Accounting and Economics* 44, 238-286.

Altay, N., Ramirez, A. 2010. Impact of Disasters on Firms in Different Sectors: Implications for Supply Chains. *Journal of Supply Chain Management* 46, 59–80.

Amihud, Y. and B. Lev, 1981. Risk Reduction as a Managerial Motive for Conglomerate Mergers. *Bell Journal of Economics* 12, 605-617.

Anderson, R.C., A. Duru, and D.M. Reeb, 2009. Founders, Heirs, and Corporate Opacity in the United States. *Journal of Financial Economics* 92, 205-222.

Anderson, R.C. and D. M. Reeb, 2003. Founding-Family Ownership and Firm Performance: Evidence from the S&P 500. *Journal of Finance* 58, 1301-1328.

Anderson, R.C., D.M. Reeb, and W.L. Zhao, 2012. Family-Controlled Firms and Informed Trading: Evidence from Short Sales. *Journal of Finance* 67, 351-385.

Arin, K.P., Ciferri, D., Spagnolo, N. 2008. The Price of Terror: The Effects of Terrorism on Stock Market Returns and Volatility. *Economics Letters* 101, 164–167.

Asiedu, E. 2002. On the Determinants of Foreign Direct Investment to Developing Countries: Is Africa Different? *World Development* 30, 107-119

Baker, S.R., Bloom, N. 2013. Does Uncertainty Reduce Growth? Using Disasters as Natural Experiments. *The National Bureau of Economic Research Working Paper 19475.*

Bandiera, O., Lemos, R., Prat, A., Sadun, R., 2018. Managing the Family Firm: Evidence from CEOs at Work. *The Review of Financial Studies* 31(5), 1605–1653.

Baviera, R., Mainetti, T.F. 2017. A Joint Model for Temperature and Natural Gas with an Application to the US Market. *Quantitative Finance* 17, 927–941.

Bebchuk, L., A. Cohen, and A. Ferrell, 2009. What Matters in Corporate Governance? *Review of Financial Studies* 22, 783-827.

Bernile, G., Delikouras, S., Korniotis, G., & Kumar, A. (2015). Geography of Firms and Propagation of Local Economic Shocks. *University of Miami Working Paper.*

Bertrand, M. and A. Schoar, 2006. The Role of Family in Family Firms. *Journal of Economic Perspectives* 20, 73-96.

Bollerslev, T. 1986. Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics* 31, 307–327.

Brounen, D., Derwall, J. 2010. The Impact of Terrorist Attacks on International Stock Markets. *European Financial Management* 16, 585–598.

Brown, S.J., Warner, J.B. 1980. Measuring Security Price Performance. *Journal of Financial Economics* 8, 205–258.

Brush, T.H., P. Bromiley, and M. Hendrickx, 2000. The Free Cash Flow Hypothesis for Sales Growth and Firm Performance. *Strategic Management Journal* 21, 455-472.

Burkart, M., F. Panunzi, and A. Shleifer, 2003. Family Firms. *Journal of Finance* 58, 2167-2201.

Cao, G.X., Xu, W., Guo, Y. 2015. Effects of Climatic Events on the Chinese Stock Market: Applying Event Analysis. *Natural Hazards* 77, 1979–1992.

Chang, C.W., Chang, J.S.K., Wen, M.M. 2014. Optimum Hurricane Futures Hedge in a Warming Environment: A Risk-Return Jump-Diffusion Approach. *Journal of Risk and Insurance* 81, 199–217.

Charles, A., Darne, O. 2006. Large Shocks and the September 11th Terrorist Attacks on International Stock Markets. *Economic Modelling* 23, 683–698.

Chava, S., D. Livdan, and A. Purnanandam, 2009. Do Shareholder Rights Affect the Cost of Bank Loans? *Review of Financial Studies* 22, 2973-3004.

Chen, F., O.K. Hope, Q.Y. Li, and X. Wang, 2011. Financial Reporting Quality and Investment Efficiency of Private Firms in Emerging Markets. *Accounting Review* 86, 1255-1288.

Chen, J., King, T., D., Li, X., 2018. National Culture and Governance on Bondholder Wealth: Evidence from Joint Ventures and Strategic Alliances around the World. *Quarterly Journal of Finance* 8, 1.

Christie, A.A. and J.L. Zimmerman, 1994. Efficient and Opportunistic Choices of Accounting Procedures - Corporate-Control Contests. *Accounting Review* 69, 539-566.

Claessens, S., S. Djankov, and L.H.P. Lang, 2000. The Separation of Ownership and Control in East Asian Corporations. *Journal of Financial Economics* 58, 81-112.

Cohen, A. and C.C.Y. Wang, 2013. How Do Staggered Boards Affect Shareholder Value? Evidence from a Natural Experiment. *Journal of Financial Economics* 110, 627-641.

DeAngelo, H. and E.M. Rice, 1983. Antitakeover Charter Amendments and Stockholder Wealth. *Journal of Financial Economics* 11, 329-360.

Dechow, P.M., S.A. Richardson, and R.G. Sloan, 2008. The Persistence and Pricing of the Cash Component of Earnings. *Journal of Accounting Research* 46, 537-566.

Deb, P. , David, P. and O'Brien, J., 2017. When is cash good or bad for firm performance? *Strategic Management Journal* 38, 436-454.

El-Khatib, R., Fogel, K., Jandik, T, 2013. CEO Network Centrality and Merger Performance. *Journal of Financial Economics* 116 (2), 349-382.

Engle, R. 1982. Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of U.K. Inflation. *Econometrica* 50, 987–1008.

Faccio, M. and L.H.P. Lang, 2002. The Ultimate Ownership of Western European Corporations. *Journal of Financial Economics* 65, 365-395.

Fairfield, P.M., J.S. Whisenant, and T.L. Yohn, 2003. Accrued Earnings and Growth: Implications for Future Profitability and Market Mispricing. *Accounting Review* 78, 353-371.

Fama, E.F. and M.C. Jensen, 1983. Separation of Ownership and Control. *Journal of Law & Economics* 26, 301-325.

Fama, E., French, K., Jensen, M., Roll, R. 1969. The Adjustment of Stock Prices to New Information. ,*International Economic Review* 10, 1–21.

Fink, J., Fink, K. 2014. Do Seasonal Tropical Storm Forecasts Affect Crack Spread Prices? *Journal of Futures Markets* 34, 420–433.

Flouris, T., Walker, T.J. 2005. The Financial Performance of Low-Cost and Full-Service Airlines in Times of Crisis. *Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration* 22, 3–20.

Francis, B.B., I. Hasan, K. John, and M. Waisman, 2010. The Effect of State Antitakeover Laws on the Firm's Bondholders. *Journal of Financial Economics* 96, 127-154.

Francis, J.A., Vavrus, S.J. 2012. Evidence Linking Arctic Amplification to Extreme Weather in Mid-Latitudes. *Geophysical Research Letters* 39(6), 1-8.

Gebregewergs, B., Hadush, M. 2017. Does Climate Change Affect Price of Vegetables? Evidence from Tigrai, Northern Most Ethiopia. *Ekonomika Poljoprivreda/Economics of Agriculture* 64, 1335–1354.

Giné, M. Moussawi, R., 2017. Governance Mechanisms and Effective Activism: Evidence from Shareholder Proposals on Poison Pills. *Journal of Empirical Finance* 43, 185-202.

Girma, P.B., Paulson, A.S. 1998. Seasonality in Petroleum Futures Spreads. *Journal of Futures Markets* 18, 581–598.

Gompers, P., J. Ishii, and A. Metrick, 2003. Corporate Governance and Equity Prices. *Quarterly Journal of Economics* 118, 107-155.

Gul, F.A. and J.S.L. Tsui, 1997. A Test of the Free Cash Flow and Debt Monitoring Hypotheses: Evidence from Audit Pricing. *Journal of Accounting & Economics* 24, 219-237.

Gul, F.A. and J.S.L. Tsui, 2001. Free Cash Flow, Debt Monitoring, and Audit Pricing: Further Evidence on the Role of Director Equity Ownership. *Auditing - A Journal of Practice & Theory* 20, 71-84.

Hochrainer, S. 2009. Assessing the Macroeconomic Impacts of Natural Disasters: Are There Any? *World Bank Policy Research Working Paper 4968.*

Hansen, P. R., Lunde, A. 2005. A Forecast Comparison of Volatility Models: Does Anything Beat a GARCH(1,1)? *Journal of Applied Econometrics*, 20, 873–889.

Jarrell, G.A. and A.B. Poulsen, 1987. Shark Repellents and Stock Prices - The Effects of Antitakeover Amendments Since 1980. *Journal of Financial Economics* 19, 127-168.

Jaskiewicz, P., Combs, J. G., & Rau, S. B., 2015. Entrepreneurial legacy: Toward a theory of how some family firms nurture transgenerational entrepreneurship. *Journal of Business Venturing*, 30, 29–49.

Jensen, M.C., 1986. Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *American Economic Review* 76, 323-329.

Jensen, M.C., 1989. Eclipse of the Public Corporation. *Harvard Business Review* 67, 61-74.

Jensen, M.C., 1993. The Modern Industrial Revolution, Exit, and the Failure of Internal Control Systems. *Journal of Finance* 48, 831-880.

Jensen, M.C. and W.H. Meckling, 1976. Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. *Journal of Financial Economics* 3, 305-360.

Ji, Q., Guo, J.F. 2015. Oil Price Volatility and Oil-Related Events: An Internet Concern Study Perspective. *Applied Energy* 137, 256–264.

Kadioglu, E., Kilic. S., Yilmaz, E.A., 2017. Testing the Relationship between Free Cash Flow and Company Performance in Borsa Istanbul. *International Business Research* 10, 148-158.

Kaplanski, G., Levy, H. 2010. Sentiment and Stock Prices: The Case of Aviation Disasters. *Journal of Financial Economics* 95, 174–201.

Kawashima, S., Takeda, F. 2012. The Effect of the Fukushima Nuclear Accident on Stock Prices of Electric Power Utilities in Japan. *Energy Economics* 34, 2029–2038.

Kilian, L., Vega, C. 2011. Do Energy Prices Respond to U.S. Macroeconomic News? A Test of the Hypothesis of Predetermined Energy Prices. *Review of Economics and Statistics* 93, 660–671.

Kim, J., Pukthuanthong, K., and Walker, T.J. 2008. Leverage, Pre-IPO Insider Ownership, and Underpricing: High-Tech versus Low-Tech IPOs. *Management Decision* 46:1, 106-130

Kirgiz, K., Burtis, M., Lunin, D.A. 2009. Petroleum-refining Industry Business Interruption Losses due to Hurricane Katrina. *Journal of Business Valuation and Economic Loss Analysis* 4, 3-3.

Klock, M., S. Mansi, and W.F. Maxwell, 2005. Does Corporate Governance Matter to Bondholders? *Journal of Financial and Quantitative Analysis* 40, 693-719.

Kollias, C., Manou, E., Papadamou, S., Stagiannis, A. 2011. Stock Markets and Terrorist Attacks: Comparative Evidence from a Large and a Small Capitalization Market. *European Journal of Political Economy* 27, S64–S77.

Kothari, S., Warner, J.B. 2008. Econometrics of Event Studies. In B. Espen Eckbo (ed.), *Handbook of Empirical Corporate Finance* SET, vol. 2 (pp. 3–36). Amsterdam: Elsevier.

La Porta, R., F. Lopez-de-Silanes, and A. Shleifer, 1999. Corporate Ownership Around the World. *Journal of Finance* 54, 471-517.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R.W. Vishny, 2000. Agency Problems and Dividend Policies Around the World. *Journal of Finance* 55, 1-33.

Lang, L.H.P., R.M. Stulz, and R.A. Walkling, 1991. A Test of the Free Cash Flow Hypothesis - The Case of Bidder Returns. *Journal of Financial Economics* 29, 315-335.

Lehn, K. and A. Poulsen, 1989. Free Cash Flow and Stockholder Gains in Going Private Transactions. *Journal of Finance* 44, 771-787.

Leiter, A.M., Oberhofer, H., Raschky, P.A. 2009. Creative Disasters? Flooding Effects on Capital, Labour and Productivity within European Firms. *Environmental & Resource Economics* 43, 333–350.

Luo, N. 2012. The Impact of Disasters on Global Stock Market: The Case of the Japanese 2011 Earthquake. *A Master Project* 19-30.

Masulis, R.W., C. Wang, and F. Xie, 2007. Corporate Governance and Acquirer Returns. *Journal of Finance* 62, 1851-1889.

McLaughlin, R., A. Safieddine, and G.K. Vasudevan, 1996. The Operating Performance of Seasoned Equity Issuers: Free Cash Flow and Post-Issue Performance. *Financial Management* 25, 41-53.

Michel-Kerjan, E., Morlaye, F. 2008. Extreme Events, Global Warming, and Insurance-Linked Securities: How to Trigger the "Tipping Point." *Geneva Papers on Risk and Insurance-Issues and Practice* 33, 153–176.

Michel-Kerjan, E.O., 2010. Catastrophe Economics: The National Flood Insurance Program. *Journal of Economic Perspectives* 24, 165–186.

Nakamura, E., Steinsson, J., Barro, R., Ursua, J. 2013. Crises and Recoveries in an Empirical Model of Consumption Disasters. *American Economic Journal: Macroeconomics* 5, 35–74.

Nelson, D.B. 1991. Conditional Heteroskedasticity in Asset Returns: A New Approach. *Econometrica* 59, 347–370.

Nelson, D.B., Cao, C.Q. 1992. Inequality Constraints in the Univariate GARCH Model. *Journal of Business & Economic Statistics* 10, 229–235.

Noy, I., Nualsri, A. 2011. Fiscal Storms: Public Spending and Revenues in the Aftermath of Natural Disasters. *Environment and Development Economics* 16, 113–128.

Opler, T., L. Pinkowitz, R. Stulz, and R. Williamson, 1999. The Determinants and Implications of Corporate Cash Holdings. *Journal of Financial Economics* 52, 3-46.

Pukthuanthong, K., and Walker, T.J., 2008. Pre-IPO Insider Ownership and Underpricing: High-tech versus Low-tech IPOs. *Financial Decisions* 20:1, 1-30

Raddatz, C.E. 2009. The Wrath of God: Macroeconomic Costs of Natural Disasters. *World Bank Policy Research Working Paper 5039.*

Rahmstorf, S., Coumou, D. 2012. Increase of Extreme Events in a Warming World. *Proceedings of the National Academy of Sciences of the United States of America* 109, 4708–4708.

Ranger, N., Niehorster, F. 2012. Deep Uncertainty in Long-Term Hurricane Risk: Scenario Generation and Implications for Future Climate Experiments. *Global Environmental Change: Human and Policy Dimensions* 22, 703–712.

Rediker, K.J. and A. Seth, 1995. Boards of Directors and Substitution Effects of Alternative Governance Mechanisms. *Strategic Management Journal* 16, 85-99.

Richardson, S., 2006. Over Investment of Free Cash Flow. *Review of Accounting Studies* 11, 159-189.

Roll, R. 1984. Orange Juice and Weather. *American Economic Review* 74, 861–880.

Ryngaert, M., 1988. The Effect of Poison Pill Securities on Shareholder Wealth. *Journal of Financial Economics* 20, 377-417.

Skidmore, M., Toya, H. 2002. Do Natural Disasters Promote Long-Run Growth? *Economic Inquiry* 40, 664–687.

Strobl, E. 2012. The Economic Growth Impact of Natural Disasters in Developing Countries: Evidence from Hurricane Strikes in the Central American and Caribbean Regions. *Journal of Development Economics* 97, 130–141.

Thomann, C. 2013. The Impact of Catastrophes on Insurer Stock Volatility. *Journal of Risk and Insurance* 80, 65–94.

Titman, S., K.C.J. Wei, and F.X. Xie, 2004. Capital Investments and Stock Returns. *Journal of Financial and Quantitative Analysis* 39, 677-700.

Trostle, R. 2010. Global agricultural supply and demand: factors contributing to the recent increase in food commodity prices. *Diane Publishing*.

Villalonga, B. and R. Amit, 2006. How Do Family Ownership, Control and Management Affect Firm Value? *Journal of Financial Economics* 80, 385-417.

Villalonga, B. and R. Amit, 2009. How Are U.S. Family Firms Controlled? *Review of Financial Studies* 22, 3047-3091.

Villalonga, B. and R. Amit, 2010. Family Control of Firms and Industries. *Financial Management* 39, 863-904.

Walker, T.J., Thiengtham, D.J., Lin, M.Y. 2005. On the Performance of Airlines and Airplane Manufacturers Following Aviation Disasters. *Canadian Journal of Administrative Sciences: Revue Canadienne des Sciences de l'Administration* 22, 21–34.

Wang, L., Kutan, A.M. 2013. The Impact of Natural Disasters on Stock Markets: Evidence from Japan and the US. *Comparative Economic Studies* 55, 672–686.

Wei, L., C., Kien, H., T., Fan, F., C., 2017. The Performance of Externally Managed REITs in Asia: Further Evidence From Free Cash Flow and Agency Costs. *Journal of Property Investment and Finance*, 35(2), 200-227.

Worthington, A., Valadkhani, A. 2004. Measuring the Impact of Natural Disasters on Capital Markets: An Empirical Application Using Intervention Analysis. *Applied Economics* 36, 2177–2186.

Worthington, A.C. 2008. The Impact of Natural Events and Disasters on the Australian Stock Market: A GARCH-M Analysis of Storms, Floods, Cyclones, Earth-Quakes and Bushfires. *Global Business and Economics Review* 10, 1–10.

Yeh, T.M., 2014. The Effects of Anti-Takeover Measures on Japanese Corporations. *Review of Quantitative Finance and Accounting* 42(4), 757-780.

Table 2.1. Descriptive Statistics

This table presents the summary statistics for our sample. Tobin's Q is calculated as the market value of the firm to the book value of the firm. Family Firms is a dummy variable that takes a value of one if a firm is considered a family firm and zero otherwise. Entrenchment Index takes a value of zero to six and is calculated using Bebchuck et al. (2009). Governance Index takes a value of 0-24 and is calculated using Gompers et al. (2003). Free Cash Flow - Poulsen Sales Scaled is the ratio of free cash flow to sales. Free Cash Flow - Poulsen Asset Scaled is the ratio of free cash flow to the book value of assets. Delaware Incorporated is a dummy variable that takes a value of one if the firm is incorporated in the state of Delaware and zero otherwise.

	Number of Observations	**Mean**	**Median**	**Standard Deviation**	**Min**	**Max**
Tobin's Q	6,114	1.9640	1.5632	1.2068	0.8293	7.4589
Family Firms	6,114	0.2516	0.0000	0.4339	0.0000	1.0000
Entrenchment Index	5,932	2.4704	3.0000	1.3755	0.0000	6.0000
Governance Index	4,279	9.7949	10.0000	2.5673	3.0000	16.0000
Free Cash Flow - Poulsen Sales Scaled	6,114	0.1172	0.0969	0.0923	-0.0972	0.4921
Free Cash Flow - Poulsen Asset Scaled	6,114	0.0876	0.0848	0.0544	-0.0579	0.2556
Return on Assets	6,114	0.1507	0.1441	0.0762	-0.0133	0.3906
Assets ($ millions)	6,114	8458.2190	7840.7829	3.8156	535.5508	480658.7710
Delaware Incorporated	6,114	0.0057	0.0000	0.0755	0.0000	1.0000
Capital Expenditure to Assets	6,114	0.0523	0.0426	0.0410	0.0000	0.2072
Market Value of Total Leverage	6,114	0.5112	0.2181	1.0538	0.0000	8.1917

Table 2.2. Correlation Matrix

This table reports the Pearson correlation coefficients between the variables used in our regressions.

	Tobin's Q	**Family Firms**	**Entrenchment Index**	**Governance Index**	**FCF - Sales Scaled**	**FCF - Asset Scaled**	**Return on Asset**	**Assets (Natural Log)**	**Delaware Incorporated**	**Capital Expenditure to Assets**	**Market Value of Total Leverage**
Tobin's Q	1										
Family Firms	0.0645	1									
Entrenchment Index	-0.0884	-0.1398	1								
Governance Index	-0.1002	-0.1073	0.7156	1							
FCF - Poulsen Sales Scaled	0.1746	-0.0623	-0.0117	-0.019	1						
FCF - Poulsen Asset Scaled	0.5191	0.0592	0.0084	0.0033	0.5521	1					
Return on Asset	0.6518	0.0734	-0.0115	0.0278	0.2878	0.7731	1				
Assets (Natural Log)	-0.2277	-0.2153	-0.1783	-0.1105	0.094	-0.2812	-0.3032	1			
Delaware Incorporated	-0.0101	0.0557	-0.0507	-0.0344	-0.0177	-0.0217	-0.0015	0.0234	1		
Capital Expenditure to Assets	0.0447	0.0349	0.0588	0.0484	0.0915	0.3256	0.2937	-0.212	-0.016	1	
Market Value of Total Leverage	-0.2156	-0.1003	-0.0597	-0.1012	-0.0352	-0.2796	-0.262	0.4258	-0.0061	-0.1878	1

Table 2.3. Univariate Analysis

This table presents the results of the univariate analysis. We divide our sample into two subsets and test whether the mean and median of Tobin’s Q have a meaningful difference for the two subsets.

	Number of Observations	Mean Q	Median Q		Number of Observations	Mean Q	Median Q	T-Test for Mean	Wilcoxon Test for Median
Family Firm	1,538	1.9542	1.5252	Non-Family Firm	4,576	2.0856	1.6996	0.0020	0.0000
E-Index 0 to 3	4,525	2.0691	1.6104	E-Index 4 to 6	1,407	1.7173	1.4639	0.0000	0.0000
G-Index 0 to 10	1,740	2.1476	1.6191	G-Index 11 to 24	2,539	1.8719	1.5410	0.0000	0.0065
ROA Below Median	3,057	1.4030	1.2206	ROA Above Median	3,057	2.5664	2.1013	0.0000	0.0000
Assets Below Median	3,057	2.2793	1.8170	Assets Above Median	3,057	1.7026	1.3542	0.0000	0.0000
Delaware Incorporated	2,425	2.0645	1.5963	Other States Incorporated	3,689	1.8693	1.4988	0.0000	0.0000
Capital Expenditure to Assets Below Median	3,057	2.0319	1.5633	Capital Expenditure to Assets Above Median	3,057	1.9384	1.5603	0.0104	0.0153
Market Value of Total Leverage Below Median	3,057	2.6818	2.2232	Market Value of Total Leverage Above Median	3,057	1.3281	1.2199	0.0000	0.0000
Free Cash Flow - Poulsen Sales Scaled Below Median	3,057	2.2482	1.7610	Free Cash Flow - Poulsen Sales Scaled Above Median	3,057	1.7073	1.4375	0.0000	0.0000
Free Cash Flow - Poulsen Asset Scaled Below Median	3,057	2.5042	2.0418	Free Cash Flow - Poulsen Asset Scaled Above Median	3,057	1.4670	1.2576	0.0000	0.0000

Table 2.4. Panel Regression of the Impact of E-Index and Family Frim on Firm Valuation

This table reports the summary results of the fixed effect panel regression for the impact of E-Index and family firm on firm valuation. Model (1) only includes the E-Index among the independent variables. Model (2) only includes our family firm dummy among the independent variables. Model (3) includes the interaction term between the E-Index and our family firm dummy. The E-index takes on a value of zero to six and is calculated using Gompers et al. (2003). All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	Tobin's Q	**Tobin's Q**	**Tobin's Q**
E-Index	**-0.0821*****		**-0.0952*****
	(0.0000)		(0.0000)
Family Firm		-0.0383	**-0.1885*****
		(0.2642)	(0.0025)
E-Index * Family Firm			**0.0467****
			(0.0399)
Return on Assets	**9.4717*****	**9.5659*****	**9.4600*****
	(0.0000)	(0.0000)	(0.0000)
Assets (Natural Log)	**-0.0690*****	**-0.0624*****	**-0.0728*****
	(0.0000)	(0.0000)	(0.0000)
Delaware Incorporated	**0.0928*****	**0.0805*****	**0.0966*****
	(0.0004)	(0.0023)	(0.0002)
Capital Expenditures to Assets	**-1.6341*****	**-1.5626*****	**-1.6436*****
	(0.0000)	(0.0000)	(0.0000)
Market Value of Total Leverage	**-0.0192****	**-0.0146**	**-0.0202****
	(0.0471)	(0.1322)	(0.0369)
Constant	**1.4164*****	**1.1469*****	**1.4995*****
	(0.0000)	(0.0000)	(0.0000)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	5,932	5,932	5,932
Adjusted R-squared	0.3892	0.3810	0.3901

Table 2.5. Panel Regression of the Impact of G-Index and Family Frim on Firm Valuation

This table reports the summary results of the fixed effect panel regression for the impact of G-Index and family firm on firm valuation. Model (1) only includes the G-Index among the independent variables. Model (2) only includes the family firm dummy among the independent variables. Model (3) includes the interaction term between the G-Index and our family firm dummy. The G-Index takes on a value of 0-24 and is calculated using Gompers et al. (2003). All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	Tobin's Q	**Tobin's Q**	**Tobin's Q**
G-Index	**-0.0488*****		**-0.0594*****
	(0.0000)		(0.0000)
Family Firm		-0.0419	**-0.4930*****
		(0.3314)	(0.0011)
G-Index * Family Firm			**0.0424*****
			(0.0053)
Return on Assets	**10.4887*****	**10.5460*****	**10.4512*****
	(0.0000)	(0.0000)	(0.0000)
Assets (Natural Log)	-0.0018	0.0073	-0.0068
	(0.8945)	(0.6009)	(0.6237)
Delaware Incorporated	**0.0617***	**0.0647****	**0.0672****
	(0.0550)	(0.0460)	(0.0370)
Capital Expenditures to Assets	**-2.9073*****	**-2.8946*****	**-2.9116*****
	(0.0000)	(0.0000)	(0.0000)
Market Value of Total Leverage	**-0.0366*****	**-0.0303*****	**-0.0374*****
	(0.0017)	(0.0096)	(0.0013)
Constant	**1.0875*****	**0.5205*****	**1.2563*****
	(0.0000)	(0.0001)	(0.0000)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	4,279	4,279	4,279
Adjusted R-squared	0.3977	0.3886	0.3991

Table 2.6. Panel Regression of the Impact of Free Cash Flow - Poulsen Sales Scaled and Family Frim on Firm Valuation

This table reports the summary results of a fixed effect panel regression on the impact of free cash flow and family firm on firm valuation. Model (1) only includes free cash flow (sales scaled) among the independent variables. Model (2) includes the interaction term between free cash flows (sales scaled) and our family firm dummy. Free cash flow (sales scaled) is calculated using Lehn and Poulsen (1989) and is divided by sales. All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	Tobin's Q	**Tobin's Q**	**Tobin's Q**
Free Cash Flow - Poulsen Sales Scaled	**-0.1318****		**-0.1913*****
	(0.0196)		(0.0010)
Family Firm		**-0.0364***	**-0.2380*****
		(0.0885)	(0.0002)
FCF * Family Firm			**0.3200*****
			(0.0003)
Return on Assets	**9.0638*****	**9.5771*****	**9.0936*****
	(0.0000)	(0.0000)	(0.0000)
Assets (Natural Log)	**-0.1193*****	**-0.0621*****	**-0.1308*****
	(0.0000)	(0.0000)	(0.0000)
Delaware Incorporated	0.0598	**0.0814*****	0.0649
	(0.1618)	(0.0021)	(0.1283)
Capital Expenditures to Assets	**-1.0622****	**-1.5391*****	**-0.9569***
	(0.0396)	(0.0000)	(0.0634)
Market Value of Total Leverage	0.0050	-0.0146	0.0051
	(0.6720)	(0.1340)	(0.6615)
Constant	**1.8757*****	**1.1408*****	**2.0094*****
	(0.0000)	(0.0000)	(0.0000)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	3,057	3,057	3,057
Adjusted R-squared	0.3469	0.3815	0.3505

Table 2.7. Panel Regression of the Impact of Free Cash Flow - Poulsen Sales Scaled and Family Frim on Firm Valuation

This table reports the summary results of a fixed effect panel regression on the impact of free cash flow and family firm on firm valuation. Model (1) only includes free cash flow (asset scaled) among the independent variables. Model (2) includes the interaction term between free cash flows (asset scaled) and our family firm dummy. Free cash flow (asset scaled) is calculated using Lehn and Poulsen (1989) and is divided by the book value of assets. All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	Tobin's Q	**Tobin's Q**	**Tobin's Q**
Free Cash Flow - Poulsen Asset Scaled	**-0.3714*****		**-0.4085*****
	(0.0000)		(0.0000)
Family Firm		**-0.0364***	**-0.1863****
		(0.0885)	(0.0222)
FCF * Family Firm			0.1625*
			(0.0706)
Return on Assets	**9.8800*****	**9.5771*****	**9.8943*****
	(0.0000)	(0.0000)	(0.0000)
Assets (Natural Log)	**-0.0599*****	**-0.0621*****	**-0.0635*****
	(0.0012)	(0.0000)	(0.0006)
Delaware Incorporated	**0.0897****	**0.0814*****	**0.0867***
	(0.0482)	(0.0021)	(0.0561)
Capital Expenditures to Assets	**-1.3318****	**-1.5391*****	**-1.3300****
	(0.0170)	(0.0000)	(0.0172)
Market Value of Total Leverage	-0.0067	-0.0146	-0.0070
	(0.5334)	(0.1340)	(0.5145)
Constant	**1.4352*****	**1.1408*****	**1.4961*****
	(0.0000)	(0.0000)	(0.0000)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	3,057	3,057	3,057
Adjusted R-squared	0.3652	0.3815	0.3659

Table 2.8. Panel Regression of the Impact of Change in E-Index and Family Frim on Change in Firm Valuation

This table reports the summary results of the fixed effect panel regression for the impact of change in E-Index and family firm on change in firm valuation. Model (1) only includes change in the E-Index among the independent variables. Model (2) only includes our family firm dummy among the independent variables. Model (3) includes the interaction term between the change in the E-Index is defined as $\Delta E\text{-}Index_{it} = E\text{-}Index_{it} - E\text{-}Index_{it-1}$ where $E\text{-}Index_{it}$ is the value of the E-Index for firm *i* at year *t* and $E\text{-}Index_{it-1}$ is the value of the E-Index for firm *i* at year *t-1* or previous year and and our family firm dummy. The change in the E-index takes on a value of -6 TO 6 and is calculated using Gompers et al. (2003). All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	ΔTobin's Q	**ΔTobin's Q**	**ΔTobin's Q**
ΔE-Index	**-0.0432****		**-0.0475****
	(0.0324)		(0.0195)
Family Firm		0.0181	0.0182
		(0.5429)	(0.5588)
ΔE-Index * Family Firm			**0.1050***
			(0.0654)
Return on Assets	**0.4520*****	**0.2890****	**0.4442*****
	(0.0035)	(0.0438)	(0.0041)
Assets (Natural Log)	0.0139	0.0169*	0.0146
	(0.1703)	(0.0764)	(0.1524)
Delaware Incorporated	-0.0212	-0.0363	-0.0270
	(0.8919)	(0.8100)	(0.8628)
Capital Expenditures to Assets	**-1.2283*****	**-1.2947*****	**-1.2189*****
	(0.0002)	(0.0000)	(0.0002)
Market Value of Total Leverage	-0.0051	0.0025	-0.0049
	(0.6195)	(0.7389)	(0.6308)
Constant	-0.1376	**-0.1737***	-0.1468
	(0.1699)	(0.0676)	(0.1475)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	5932	5932	5932
Adjusted R-squared	0.0044	0.0040	0.0041

Table 2.9. Panel Regression of the Impact of Change in G-Index and Family Frim on Change in Firm Valuation

This table reports the summary results of the fixed effect panel regression for the impact of change in the G-Index and family firm on change in firm performance. Model (1) only includes change in the G-Index among the independent variables. Model (2) only includes the family firm dummy among the independent variables. Model (3) includes the interaction term between change in the G-Index and our family firm dummy. The change in G-Index is defined as $\Delta G\text{-}Index_{it} = G\text{-}Index_{it} - G\text{-}Index_{it-1}$ where $G\text{-}Index_{it}$ is the value of the G-Index for firm *i* at year *t* and $G\text{-}Index_{it-1}$ is the value of the G-Index for firm *i* at year *t-1* or previous year and takes on a value of -24 to 24 and is calculated using Gompers et al. (2003). All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	ΔTobin's Q	**ΔTobin's Q**	**ΔTobin's Q**
ΔG-Index	**-0.0645*****		**-0.0726*****
	(0.0034)		(0.0012)
Family Firm		0.0130	0.0168
		(0.7470)	(0.6764)
ΔG-Index * Family Firm			**0.1302****
			(0.0421)
Return on Assets	**0.3979****	**0.4812****	**0.3959****
	(0.0415)	(0.0132)	(0.0426)
Assets (Natural Log)	0.0117	0.0169	0.0128
	(0.3669)	(0.1924)	(0.3270)
Delaware Incorporated	-0.0413	-0.0331	-0.0487
	(0.8199)	(0.8565)	(0.7886)
Capital Expenditures to Assets	**-1.1430*****	**-1.1858*****	**-1.1403*****
	(0.0060)	(0.0044)	(0.0061)
Market Value of Total Leverage	-0.0020	-0.0021	-0.0019
	(0.8399)	(0.8276)	(0.8461)
Constant	-0.1403	-0.2046	-0.1537
	(0.2660)	(0.1088)	(0.2305)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	4279	4279	4279
Adjusted R-squared	0.0072	0.0085	0.0066

Table 2.10. Panel Regression of the Impact of Change in Free Cash Flow - Poulsen Sales Scaled and Family Frim on Change in Firm Valuation

This table reports the summary results of a fixed effect panel regression on the impact of change in free cash flow and family firm on change in firm performance. Model (1) only includes change in free cash flow (sales scaled) among the independent variables. Model (2) only includes the family firm dummy among the independent variables. Model (3) includes the interaction term between change in free cash flows (sales scaled) and our family firm dummy. Free cash flow (sales scaled) is calculated using Lehn and Poulsen (1989) and is divided by sales. ΔFree Cash Flow or ΔFCF_{it} is a dummy variable that takes on a value of one if the change in free cash flow value (sales-scaled) for firm i from year t-1 to year t (FCF_{it} - FCF_{it-1}) is in the top quartile of changes in free cash flow values in our sample from year t-1 to year t. All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	ΔTobin's Q	**ΔTobin's Q**	**ΔTobin's Q**
ΔFree Cash Flow - Poulsen Sales Scaled	**-0.1623*****		**-0.1907*****
	(0.0002)		(0.0000)
Family Firm		0.0130	-0.0532
		(0.7470)	(0.6016)
ΔFCF * Family Firm			**0.2123***
			(0.0854)
Return on Assets	0.3080	**0.4812****	0.3120
	(0.2793)	(0.0132)	(0.2730)
Assets (Natural Log)	0.0160	0.0169	0.0185
	(0.4236)	(0.1924)	(0.3577)
Delaware Incorporated	-0.0845	-0.0331	-0.0975
	(0.7627)	(0.8565)	(0.7275)
Capital Expenditures to Assets	**-1.7980*****	**-1.1858*****	**-1.8454*****
	(0.0037)	(0.0044)	(0.0029)
Market Value of Total Leverage	-0.0017	-0.0021	-0.0021
	(0.8993)	(0.8276)	(0.8776)
Constant	-0.0817	-0.2046	-0.0965
	(0.6750)	(0.1088)	(0.6265)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	3,057	3,057	3,057
Adjusted R-squared	0.0104	0.0085	0.0095

Table 2.11. Panel Regression of the Impact of Change in Free Cash Flow - Poulsen Asset Scaled and Family Frim on Change in Firm Valuation

This table reports the summary results of a fixed effect panel regression on the impact of change in free cash flow and family firm on change in firm valuation. Model (1) only includes free cash flow (asset scaled) among the independent variables. Model (2) only includes the family firm dummy among the independent variables. Model (3) includes the interaction term between free cash flows (asset scaled) and our family firm dummy. Free cash flow (asset scaled) is calculated using Lehn and Poulsen (1989) and is divided by the book value of assets. ΔFree Cash Flow or ΔFCF_{it} is a dummy variable that takes on a value of one if the change in free cash flow value (sales-scaled) for firm i from year t-1 to year t (FCF_{it} - FCF_{it-1}) is in the top quartile of changes in free cash flow values in our sample from year t-1 to year t. All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**
	ΔTobin's Q	**ΔTobin's Q**	**ΔTobin's Q**
ΔFree Cash Flow - Poulsen Asset Scaled	**-0.0726***		**-0.1121****
	(0.0912)		(0.0168)
Family Firm		0.0130	-0.1040
		(0.7470)	(0.2632)
ΔFCF * Family Firm			**0.2422****
			(0.0332)
Return on Assets	**0.5801****	**0.4812****	**0.5751****
	(0.0354)	(0.0132)	(0.0370)
Assets (Natural Log)	0.0144	0.0169	0.0155
	(0.4894)	(0.1924)	(0.4596)
Delaware Incorporated	-0.0506	-0.0331	-0.0594
	(0.8444)	(0.8565)	(0.8182)
Capital Expenditures to Assets	**-1.5728*****	**-1.1858*****	**-1.6024*****
	(0.0086)	(0.0044)	(0.0074)
Market Value of Total Leverage	-0.0021	-0.0021	-0.0028
	(0.9189)	(0.8276)	(0.8937)
Constant	-0.1488	-0.2046	-0.1391
	(0.4515)	(0.1088)	(0.4895)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	3,057	3,057	3,057
Adjusted R-squared	0.0149	0.0085	0.0137

Table 2.12. Robustness Tests for E-Index

This table reports the summary results of the fixed effect panel regression for the impact of E-Index and family firm on firm performance. Model (1) only includes our observations for the period 1993 to 1999 inclusive. Model (2) only includes our observations for the period 2000 to 2014 inclusive. Model (3) only includes observations for High Tech firms. High Tech firms are firms classified with sic codes 283, 357, 366, 367, 382, 384, and 737). Model (4) only includes observations for Low Tech firms. All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**	**(4)**
	1993-1999	**2000-2014**	**High Tech Firms**	**Low Tech Firms**
	Tobin's Q	**Tobin's Q**	**Tobin's Q**	**Tobin's Q**
E-Index	**-0.0435****	**-0.1266*****	**-0.1638*****	**-0.0555*****
	(0.0206)	0.0000	(0.0000)	(0.0000)
Family Firm	-0.0099	**-0.0181****	**-0.0061****	-0.0034
	(0.2955)	(0.0293)	(0.0250)	(0.4750)
E-Index * Family Firm	**0.0279****	**0.0442****	**0.2144***	**0.0029***
	(0.0414)	(0.0355)	(0.0708)	(0.0656)
Return on Assets	**11.0650*****	**8.7756*****	**10.6749*****	**8.8118*****
	0.0000	0.0000	(0.0000)	(0.0000)
Assets (Natural Log)	**-0.0768*****	**-0.1802*****	**-0.2058*****	**-0.0182****
	(0.0001)	0.0000	(0.0000)	(0.0491)
Delaware Incorporated	0.0121	**0.1451*****	0.1272	**0.0661*****
	(0.7726)	0.0000	(0.1753)	(0.0016)
Capital Expenditures to Assets	**-2.6321*****	-0.0324	**-5.3063*****	**-0.8753*****
	0.0000	(0.9482)	(0.0000)	(0.0024)
Market Value of Total Leverage	**-0.1026*****	-0.0044	**-1.4644*****	**-0.0189*****
	(0.0001)	(0.6759)	(0.0000)	(0.0062)
Constant	-0.158	**2.6668*****	**3.6110*****	**0.7761*****
	(0.4399)	0.0000	(0.0000)	(0.0000)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Observations	2305	3627	1298	4634
Adjusted R-squared	0.3743	0.418	0.3684	0.4885

Table 2.13. Robustness Tests for Free Cash Flow - Poulsen Sales Scaled

This table reports the summary results of a fixed effect panel regression on the impact of free cash flow and family firm on firm performance Model (1) only includes our observations for the period 1993 to 1999 inclusive. Model (2) only includes our observations for the period 2000 to 2014 inclusive. Model (3) only includes observations for High Tech firms. High Tech firms are firms classified with sic codes 283, 357, 366, 367, 382, 384, and 737). Model (4) only includes observations for Low Tech firms. All other variables are as previously defined. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	(1)	**(2)**	**(3)**	**(4)**
	1993-1999	**2000-2014**	**High Tech Firms**	**Low Tech Firms**
	Tobin's Q	**Tobin's Q**	**Tobin's Q**	**Tobin's Q**
Free Cash Flow - Poulsen Sales Scaled	**-0.0355***	**-0.1542****	**-0.5179*****	**-0.1892*****
	(0.0371)	(0.0270)	(0.0086)	(0.0000)
Family Firm	**-0.1110***	**-0.0913****	**-0.0697*****	**-0.0499****
	(0.0744)	(0.0233)	(0.0033)	(0.0487)
FCF * Family Firm	**0.3673****	**0.0840***	**0.5200****	**0.0757****
	(0.0149)	(0.0510)	(0.0134)	(0.0347)
Return on Assets	**10.0599*****	**8.4795*****	**11.4649*****	**7.7994*****
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Assets (Natural Log)	**-0.0827****	**-0.2108*****	**-0.3145*****	**-0.0421*****
	(0.0279)	(0.0000)	(0.0000)	(0.0014)
Delaware Incorporated	-0.0633	**0.1206****	0.0046	0.0385
	(0.4107)	(0.0200)	(0.9758)	(0.1852)
Capital Expenditures to Assets	**-1.7431***	-0.5190	**-3.5984****	-0.3834
	(0.0642)	(0.4217)	(0.0378)	(0.2768)
Market Value of Total Leverage	**-0.1739****	0.0121	**-1.3452*****	-0.0052
	(0.0118)	(0.3173)	(0.0000)	(0.4659)
Constant	0.0487	**2.8534*****	**4.5595*****	**1.0649*****
	(0.8885)	(0.0000)	(0.0000)	(0.0000)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Observations	1016	2041	793	2289
Adjusted R-squared	0.2952	0.3708	0.3698	0.4524

Table 3.1. Sample Construction

This table explains our sample construction. The entry "all disasters in the CRED database" includes all agricultural and nonagricultural disasters recorded in CRED. "All disasters affecting production centers" include all agricultural and nonagricultural disasters recorded in CRED affecting countries producing cocoa, coffee, rice, soybeans, sugar, and wheat. "All observations" include all agriculture-relevant disasters such as landslides, wildfires, floods, storms, and droughts that occurred in production centers of commodities causing a level of damage greater than zero. "Small disasters" are all agricultural disasters in production centers of commodities causing a level of damage less than US$5 million. "Major disaster observations" are agricultural natural disasters causing a level of damage above US$5 million affecting a production center country with a production share greater than 5% of global production. We include all major disaster observations in our event study but only include a major disaster observation in our OLS regressions if all available data points needed in our regression model are available for that particular observation. A major disaster can be included more than once among the major disaster observations because one disaster can affect a country that is considered a production center of more than one commodity. "Unique major disasters" reports unique disasters causing a level of damage above US$5 million affecting a production center country with production share greater than 5% of global production.

All disasters in the CRED database	22,164
All disasters affecting production centers	8,747
All observations	1,577
Small disasters	717
Major disaster observations in event study sample	860
Missing data	112
Major disaster observations included in regression sample	748
Unique major disaster	507

Table 3.2. Disasters by Country and Decade

This table lists the number of natural disasters by country and decade in our sample. Only agriculture-relevant disasters including landslides, wildfires, floods, storms, and droughts causing a level of damage above US$5 million affecting a production center country with a production share greater than 5% of global production are included.

	1970s	1980s	1990s	2000s	2010–2015	Total by Country
Argentina	0	5	7	8	4	24
Bangladesh	2	2	5	7	5	21
Brazil	0	0	1	0	0	1
Canada	1	0	0	0	0	1
China	1	29	119	161	76	386
Colombia	0	0	0	2	7	9
Cuba	0	2	3	0	0	5
France	0	1	0	0	0	1
Ghana	0	0	2	0	0	2
India	6	0	0	0	6	12
Indonesia	0	0	0	5	12	17
Malaysia	0	1	1	0	0	2
Nigeria	0	2	2	5	4	13
Russia	0	0	1	0	1	2
Thailand	0	0	0	2	2	4
United States	0	0	3	0	2	5
Vietnam	0	0	0	2	0	2
Total by Decade	10	42	144	192	119	507

Table 3.3. Price and Volatility Impact of Natural Disasters on Coffee

This table shows the impact of natural disasters on the price and price volatility of coffee for six event windows before, during, and after the event (day 0). *P*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

Total damages >$5M and production share >5% (N = 70)

Event Window	Mean-Adjusted Return CAR (*p*-value)	Market-Adjusted Return CAR (*p*-value)	Abnormal Variance (*p*-value)
[–7, +7]	0.4692	0.2764	**0.0311*****
	(0.5801)	(0.7461)	(0.0000)
[–7, –1]	**1.1509****	**0.9615****	**0.0064*****
	(0.0154)	(0.0496)	(0.0000)
[–5, –1]	0.4165	0.2997	**0.0064*****
	(0.2530)	(0.4413)	(0.0000)
[–1, +1]	-0.1387	0.1770	**0.0028*****
	(0.6920)	(0.6154)	(0.0000)
[+1, +5]	-0.3861	0.3748	**0.0101****
	(0.4928)	(0.5062)	(0.0201)
[+1, +7]	-0.2854	0.2736	**0.0184*****
	(0.6534)	(0.6658)	(0.0002)

Table 3.4. Price and Volatility Impact of Natural Disasters on Wheat

This table shows the impact of natural disasters on the price and price volatility of wheat for six event windows before, during, and after the event (day 0). *P*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

Total damages >$5M and production share >5% (N = 305)

Event Window	Mean-Adjusted Return CAR (*p*-value)	Market-Adjusted Return CAR (*p*-value)	Abnormal Variance (*p*-value)
[–7, +7]	0.0927	0.9469	**0.1062*****
	(0.9469)	(0.4365)	(0.0000)
[–7, –1]	0.1462	0.7557	**0.0549*****
	(0.8872)	(0.4103)	(0.0001)
[–5, –1]	0.2988	0.0296	**0.0532*****
	(0.7347)	(0.9699)	(0.0000)
[–1, +1]	-0.2065	0.1611	**0.0305*****
	(0.7224)	(0.7337)	(0.0000)
[+1, +5]	0.1570	0.0128	**0.0480*****
	(0.8401)	(0.9849)	(0.0000)
[+1, +7]	-0.0520	0.3620	**0.0556*****
	(0.9544)	(0.6451)	(0.0000)

Table 3.5. Price and Volatility Impact of Natural Disasters on Soybeans

This table shows the impact of natural disasters on the price and price volatility of soybeans for six event windows before, during, and after the event (day 0). *P*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

Total damages >$5M and production share >5% (N = 237)

Event Window	Mean-Adjusted Return CAR (*p*-value)	Market-Adjusted Return CAR (*p*-value)	Abnormal Variance (*p*-value)
[–7, +7]	**2.2011****	**2.5213*****	**0.0237*****
	(0.0186)	(0.0015)	(0.0000)
[–7, –1]	**1.0758***	0.8122	**0.0099*****
	(0.0924)	(0.1360)	(0.0000)
[–5, –1]	0.8543	-0.7423	**0.0066*****
	(0.1107)	(0.1062)	(0.0000)
[–1, +1]	0.6362	**0.6726***	**0.0048*****
	(0.1471)	(0.0728)	(0.0000)
[+1, +5]	0.4957	**0.8664***	**0.0104*****
	(0.3747)	(0.0651)	(0.0000)
[+1, +7]	0.6977	**1.3560****	**0.0139*****
	(0.2799)	(0.0135)	(0.0000)

Table 3.6. Price and Volatility Impact of Natural Disasters on Rice
This table shows the impact of natural disasters on the price and price volatility of rice for six event windows before, during, and after the event (day 0). *P*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

Total damages >$5M and production share >5% (N = 102)

Event Window	Mean-Adjusted Return CAR (*p*-value)	Market-Adjusted Return CAR (*p*-value)	Abnormal Variance (*p*-value)
[–7, +7]	**1.0453***	**1.0240***	**0.0602*****
	(0.0658)	(0.0734)	(0.0000)
[–7, –1]	**0.6720***	0.6173	**0.0466*****
	(0.0863)	(0.1172)	(0.0000)
[–5, –1]	0.4006	0.3039	**0.0276*****
	(0.1667)	(0.3022)	(0.0000)
[–1, +1]	0.3164	0.3084	**0.0085*****
	(0.2298)	(0.3084)	(0.0000)
[+1, +5]	0.3858	0.4101	**0.0081*****
	(0.2187)	(0.1960)	(0.0000)
[+1, +7]	0.1969	-0.2157	**0.0076*****
	(0.6153)	(0.5865)	(0.0015)

Table 3.7. Price and Volatility Impact of Natural Disasters on Cocoa

This table shows the impact of natural disasters on the price and price volatility of cocoa for six event windows before, during, and after the event (day 0). *P*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

Total damages >$5M and production share >5% (N = 51)

Event Window	Mean-Adjusted Return CAR (*p*-value)	Market-Adjusted Return CAR (*p*-value)	Abnormal Variance (*p*-value)
[–7, +7]	-0.0132	0.0848	**–0.0078*****
	(0.9747)	(0.8431)	(0.0000)
[–7, –1]	0.0174	0.0552	**–0.0029*****
	(0.9529)	(0.8548)	(0.0000)
[–5, –1]	-0.0001	0.0593	**–0.0021*****
	(0.9997)	(0.8111)	(0.0000)
[–1, +1]	-0.1108	0.1371	**–0.0014*****
	(0.5349)	(0.4459)	(0.0000)
[+1, +5]	-0.1191	0.1022	**–0.0030*****
	(0.5826)	(0.6473)	(0.0000)
[+1, +7]	0.0603	0.0662	**0.8220*****
	(0.8342)	(0.8220)	(0.0000)

Table 3.8. Price and Volatility Impact of Natural Disasters on Sugar

This table shows the impact of natural disasters on the price and price volatility of sugar for six event windows before, during, and after the event (day 0). *P*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

Total damages >$5M and production share >5% (N = 95)

Event Window	Mean-Adjusted Return CAR (*p*-value)	Market-Adjusted Return CAR (*p*-value)	Abnormal Variance (*p*-value)
[–7, +7]	0.2209	-0.3743	0.0017
	(0.7830)	(0.6361)	(0.4724)
[–7, –1]	0.8895	**1.0462***	**–0.0035*****
	(0.1082)	(0.0557)	(0.0004)
[–5, –1]	0.6640	0.7654	**–0.0030*****
	(0.1615)	(0.1013)	(0.0000)
[–1, +1]	**0.9585****	**0.9023****	**–2.0500*****
	(0.0381)	(0.0321)	(0.0000)
[+1, +5]	-0.3121	-0.3831	**0.0058*****
	(0.5168)	(0.4246)	(0.0000)
[+1, +7]	-0.4453	0.5025	**0.0070*****
	(0.4058)	(0.3414)	(0.0000)

Table 3.9. Production Share Concentration of Commodities

This table shows the production concentration of commodities among producing countries. 'Production Share of Top 5 Producing Countries' is calculated using historical average of combined production share of the five countries with the highest production share. 'Number of Countries With 70% or More Combined World Production' is calculated using the historical average of production share of the top producing countries exceeding 70% of the global production share. 'Production Share Herfindahl' is calculated using the production shares of countries. Specifically, the Herfindahl Index for commodity k is calculated as $HI_{kt} = \sqrt{\sum_{i=1}^{n} P_{ikt}^2}$ for each year t, where HI_{kt} is the Herfindahl Index for commodity k in year t and P_{ikt} is the production share of country i for commodity k in year t. 'Planting to Harvest Time' is the average number of months it takes from planting to first harvesting a given commodity.

	Production Share of Top 5 Producing Countries	Number of Countries With 70% or more Combined World Production	Production Share Herfindahl	Planting to Harvest Time (Months)
Coffee	0.5764	8.53	0.3259	8
Wheat	0.5503	8.96	0.2787	9
Soybeans	0.8950	2.64	0.5449	6
Rice	0.7320	4.65	0.4159	4
Cocoa	0.7801	4.41	0.4078	48
Sugar	0.4407	11.66	0.2306	14

Table 3.10. Correlation Matrix

This table presents the pairwise Pearson correlation coefficients between the independent variables used in our OLS regressions. Price Increase measures the increase in the price of a commodity in the two years prior to the occurrence of the natural disaster. Total Damage is the natural log of the total damage caused by a natural disaster in US dollars as reported by CRED. Total Deaths is the number of casualties caused by a natural disaster. Production Share is a country’s production share of a certain commodity in year prior to the occurrence of a natural disaster. GDP per Capita is the natural log of the gross domestic product per capita of the affected country. Cocoa, Coffee, Rice, Soybeans, and Wheat are dummy variables identifying the commodity for which cumulative abnormal returns or cumulative abnormal variances are calculated. for which commodity. Landslide, Storm, Flood, Drought, and Wildfire are dummy variables identifying which agricultural natural disaster occurred.

	Price Increase	Total Damage	Total Deaths	Production Share	GDP per Capita	Cocoa	Coffee	Rice	Soybeans	Wheat	Sugar	Landslide	Storm	Flood	Drought	Wildfire
Price Increase	1.0000															
Total Damage	0.0861	1.0000														
Total Deaths	–0.0273	0.1010	1.0000													
Production Share	0.0765	0.0600	–0.0471	1.0000												
GDP per Capita	–0.0459	0.1122	–0.0542	–0.0070	1.0000											
Cocoa	–0.0442	–0.1146	–0.0173	–0.0792	0.1090	1.0000										
Coffee	0.0528	–0.0829	–0.0203	0.0634	0.2079	–0.0818	1.0000									
Rice	–0.0332	–0.0608	0.1155	0.1666	–0.1812	–0.0883	–0.1035	1.0000								
Soybeans	–0.0889	0.0634	–0.0335	–0.2774	0.0305	–0.1651	–0.1934	–0.2088	1.0000							
Wheat	0.1279	0.0788	–0.0187	0.1644	–0.0445	–0.1961	–0.2297	–0.2481	–0.4635	1.0000						
Sugar	–0.0487	0.0122	–0.0023	–0.0079	–0.0750	–0.0934	–0.1094	–0.1181	–0.2207	–0.2622	1.0000					
Landslide	–0.0503	–0.2276	–0.0154	0.0146	0.0569	0.1587	0.1208	0.0436	–0.0758	–0.1067	–0.0041	1.0000				
Storm	0.0471	0.0359	0.0436	–0.0639	–0.1283	–0.1886	–0.1420	–0.1324	0.1410	0.1878	–0.0849	–0.1818	1.0000			
Flood	–0.0212	0.0653	–0.0425	0.0777	0.0655	0.1019	0.0617	0.1164	–0.0954	–0.1227	0.0763	–0.2414	–0.8407	1.0000		
Drought	–0.0127	0.1063	–0.0050	–0.0169	0.0123	–0.0191	–0.0224	–0.0242	0.0354	0.0219	–0.0256	–0.0166	–0.0577	–0.0765	1.0000	
Wildfire	0.0780	–0.1174	–0.0085	–0.0503	0.0600	0.0693	0.0949	0.0038	–0.0142	–0.0809	0.0001	–0.0249	–0.0868	–0.1152	–0.0079	1.0000

Table 3.11. OLS Regression of Cumulative Abnormal Return

This table provides OLS regression results for the impact of various factors on cumulative abnormal returns prior, during, and after the occurrence of a natural disaster. The dependent variable CAR.BCI is the cumulative abnormal return using the Bloomberg Commodity Index as the bench mark for the event window [t1, t2]. Similarly, CAR.GSCI is the cumulative abnormal return using the Goldman Sachs Commodity Index as the bench mark for the event window [t1, t2]. All other variables are as defined earlier. The event windows used to calculate the cumulative abnormal returns before, during, and after the event (day 0) are shown in the first row. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold. Only major disasters affecting production centers are used in the sample.

Event Window	(–5, –1) CAR.BCI	(–5, –1) CAR.GSCI	(–1, +1) CAR.BCI	(–1, +1) CAR.GSCI	(+1, +5) CAR.BCI	(+1, +5) CAR.GSCI
Demand Pressure	**0.0521*****	**0.0467*****	**0.0345*****	**0.0326*****	**0.0410*****	**0.0322*****
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0037)
Total Damage	–0.0004	–0.0007	–0.0001	–0.0004	0.0008	0.0010
	(0.6855)	(0.4719)	(0.9144)	(0.5852)	(0.4457)	(0.3461)
Total Deaths	0.0000	0.0000	–0.0000	–0.0000	–0.0000	–0.0000
	(0.6626)	(0.6520)	(0.8754)	(0.8807)	(0.8232)	(0.6868)
Production Share	0.0024	0.0093	–0.0034	–0.0015	**0.0536***	**0.0572***
	(0.9275)	(0.7360)	(0.8541)	(0.9371)	(0.0681)	(0.0515)
GDP	0.0001	–0.0000	0.0000	0.0005	0.0006	0.0006
	(0.9293)	(0.9928)	(0.9978)	(0.6231)	(0.6982)	(0.6789)
Cocoa	0.0119	0.0124	0.0090	0.0098	–0.0020	–0.0005
	(0.1247)	(0.1298)	(0.1338)	(0.1102)	(0.8036)	(0.9488)
Coffee	–0.0020	–0.0009	0.0056	0.0035	0.0007	–0.0020
	(0.7685)	(0.8959)	(0.2440)	(0.4705)	(0.9210)	(0.7923)
Rice	0.0054	0.0054	0.0066	0.0046	–0.0084	–0.0099
	(0.3965)	(0.4196)	(0.1419)	(0.3189)	(0.2390)	(0.1646)
Soybeans	0.0053	0.0052	0.0049	0.0025	–0.0062	–0.0081
	(0.3125)	(0.3408)	(0.1824)	(0.5062)	(0.2910)	(0.1646)
Wheat	0.0035	0.0076	**0.0062***	0.0048	–0.0074	–0.0073
	(0.4882)	(0.1577)	(0.0862)	(0.1948)	(0.1926)	(0.2000)
Landslide	–0.0049	–0.0033	**–0.0103****	–0.0054	–0.0018	–0.0028
	(0.4868)	(0.6617)	(0.0438)	(0.3063)	(0.8131)	(0.7241)
Storm	–0.0000	0.0001	0.0023	0.0018	–0.0015	0.0009
	(0.9993)	(0.9737)	(0.3142)	(0.4278)	(0.6882)	(0.7958)
Drought	0.0302	0.0161	0.0123	0.0001	–0.0039	–0.0000
	(0.1323)	(0.4481)	(0.3889)	(0.9949)	(0.8609)	(0.9991)
Wildfire	–0.0013	–0.0145	0.0019	–0.0027	–0.0090	–0.0014
	(0.9298)	(0.3418)	(0.8651)	(0.8128)	(0.5523)	(0.9292)
Constant	–0.0044	–0.0014	–0.0061	–0.0049	–0.0147	–0.0182
	(0.7564)	(0.9255)	(0.5456)	(0.6352)	(0.3524)	(0.2491)
Observations	748	748	748	748	748	748
Adjusted R-squared	0.0269	0.0180	0.0322	0.0187	0.0140	0.0082

Table 3.12. OLS regression of Cumulative Abnormal Variance

This table provides OLS regression results for the impact of various factors on cumulative abnormal variances prior, during, and after the occurrence of a natural disaster. The dependent variable CAV.BCI is the cumulative abnormal variance using the Bloomberg Commodity Index as the bench mark for the event window [t1, t2]. Similarly, CAV.GSCI is the cumulative abnormal variance using the Goldman Sachs Commodity Index as the bench mark for the event window [t1, t2]. All other variables are as defined earlier. The event windows used to calculate the cumulative abnormal variances before, during, and after the event (day 0) are shown in the first row. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold. Only major disasters affecting production centers are used in the sample.

Event Window	(–5, –1) CAV.GARCH	(–5, –1) CAV.EGARCH	(–1, +1) CAV.GARCH	(–1, +1) CAV.EGARCH	(+1, +5) CAV.GARCH	(+1, +5) CAV.EGARCH
Demand Pressure	–0.0008	**–0.0007****	–0.0004	–0.0002	**–0.0014****	**–0.0007****
	(0.2187)	(0.0283)	(0.2478)	(0.2101)	(0.0107)	(0.0206)
Total Damage	0.0000	0.0000	0.0000	0.0000	**0.0001***	**0.0001***
	(0.9963)	(0.3916)	(0.9991)	(0.6930)	(0.0931)	(0.0969)
Total Deaths	0.0000	–0.0000	0.0000	–0.0000	–0.0000	–0.0000
	(0.9041)	(0.9816)	(0.8882)	(0.9890)	(0.7238)	(0.8555)
Production Share	**0.0037****	**0.0016***	**0.0023****	**0.0013****	**0.0025***	**0.0018****
	(0.0250)	(0.0782)	(0.0170)	(0.0102)	(0.0879)	(0.0282)
GDP	–0.0000	–0.0000	–0.0000	–0.0000	–0.0001	–0.0000
	(0.7671)	(0.9097)	(0.8143)	(0.8850)	(0.3279)	(0.7308)
Cocoa	0.0001	0.0001	0.0000	0.0000	–0.0002	–0.0002
	(0.7780)	(0.7004)	(0.9262)	(0.7402)	(0.6313)	(0.3023)
Coffee	0.0003	0.0003	0.0001	0.0001	0.0006	0.0001
	(0.4936)	(0.2106)	(0.7420)	(0.5468)	(0.1275)	(0.6164)
Rice	0.0003	–0.0002	0.0000	–0.0000	0.0003	–0.0000
	(0.4452)	(0.3739)	(0.8734)	(0.8608)	(0.3667)	(0.8258)
Soybeans	0.0004	0.0003	0.0002	0.0001	0.0001	–0.0001
	(0.2477)	(0.1270)	(0.3075)	(0.1510)	(0.7483)	(0.4409)
Wheat	0.0003	0.0002	0.0001	0.0001	**0.0005***	0.0001
	(0.4271)	(0.2400)	(0.4484)	(0.3280)	(0.0573)	(0.4606)
Landslide	–0.0007	–0.0003	–0.0004	**–0.0002***	0.0005	0.0001
	(0.1276)	(0.2425)	(0.1087)	(0.0933)	(0.2307)	(0.7759)
Storm	**–0.0004***	–0.0002	**–0.0002***	**–0.0001***	0.0002	0.0001
	(0.0547)	(0.1428)	(0.0538)	(0.0641)	(0.3577)	(0.1439)
Drought	–0.0005	–0.0005	–0.0003	–0.0003	–0.0008	–0.0006
	(0.6898)	(0.4807)	(0.6805)	(0.5296)	(0.4567)	(0.3619)
Wildfire	–0.0005	–0.0002	–0.0003	–0.0001	–0.0005	–0.0002
	(0.5827)	(0.7216)	(0.5452)	(0.6310)	(0.5207)	(0.5694)
Constant	–0.0002	–0.0005	–0.0001	–0.0002	–0.0007	–0.0004
	(0.7988)	(0.3079)	(0.7989)	(0.4742)	(0.4003)	(0.3505)
Observations	748	748	748	748	748	748
Adjusted R-squared	0.0018	0.0057	0.0018	0.0053	0.0168	0.0161

Table 3.13. Robustness Tests for Cumulative Abnormal Returns

This table provides OLS regression results for the impact of various factors on cumulative abnormal returns after the occurrence of a natural disaster for event window (+1,+5) using alternative samples. Model (1) uses all agriculture-relevant disasters in the CRED database that caused any type of damage. Model (2) uses a sample of disasters that caused damage in excess of 50M$. Model (3) uses all disasters that occurred in countries with a production share in excess of 10% of global production. Model (4) uses a sample of disasters that caused damages in excess of 50M$ and occurred in countries with a production share in excess of 10% of global production. Model (5) uses a sample of disasters that caused more than 5M$ in damages and occurred in countries with a production share in excess of 5% of global production in the period of 1970 to 1999 inclusive. Model (6) employs the same disaster and country filters but focuses on the period from 2001 to 2015 inclusive. The dependent variable CAR.BCI is the cumulative abnormal return using the Bloomberg Commodity Index as the bench mark for the event window [t1, t2]. All other variables are as defined earlier. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

	(1)	(2)	(3)	(4)	(5)	(6)
	All Disasters	Damage > 50M$	Production Share > 10%	Damage > 50M$ and Production Share > 10%	1970-1999	2000-2015
Event Window	(+1, +5)	(+1, +5)	(+1, +5)	(+1, +5)	(+1, +5)	(+1, +5)
	CAR.BCI	CAR.BCI	CAR.BCI	CAR.BCI	CAR.BCI	CAR.BCI
Price Increase	**0.0276*****	**0.0300****	**0.0392****	**0.0459****	0.0007	**0.0812*****
	(0.0000)	(0.0197)	(0.0250)	(0.0130)	(0.9657)	(0.0000)
Total Damage	0.0007	0.0014	0.0016	0.0019	0.0021	-0.0010
	(0.1292)	(0.1425)	(0.1635)	(0.4070)	(0.1436)	(0.4930)
Total Deaths	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	0.0000
	(0.5504)	(0.2011)	(0.3598)	(0.5171)	(0.5495)	(0.1075)
Production Share	0.0081	0.0400	**0.0700*****	**0.0226***	**0.1383****	**0.0050***
	(0.6511)	(0.1428)	(0.0031)	(0.0869)	(0.0151)	(0.0969)
GDP	-0.0004	-0.0009	-0.0011	-0.0002	0.0011	0.0036
	(0.6007)	(0.3389)	(0.6860)	(0.9446)	(0.6258)	(0.1672)
Cocoa	-0.0029	0.0014	**-0.0189****	-0.0073	-0.0098	0.0003
	(0.5351)	(0.7895)	(0.0186)	(0.6197)	(0.4586)	(0.9743)
Coffee	-0.0034	0.0048	-0.0018	**0.0385****	0.0005	-0.0070
	(0.4065)	(0.5062)	(0.9401)	(0.0193)	(0.9627)	(0.4842)
Rice	0.0029	-0.0010	-0.0169	-0.0073	-0.0147	-0.0066
	(0.4737)	(0.8481)	(0.1090)	(0.5791)	(0.1872)	(0.4954)
Soybeans	-0.0017	-0.0025	-0.0062	-0.0039	-0.0123	-0.0051
	(0.6247)	(0.4935)	(0.2817)	(0.6846)	(0.1314)	(0.5388)
Wheat	-0.0034	-0.0050	-0.0085	-0.0063	**-0.0156***	-0.0040
	(0.3421)	(0.2183)	(0.1474)	(0.4611)	(0.0555)	(0.6189)
Landslide	-0.0025	**-0.0157****	**-0.0185***	**-0.0251***	0.0155	-0.0119
	(0.6277)	(0.0489)	(0.0897)	(0.0967)	(0.4391)	(0.1734)
Storm	-0.0003	-0.0021	-0.0046	-0.0053	-0.0023	-0.0022
	(0.9124)	(0.4207)	(0.2503)	(0.3742)	(0.6482)	(0.6816)
Drought	-0.0049	-0.0069	-0.0010	-0.0016	0.0000	0.0011
	(0.8208)	(0.5784)	(0.9668)	(0.9642)	(0.6492)	(0.9614)
Wildfire	0.0002	0.0050	-0.0160	-0.0007	-0.0061	-0.0010
	(0.9766)	(0.5922)	(0.6905)	(0.8707)	(0.6946)	(0.4669)
Constant	-0.0048	-0.0108	-0.0118	-0.0094	-0.0362	-0.0125
	(0.5747)	(0.4928)	(0.5104)	(0.7760)	(0.1378)	(0.5960)
Observations	1577	967	524	348	352	396
Adjusted R-squared	0.0066	0.0141	0.0205	0.0264	0.0063	0.0537

Table 3.14. Robustness tests for Cumulative Abnormal Variances

This table provides OLS regression results for the impact of various factors on cumulative abnormal variances after the occurrence of a natural disaster for event window (+1,+5) using alternative samples. Model (1) uses all agriculture-relevant disasters in the CRED database that caused any type of damage. Model (2) uses a sample of disasters that caused damage in excess of 50M\$. Model (3) uses all disasters that occurred in countries with a production share in excess of 10% of global production. Model (4) uses a sample of disasters that caused damages in excess of 50M\$ and occurred in countries with a production share in excess of 10% of global production. Model (5) uses a sample of disasters that caused more than 5M\$ in damages and occurred in countries with a production share in excess of 5% of global production in the period of 1970 to 1999 inclusive. Model (6) employs the same disaster and country filters but focuses on the period from 2001 to 2015 inclusive. The dependent variable CAV.BCI is the cumulative abnormal variance using the Bloomberg Commodity Index as the bench mark for the event window [t1, t2]. All other variables are as defined earlier. Robust *p*-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% significance level, respectively. Significant results are in bold.

	(1)	(2)	(3)	(4)	(5)	(6)
	All Disasters	Damage > 50M\$	Production Share > 10%	Damage > 50M\$ and Production Share > 10%	1970-1999	2000-2015
Event Window	(+1, +5)	(+1, +5)	(+1, +5)	(+1, +5)	(+1, +5)	(+1, +5)
	CAV.BCI	CAV. BCI	CAV. BCI	CAV. BCI	CAV. BCI	CAV. BCI
Price Increase	-0.0006	-0.0010	-0.0010	**-0.0020****	**-0.0020****	-0.0006
	(0.1134)	(0.1069)	(0.3960)	(0.0407)	(0.0400)	(0.4015)
Total Damage	-0.0000	0.0000	0.0000	0.0001	**0.0002****	**0.0001***
	(0.9736)	(0.9048)	(0.5972)	(0.6397)	(0.0422)	(0.0647)
Total Deaths	0.0000	0.0000	-0.0000	-0.0000	0.0000	**0.0000*****
	(0.8963)	(0.8824)	(0.5818)	(0.5172)	(0.7808)	(0.0098)
Production Share	0.0009	0.0011	-0.0034	**0.0084***	**0.0084****	**0.0041*****
	(0.3745)	(0.4130)	(0.3579)	(0.0562)	(0.0165)	(0.0096)
GDP	-0.0000	-0.0000	0.0000	0.0001	0.0000	-0.0000
	(0.4221)	(0.5744)	(0.6871)	(0.4458)	(0.9325)	(0.8328)
Cocoa	0.0001	-0.0000	0.0000	-0.0002	-0.0005	0.0002
	(0.7793)	(0.8314)	(0.8659)	(0.7901)	(0.5608)	(0.5996)
Coffee	0.0003	**0.0007****	**0.0017***	**0.0029*****	0.0008	-0.0000
	(0.2198)	(0.0205)	(0.0689)	(0.0008)	(0.2538)	(0.9721)
Rice	0.0001	0.0000	0.0007	0.0008	-0.0010	0.0004
	(0.7176)	(0.8725)	(0.2189)	(0.2663)	(0.1634)	(0.3774)
Soybeans	0.0001	0.0001	0.0001	0.0002	0.0002	0.0003
	(0.6551)	(0.6727)	(0.4903)	(0.7006)	(0.6978)	(0.3413)
Wheat	0.0001	0.0002	0.0004	0.0007	-0.0003	0.0004
	(0.7068)	(0.3838)	(0.1750)	(0.1336)	(0.4990)	(0.2607)
Landslide	-0.0002	0.0009	0.0000	0.0001	-0.0005	-0.0005
	(0.5500)	(0.3491)	(0.9422)	(0.9361)	(0.7103)	(0.1727)
Storm	-0.0002	-0.0001	-0.0004	-0.0005	**-0.0005***	-0.0001
	(0.1219)	(0.3134)	(0.1012)	(0.1025)	(0.0951)	(0.5860)
Drought	-0.0004	**-0.0004*****	**-0.0006****	-0.0010	0.0000	-0.0006
	(0.7697)	(0.0092)	(0.0249)	(0.6110)	(0.6311)	(0.5399)
Wildfire	-0.0000	0.0002	-0.0010	0.0004	-0.0009	0.0021
	(0.9925)	(0.7421)	(0.3274)	(0.4717)	(0.3623)	(0.7840)
Constant	0.0003	0.0001	0.0000	-0.0002	0.0000	-0.0012
	(0.5666)	(0.9205)	(0.9963)	(0.9050)	(0.9898)	(0.2299)
Observations	1577	967	524	348	352	396
Adjusted R-squared	0.0023	0.0084	0.0002	0.0262	0.0089	0.0258