Agricultural Commodity Futures Market Volatility: A Case for Punctuated Equilibrium

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Abstract

Agricultural commodity futures markets have experienced dramatic price swings since 2007 as compared to previous periods. Applied economic research has not reached a consensus as to whether market fundamentals or speculative participation has been the cause of the increased volatility. Policy research has concentrated on the legislative intent of the law and how recent financial and commodity market regulation should revert back to the successful policies of the twentieth century. Policy scholars credit financial and commodity market turmoil to changes in regulatory policy, but no specific research has been identified that associates changes in market behavior with changes in regulatory policy. This paper addresses the following research question: why has agricultural commodity futures price volatility changed over time? Applying quasi-experimental analysis methodology with change-point analysis design and econometric modeling, this research uses cotton futures price variability (volatility) as a measurement of commodity market behavior. The findings indicate that commodity futures market regulation is one of many factors that may lead to a change in cotton futures market volatility.

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Since 2006, increased price volatility in physical and agricultural futures markets has drawn the attention of both applied economic and public policy scholars because turbulent commodity prices have significant economic and political implications, (Janzen, Smith, and Carter, 2013). The larger commodity markets, such as energy and metals, have attracted the most interest and smaller agricultural markets, such as grains and cotton, have received less attention. Regardless of size, commodity futures regulatory policy blankets all actively traded futures markets. Regulatory policy change may be one of many causes of these booms and busts.

The research question for this study is: why has agricultural commodity futures price volatility changed over time? This question is important to policy studies because it is important to understand if a particular type of regulatory policy has an effect on market volatility. If regulatory policy can influence market volatility, policy makers can enact a policy that is gauged for a particular level of volatility in the market. Comparing market volatility both prior and subsequent to a major regulatory policy change is one way to determine the magnitude of a regulatory policy change on market volatility. Economic research has centered on the causes of price volatility. Policy research has observed market behavior before and after regulatory change but without quantitative analysis, especially for agricultural commodity markets.

Economic research has focused on whether increased speculation or unusual economic supply and demand fundamentals have led to more dramatic price swings and the resulting financial hardship for commodity hedgers (Janzen, 2010; Power and Robinson, 2009). While economists have not reached a consensus as to the causes of recent volatile commodity futures prices (Irwin and Sanders, 2011), they have acknowledged that extreme volatility can be detrimental to commercial market participants (Janzen, 2010; Carter and Janzen, 2009). However, applied economists caution that a change in market regulatory policy to induce a change in market behavior could be made for the wrong reasons (Irwin and Sanders, 2011; Wright, 2011).

Public policy research has focused on the change in financial and commodity market regulation. The findings stress that regulatory policy needs to revert to the tighter controls utilized to curb speculative participation in financial and commodity markets prior to 2000 (Randall, 2008). Policy scholars stress that the degree of market volatility in financial and commodity markets is not just the concern of professional market participants, commercial or speculative, but also the general public at large. Regulatory policies that encourage market volatility can do great harm, and can lead to devastation of the American (Anderson, 2011, pp. 328-329) and global economy. Policy scholars have identified the influential stakeholders and authorities that made policy changes, and the periods of complacency and disruption that preceded policy change (Topham, 2010), but policy research has not applied a measurement of market behavior to gauge regulatory policy effectiveness.

According to Topham (2010), since the early 1970's two theories have dominated economic policy: (1) the "efficient market" hypothesis holds that asset prices reflect all information available in the market and (2) the "capital asset pricing model" assumes every investor rationally balances risk against reward. These popular economic theories, combined with financial industry lobbying efforts and subsequent legislation, pushed commodity futures market regulatory policy towards financial deregulation that culminated in the creation of the Commodity Futures Modernization Act of 2000 (CFMA). Policy scholars warned about serious disruptions in the market place in the absence of public policy reform of CFMA (Randall 2008, p. 5). In the shadow of the financial crisis of 2008, these "free market" theories have proven gravely false (Krugman, 2009) and the warnings by policy scholars were proven correct. Public reaction to the financial crisis that led to the call for expanded regulation of the financial industry gained prominence as the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Dodd-Frank) surfaced on the policy agenda. Policy scholars (Anderson, 2011) made further warnings that reform legislation would be moderate in tone as the economy improved. They also predicted that resistance would be strong from free market economists, and their Wall Street colleagues, causing delayed implementation.

This study focuses on the cotton futures market because of the unique increase in price volatility relative to its own historical volatility and relative to other commodities since 2006. Cotton futures price volatility dramatically increased in the late 2000's and was one of the most volatile of fifty-three actively traded commodities by 2010 (Plastina and Ding, 2011). This activity makes cotton a useful case study as to the effect commodity market regulation has on commodity price movement. Despite its relatively small size by traded volume and market capitalization compared to the energy, metal, and grain markets, cotton is one of the most important and widely produced agricultural and industrial crops in the world (Gruere, Guitchounts, Plastina, and Townsend, 2010). It is the world's most important textile fiber, representing 40% of fiber production, and 30-40% of cotton fiber crosses international borders before processing (Meyer, MacDonald, and Foreman, 2007). Cotton is grown in more than one hundred countries on about 2% of the world's arable land, making it one of the most significant crops in terms of land use after grains and oilseeds (Gruere, Guitchounts, Plastina, and Townsend, 2010). With over one hundred fifty countries involved in exporting and importing cotton, its dramatic increase in price volatility warrants inclusion in research into the effect regulatory policy change has on futures market activity.

Review of Literature

Market behavior, as reflected by price volatility, is naturally drawn into the vortex of economic rather than public policy research. This preference has been especially noticeable following a financial crisis. Once the fallout of a crisis is evident, policy scholars and researchers follow their economic counterparts and begin to reflect and reassess what policy changes should be made to prevent market turmoil and hardship. Given the magnitude and daily impact on peoples' lives, energy market price volatility has drawn the greatest attention of all physical commodity markets from researchers. To a lesser degree, base and precious metal market volatility has been studied. Further down the chain of popularity are agricultural commodity markets, the grain and oilseed markets of corn, wheat and soybeans commanding the most attention. The cotton market has received some economic attention, though very small in comparison to other markets.

Due to the sheer size and influence of the energy markets on people worldwide, scholarly research covers both the economic and political effects of oil price volatility. In their research on how the energy futures market has changed since the implementation of the CFMA, Medlock and Jaffe (2009, p. 5) found that noncommercial participants constituted about 50% of the United States oil futures market at any given time, compared to an average of 20% prior to 2002. The authors cite a 2007 United States Government Accountability Office report that the CFMA made it easier for financial participants to remove speculative limits and made it more difficult for the government's regulatory authority, Commodity Futures Trading Commission (CFTC), to regulate oil futures markets. In 1990, there were 10 active oil futures contracts trading worldwide, with a combined daily volume equivalent to 150 million barrels a day, or 130% of the daily volume of oil demand at the time. In 2009, total New York Mercantile Exchange oil futures daily trading activity represented the equivalent of 600 million barrels, which was about 700% the daily volume of oil demand. According to Medlock and Jaffe (2009), previous rules for speculative position limits were historically much stricter than they were in 2009. Despite financial industry rhetoric that imposing stricter limits would harm market liquidity, there has been no evidence to support such claims in the oil market (Dugan, 2008).

The oil futures market was functioning very well prior to 2000 when speculative position limits were tighter. Medlock and Jaffe question the time-series econometric techniques of Auto-Regressive Conditional Heteroskedasticiy (ARCH) and Generalized Auto-Regressive Conditional Heteroskedasticiy (GARCH) to forecast and analyze the volatility of time-series data. They argue that ARCH and GARCH models, employed by those who have found that increased speculative participation has not been the cause of increased volatility, are inadequate to answer the type of questions being asked (Medlock and Jaffe, 2009, pp. 13-14). The authors conclude that the surge in oil prices from 2007-2008 set the stage for renewed analysis of the application of position limits in the regulation of commodity futures markets as well as the role of government in preventing oil price shocks from harming the overall United States economy.

As the focus narrows to less visible commodity markets, the research concentrates on the economic causes of increased volatility rather than the regulatory policies that allowed market volatility to change. In his institutional study of crude oil, non-ferrous metal, and grain futures prices between 2006 and 2008, Gilbert (2010) found that index-based investments pushed prices away from their fundamentally-based values, suggesting additional controls on futures market activity may be required to prevent repetition of the 2008 bubble (p. 18). Gilbert (2010) also found that index-based investment is driven by views about the likely future evolution of the macroeconomic fundamentals, which drive commodity prices (in particular, perceptions of likely demand growth in China and other parts of developing Asia)(p.8). The latter finding suggests that there was not a commodity price bubble and the price collapse of the summer of 2008 was temporary and a result of the financial crisis. Gilbert tested whether lagged changes in a constructed quantum index of twelve agricultural markets helped to forecast price changes in each of the seven markets included in his analysis. The results indicated that index-based investment in commodity futures may have been responsible for a significant and "bubble-like" price increase in three of the seven markets: crude oil, aluminum, and copper. Gilbert estimates that the maximum impact of index funds in these markets to be a price increase of 15% (Irwin and Sanders, 2010, p. 12).

Other scholars credit increased trading volumes and outstanding contracts (open interest) to participation by large speculators during the first decade of the twenty-first century (Irwin and Sanders, 2012, 2011; Irwin, Sanders, and Merrin, 2010, 2009). However, they have seen little evidence that passive index investment was the cause of increased volatility in grain futures markets between 2007 and 2011. The authors' research focused on the index fund component of large speculative traders; data for that component of speculative participation has only been available since 2004. Irwin and Sanders question the findings that negate the argument that no evidence exists of a relationship between commodity index investment and movements in commodity futures prices. They state that the data and methods used in these studies are subject to a number of important criticisms that limit the degree of confidence one can place in their results. The authors point out that, historically, when financial and commodity markets experience periods of extreme volatility, the initial public reaction is to attack speculation. Wright also found inconsistency in the argument that index fund investors influenced futures prices. He concluded that price volatility was based on market economic supply and demand conditions, especially given the increased multiple utilization of corn (ethanol mandate) and soybeans (biofuels) (Wright, 2011, pp. 55-56).

Independent research groups from the International Food Policy Research Institute and The World Bank take a contrary view. Robles, Torero, von Braun (2009) analysis of the corn, soybean, rice, and wheat futures markets assessed whether speculative activity in the futures market could be a source of the increasing agricultural commodity prices in 2007-2008. Their results showed that speculative activities might have been influential in causing the price surges of 2007-2008. The authors' conclusion called for reducing the incentives for speculation in food commodities by: (1) changing regulatory frameworks to limit the volume of speculation versus hedging, (2) making delivery on contracts or portions of contracts compulsory, and (3) imposing capital deposit requirements when each futures transaction is made. Baffes, and Haniotis (2010) argue that the economic effect of biofuels on food prices has not been as large as originally thought, but that the use of commodities by financial investors may have been partly responsible for the 2007-2008 price spike. They observe that collective measures by central governments (buffer stocks and regulatory controls) historically have not been successful economic policies to reduce market volatility.

Prior to 2009, the only published economic study specifically on cotton futures price volatility was that of the 1930's (Howell, 1934), a time of similar market turmoil and regulatory policy uncertainty. Following the United States Farm Bill of 1985, cotton policy research has been generated mostly by institutions and has concentrated on the global agricultural policy subject of subsidized cotton production in developed countries compared to unsubsidized production in developing countries (Baffes, 2005). After the dramatic price swings of 2007-2008 and the documented hardships faced by cotton industry participants during that period (Carter and Janzen, 2009; McFerron, Javier, and Perez, 2013), two studies investigated causes of cotton price volatility. Power and Robinson (2009) found that well-established economic relationships for cotton futures markets were disrupted during the period 2006-2009. The authors found no direct evidence to support the claim that index traders were responsible for changes in prices or volatility. Janzen, Smith, and Carter (2013) found that supply and demand shocks unique to the cotton market were the major source of cotton price variation. The 2008 price spike, specifically, came from an increase in precautionary demand that was based on projections of lower future production. The study also found no evidence of co-movement (correlated movement among commodity prices, caused by the inclusion of commodities into major indexes) type effect related to financial speculation. Janzen, Smith, and Carter (2013) conclude that legislative and regulatory efforts to restrict trading activities of index traders and other financial speculators will not prevent future price spikes.

Economic research has addressed the causes of market volatility without coming to a general consensus. Policy research has identified how policy authorities have reacted to prevailing economic theory, influential stakeholders, and public opinion. Where economists advise caution in implementing policy instruments that seek to reduce market volatility (in fear of adverse market effects), policy scholars call for regulatory change that reverts back to tighter controls in order to prevent predatory behavior (in fear of economic and political instability). Economists theorize that policy drives market behavior; policy scholars theorize that market behavior, or a transition in power, ultimately lead to a change in policy. Regardless of why volatility levels change, research has yet to identify whether market behavior is significantly different prior or subsequent to a major regulatory policy change.

Theory

In order to explain distinct changes in commodity price volatility over time, the theory of punctuated equilibrium, a theoretical model applied to agenda setting in the policy process, is applied to this study. Baumgartner and Jones' (2009) theory of punctuated equilibrium states that the course of public policy in the United States is not one of gradual and incremental change, but is rather disjointed and episodic. Long periods of stability are interrupted by bursts of frenetic policy activity (Baumgartner and Jones, 2009, p. xvii). The concept of punctuated equilibrium is founded on human behavior operating within formal and informal social and political environments. Human behavior is influenced by perceptions and mechanisms of change, such as a dramatic event or expanded knowledge. It is major events or expanded knowledge that lead to a change in public behavior and call for a change in public policy (Baumgartner and Jones, 2009).

Punctuated equilibrium (Baumgartner and Jones, 2009) encompasses ideas of bounded rationality, institutionalism, incrementalism, impact of image and venue, and the study of agenda setting. Bounded rationality is responsible for both policy stability and change. People have a fixed understanding of how the world works and they have a sense of urgency to respond to new information. Institutionalism is social theory that studies the way formal and informal rules in society affect social change. Institutions operate within the limits of bounded rationality. Periods of incremental change (marginal decision-making) are the result of institutionalism and the bounded rationality of individual decision makers that keep policy stable. Policy image is how the public perceives a particular policy, the way in which the policy is understood and discussed. Policy venue is the structure under which policy is made, the institutions or groups that have the authority to make decisions concerning an issue. Policy change will be stimulated by a change in policy image, the bounded rationality of individual decision makers having urgency to respond to new change, and a change in venue. The interaction between changing images and venues can produce a system of punctuated equilibrium (compromise or balance), a shift from one point of stability to another.

Within each policy venue are policy actors (networks or subsystems) that share beliefs related to a particular problem or issue. The actors consist of those in authority who make decisions and those who have a vested interest in the problem or issue, the latter influencing the decisions of those in authority. When a group of policy actors come together under structural arrangements supported by common beliefs and dominate the agenda, a policy monopoly emerges. Policy monopolies do not last forever because new beliefs and ideas make them unstable. Instability leads to a burst of activity of change in policy image and venue that interrupts the state of incrementalism (Baumgartner and Jones, 2009, pp. 84-86). It is in the agenda setting stage of the policy process (Anderson, 2011, p. 93) where dominant policy monopolies, usually with the support of public opinion following an image-changing event or expanded knowledge, introduce a proposal for change.

When applied to regulatory policy for agricultural commodity futures markets in the United States, punctuated equilibrium says that commodity futures regulatory policy does not change incrementally; it experiences periods of relative stability interrupted by major policy shifts. For example, if futures markets have a negative public image as a result of price volatility, perceived to be caused by speculation, policy makers should respond by implementing regulations that restrict speculation in commodity markets. In hopes of reducing volatility, the regulation might entail tighter position limits on traders so they are unable to dominate market activity. A policy change could also occur if, as a result of a catastrophic event, there was a complete shift in the majority of elected officials that favored increased regulation in financial markets. Thus, punctuated equilibrium theory would explain that market failure (monopolistic or rent-seeking behavior) or shift in authority would lead to a change in commodity regulatory policy. Once a policy solution is formulated, adopted, and implemented, the evaluation stage would assess if the policy had been effective (Anderson, 2011). In the case of commodity regulatory policy, does the desired market behavior follow the change in policy?

The policy actors in commodity futures regulatory policy consist of three factions: government authorities overseeing regulatory policy and two policy subsystems looking after their vested interests. Government authorities consist of the CFTC, Congress, the president, and the courts. The CFTC is the independent agency authorized by Congress that oversees the regulation of exchange-based futures markets. Congress is the government authority that makes laws concerning futures market regulatory policies. The president (advised by the President's Financial Working Group, PFWG) makes recommendations to Congress on financial market regulatory policy, appoints the chairman and commissioners of the CFTC, and has the power to veto congressional legislation. The courts make rulings, usually on appeal, as to the constitutionality of proposals (under the guidance of Congress) set forth by the CFTC.

All government authorities have a political party connection and tend to side with one subsystem or the other. Since the early 1990's, evidence suggests that Republicans favor less regulation and Democrats favor more regulation in financial markets (Topham, 2010, p. 157). However, presidents are not necessarily consistent along party lines. Bill Clinton signed CFMA (de-regulatory policy), but it was the PFWG, consisting of ex-Wall Street and Chicago-school free-market economists, that set White House policy on financial market regulation. Clinton appointed a regulation advocate to chair the CFTC but Brooksley Born was outnumbered on the PFWG and in confronting a Republican controlled Congress. Under appeal, President Obama's nominee to the District Court for the District of Columbia ruled in favor of de-regulatory policy (Peterson, 2012, p. 1).

One policy subsystem consists of traditional participants in commodity futures markets and associated entities who share the common belief that commodity futures markets should be regulated and provide a safe and secure price discovery mechanism, allowing participants to manage financial risks in order to engage in forward commerce. These participants have utilized futures markets since their inception for hedging purposes, encouraging speculative participation but favoring regulation that prevents market manipulation. The common bond is that they are all part of the commodity supply chain involving production, warehousing, processing, distribution, and manufacturing. The subsystem consists of organizations such as the National Grains Council, the National Cotton Council, the American Cotton Shippers Association, Commodity Markets Council, the American Farm Bureau, farmer cooperatives, and other agricultural groups in the grains, oilseeds, and cattle industries. Members of the Democratic party tend to support the views of this "traditional" network (Topham, 2010; Wetjen, 2013).

The other policy subsystem consists of non-traditional participants in commodity futures markets and associated entities that share the common belief that financial markets should have minimum regulation, allowing them flexibility to innovate products and compete with overseas markets. The subsystem consists of the International Swaps and Derivative Association, the Securities Industry and Financial Markets Association, Goldman Sachs, J P Morgan, Morgan Stanley, money mangers, index funds, hedge funds, and their major customers. Members of the Republican party tend to support the views of this "non-traditional" network (Topham, 2010; Wetjen, 2013).

It has not been documented which policy subsystem, traditional or non-traditional, the commodity futures exchanges (such as the Chicago Mercantile Exchange and the Intercontinental Exchange) support. Formerly structured as private membership exchanges, the transition to "for-profit" occurred early in the twenty-first century simultaneously with de-regulatory legislation. During this time, trading volumes markedly increased (Irwin and Sanders, 2012), boosting revenue for shareholders. Many commodity exchanges merged and are now publicly listed on stock exchanges.

In their presentation of punctuated equilibrium, Baumgartner and Jones (1993), offer the dual mobilization thesis. Based on the works of Downs (1972) and Schattschneider (1960), the mobilization of new voices and previously excluded interests either can come during a wave of enthusiasm for a particular policy or out of opponents' criticism of, and attack against, the policy *status quo*. A Downsian mobilization is marked by a positive policy image and by the creation of institutions likely to support system interests. An example of Downsian mobilization is the period preceding the enactment of CFMA in 2000. During this period, commodity futures regulatory policy change was incremental. The futures industry grew exponentially on the back of financial futures in the 1970's and 1980's (Irwin and Sanders, 2012). A growing and healthy economy in the United States in the 1990's provided an environment of financial stability and the perception that the efficient market theory was working to everyone's economic benefit. The non-traditional subsystem became the policy monopoly when Republicans took both the House and Senate in early 1995. However, the real push occurred when President Clinton's PFWG pushed Congress to keep OTC derivative markets free of CFTC regulation (Topham, 2010, pp. 141-143) in November 1999 and when George W. Bush was elected to the White House. The passage and implementation of the CFMA ensured the deregulation of financial products and prosperity would continue.

A Schattschneider mobilization, by contrast involves negative policy images and the greater policy role played by institutions less likely to offer complete support for the *status quo* (Bosso, 1994). An example of Schattschneider mobilization is the period preceding the enactment of Dodd-Frank 2010. Commodity futures regulatory policy was again incremental since the passage of CFMA in 2000; however bank failures on Wall Street, followed by a change in venue in Washington, led to the traditional subsystem becoming the policy monopoly. The Economic Crisis of 2007-2009 was the jolt to the system that changed public opinion against Wall Street and changed Congress's attitude towards financial market regulation. In 2009, Democrats controlled the House and the office of the President. The passage of Dodd-Frank in July 2010 promised to control speculation and tighten financial market regulations (Protess, 2011), returning to a more stable and sustainable economic environment. Because of President Obama's focus on healthcare and foreign affairs and the huge financial resources of Wall Street committed to lobby government authorities, many of the Dodd-Frank requirements have not been implemented (Brush and Schmidt, 2013).

Hypotheses

Policy actors who favor de-regulated markets accept volatility and view any level of volatility as a function of an efficient market. Policy actors that favor regulated markets accept volatility, but view sustained periods of high of volatility as potentially detrimental to commercial market participants. The latter fear that sustained volatility is a sign of excessive speculation and can lead to market inefficiency. Commodity regulatory policy, less restrictive or more restrictive, should guide market volatility.

The first hypothesis is: if commodity regulatory policy is not restrictive on market participants, then the elasticity of price volatility with respect to shocks, and the rate at which shocks are transmitted into futures prices, is likely to be higher than under a more restrictive policy. Sustained periods of historically high volatility may occur because less-restrictive (de-regulatory) policy may not limit participant activity, resulting in greater speculation in the market. A less-restrictive policy may be one where position limits are relaxed and margin requirements are low enough to encourage greater market participation. Following the less-restrictive regulatory legislation of CFMA, increased volatility was evident by 2007-2009. This period of market turmoil led to the passage of Dodd-Frank 2010, a more restrictive regulatory policy. Thus, sustained levels of high volatility may lead policy actors to influence elected officials to change regulation in favor of lower volatility levels.

The second hypothesis is: if commodity market regulatory policy is restrictive on participants, then the elasticity of price volatility with respect to shocks, and the rate at which shocks are transmitted into futures prices, is likely to be lower than under a less-restrictive policy. Normal volatility by historical standards may occur because a restrictive regulatory policy limits participant activity and decreases speculation in the market. A more-restrictive policy may be one where position limits are strictly enforced and margin requirements are high enough to discourage market participation. Following the more-restrictive regulatory legislation of Dodd-Frank 2010, market volatility subsided after one to two years, depending on the commodity. If volatility continues to be deemed low or moderate for a sustained period, policy actors in favor of de-regulated markets may influence elected officials to change regulation to being less restrictive in order to increase market participation. Prior to 2000, markets were quite stable for a sustained period of time when regulatory policy was more restrictive than that which existed post-2000.

The third hypothesis is: if commodity regulatory policy shifts from restrictive to less-restrictive or vice versa, then a change in market behavior will not be immediate. There may be a time lag before the new policy has had an effect in changing market behavior. Following Dodd-Frank 2010, commodity futures volatility did not change immediately; implementation has been slow as a result of continued court challenges by de-regulatory factions looking to repeal Dodd-Frank.

Data Collection

Previous economic research on physical commodity markets has focused on time periods of less than ten years, rather than longitudinal studies. The time period of study is twenty-eight years, from the week of August 6, 1986 until the week of July 30, 2014; the duration encompasses twenty-eight marketing years for cotton. The United States Department of Agriculture (USDA) defines the cotton-marketing year from August 1st to July 31st, coinciding with the North American harvest cycle.

The intention is not to identify the cause of the problem from an economic standpoint, or to identify the policy networks behind changes in legislation; but to observe the levels of cotton futures price volatility, before and after shifts in commodity regulatory policy. The data is dissected into three segments to test the "quasi-treatment effect" before and after commodity regulatory policy change. Quasi-treatment refers to the fact that the study is not a true experiment, but rather one where the treatment is imposed in hindsight. This methodology is based on the Campbell and Ross (1968) study. Segments of study reflect time periods before and after two major commodity regulatory policy events, CFMA 2000 and Dodd-Frank 2010. Three major time periods of study without a transition period are as follows: (A) August 1986 to December 2000, start of data to effective date of CFMA; (B) December 2000 to July 2010, effective date CFMA to effective date Dodd-Fran; and (C) July 2010 to July 2014, effective date Dodd-Frank to end of data.

In order to incorporate a lead and lag for a policy shift, two transition periods were applied to the study, twelve months before and after CFMA 2000 and Dodd-Frank 2010. With transitions, five time periods of study are as follows: (AA) August 1986 to January 2000, start of data to 12 months before CFMA; (T1) February 2000 to January

2002, transition before and after CFMA; (BB) February 2002 to July 2009, 12 months after CFMA to 12 months before Dodd-Frank; (T2) August 2009 to July 2011, transition before and after Dodd-Frank; and (CC) August 2011 to July 2014, 12 months after Dodd-Frank to end of data.

Data is utilized from a specific commodity in the agricultural sector, cotton, which is one of many agricultural commodities that comprise 13% of the S&P Goldman Sachs Commodity Index (Plastina, 2008), a recognized benchmark for investment in commodity markets. Mid-1986 was chosen as it marked the implementation of the 1985 Farm Bill, a significant piece of legislation for the cotton futures market in the United States. Immediately preceding the 1985 Farm Bill, the New York futures market did not reflect the world price of cotton (for the same quality and delivery standard).[1] For almost four years preceding the 1985 Farm Bill, activity on the New York futures market was virtually dormant. It did not appear that the international cotton trade was using "New York" as a price discovery and hedging mechanism; the futures market was only reflecting the price of the United States domestic cotton market. Following the implementation of the 1985 Farm Bill in July 1986, the New York futures market began to correlate more closely with world cotton prices, as reflected by the "A Index."

The data source for the weekly nearby cotton futures price is a database compiled from the Intercontinental Exchange, Inc. (Cotton No. 2 Futures Contract, 2014) futures contract historical price database, formerly the New York Board of Trade and the New York Cotton Exchange. The weekly nearby cotton futures price is a function of the front (current) delivery month for cotton futures until the Last Trading Day (LTD) of the contract. The weekly price is the mid-week closing (settlement) price, preferably Wednesday, Tuesday or Thursday, depending on the business day futures are trading. The delivery months for cotton futures are October, December, March, May, and July. Once a futures contract reaches LTD, the nearby cotton futures month rotates to the next delivery month, thus a continuous price is maintained. The sources for major commodity futures market regulations are the CFTC and United States Congressional Records. Cotton economic indicators were obtained from the International Cotton Advisory Committee (ICAC).

In order to determine whether market behavior has changed as a result of a regulatory shift in policy both descriptive statistics and econometric modeling were conducted. The coefficient of variation (CV) was applied as a measure of volatility to test for a significant difference in cotton price volatility before and after a regulatory shift. Econometric modeling was applied to test if the conditional variance, a measure of volatility, significantly changed before and after a regulatory shift. By including other factors that influence price movement, such as economic supply and demand and previous price movement, alongside an indicator variable for regulatory legislation, the significant effect of regulatory policy on price volatility may be determined. A squared

[1] The cotton loan price set by the cotton program of the United States Farm Bill was above world cotton prices. The 1985 Farm Bill introduced the "marketing loan program" where the United States government subsidized the difference in the "cotton loan value" and the world price of cotton (as reflected by a formula based on Cotlook's A Index of world prices). The New York cotton futures market, and today's ICE cotton futures market, call for delivery of United States cotton only, no foreign cotton can be delivered on the futures contract (Cotton No. 2 Futures Contract, 2014).

residual analysis was also applied to confirm the results as of descriptive statistics and the linear regression model.

For the descriptive statistics, the *dependent variable* for market behavior is a rolling CV. A problem using nominal prices over a long period of time is inflation. Thus by using the average of a rolling CV of four observations (4-week moving average), the inflationary effect is minimized. The CV measures the variability in the values in a population relative to the magnitude of the population mean (Ott and Longneckar, 2010), or simply the relative standard deviation (expressed as a percentage). The *independent variable* is weekly time, particularly the effective date of regulatory policy change, i.e. the week that particular legislation, CFMA or Dodd-Frank, was put into place. Thus a significant change in legislation at a particular point in time (independent variable) is expected to correlate to a significant change in market behavior (dependent variable), as expressed by market volatility.

For econometric modeling, the *dependent variable* ($\ln y_t$) is the log of the ending bi-monthly price (based on the weekly nearby cotton futures settlement prices). *Independent variables* include the log of the current season's cotton world stocks to use ratio (Current S/U, $\ln x_{1t}$), the log of the following season's cotton worlds stock to use ratio (Following S/U, $\ln x_{2t}$), a lag of the log ending price (t-n Log End Price, $\ln y_{t-n}$), and an indicator variable for separating the periods before or after regulatory legislation (D_{kt}). The ICAC reports world cotton supply and demand figures for the current and following seasons' balance sheet on a monthly basis.[2] The stocks to use ratio is defined as world ending stocks (inventory) of cotton as of July 31 divided by world consumption for that marketing year, expressed in a ratio or percentage terms. Given the autocorrelation of financial time-series data (past observations influence future observations), a lag of $\ln y_{t-n}$ was incorporated into the model. Indicator (dummy) variables represented each of the periods before, after, and surrounding commodity regulatory policy shifts.

Results

For descriptive statistical analysis, Table 1 presents the rolling CV for the three periods surrounding CFMA 2000 and Dodd-Frank 2010 with transitions periods. The mean rolling CV increased from period AA to period BB, but declined from period BB to period CC. Allowing for transition periods, the mean rolling CV for period CC becomes closer to that of period AA than period BB. Comparing all periods, each mean rolling CV is significantly different (α = 5%). At this stage, hypotheses 1, 2, and 3 are supported.

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[2] At the time of the research analysis, only bi-monthly supply and demand numbers were available for the time period of study. Future research will include monthly numbers from the ICAC. Using both current and following season estimates encompasses more economic data that potentially influences futures price movement. The USDA provides only current season world supply and demand estimates consistently on a monthly basis where the ICAC provides both current and following season estimates.

Table 1: Rolling CV of weekly nearby futures price with transitions

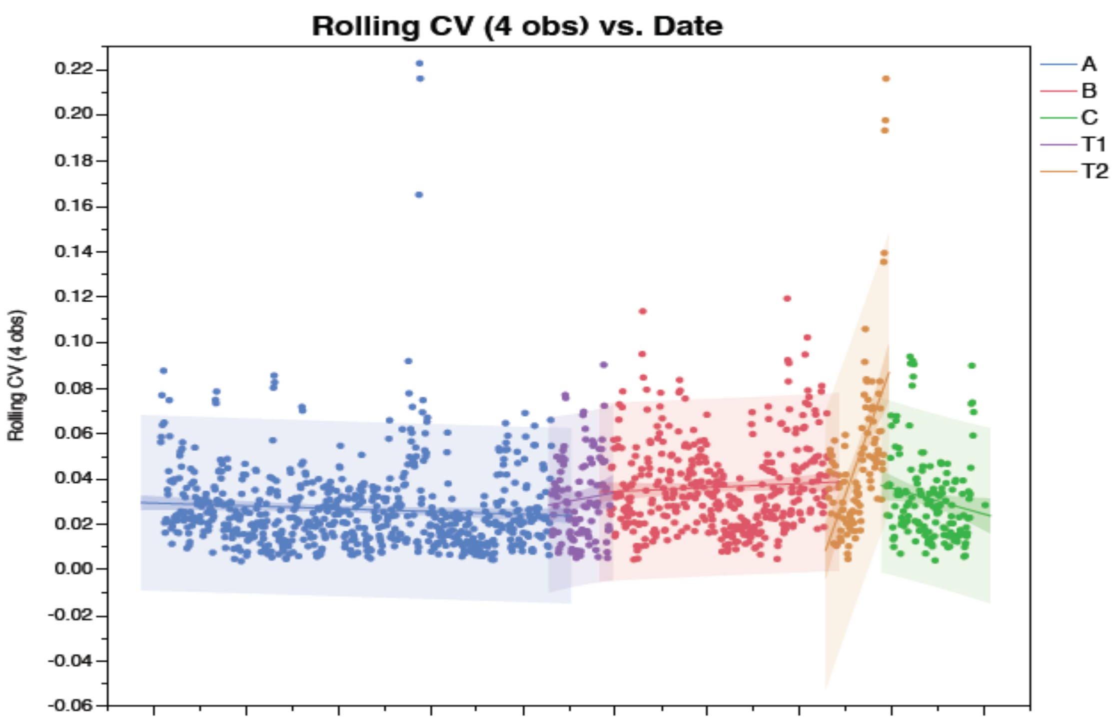
Period	Dates	Obs	Years	CV	CV%
AA	*Aug 1986 to Jan 2000*	703	14.4	0.0265	2.65%
T1	*Feb 2000 to Jan 2002*	105	2	0.0309	3.09%
BB	*Feb 2002 to Jul 2009*	391	6.5	0.0361	3.61%
T2	*Aug 2009 to Jul 2011*	104	2	0.0474	4.74%
CC	*Aug 2011 to Jul 2014*	157	3	00309	3.09%

Comparisons with transitions	Diff	Std Err	P-Value	Holm-Bon*
BB > AA	0.0098	0.0013	<0.0001	0.0167
BB > CC	0.0052	0.0020	0.0091	0.0250
CC > AA	0.0045	0.0019	0.0161	0.0500
T2 > T1	0.0165	0.0029	<0.0001	0.0167

* *the sequential Holm-Bonferroni method was used to adjust the p-value for F test 2-sided*

Figure 1 presents the transition results showing both the confidence of fit and prediction. The volatility in T2 surrounding Dodd-Frank 2010 is much higher than that experienced in T1 surrounding CFMA 2000. Most significantly, volatility was higher in period BB than that of AA and CC.

Figure 1: Rolling CV for Periods with transitions



To conduct a more critical evaluation of the identified changes in price volatility and further test the statistical significance of a major shift in regulatory policy, econometric time series analysis was employed. Time series analysis was conducted on a bi-monthly basis due to the availability of economic data. By including the dependent variable on the right side of the equation, the presence of auto-correlation in times series analysis is reduced. Autoregressive software was utilized to minimize autocorrelation; the optimum "best-fit" lags in the model were *t-1* and *t-5*. The results of the model are presented in Table 2.

Table 2: Econometric Modeling Results for Log Ending Bi-monthly Futures Price

Coefficient (t-ratio)	***Cotton***
Intercept (Period T2)	-0.15**(0.06)
Log Current S/U Ratio	0.15 (0.15)
Log Following S/U Ratio	-0.25* (0.15)
Lag *t-1* Log End Price	0.80** (0.05)
Lag *t-5* Log End Price	0.02 (0.05)
Period AA	-0.01 (0.02)
Period BB	-0.05**(0.02)
Period CC	0.05 (0.04)
Period T1	-0.11**(0.03)
Effect Test	***F Ratio***
Period**	5.10
R-square	0.85

Note: **denotes significance at the 5% level, and *denotes significance at the 10% level.

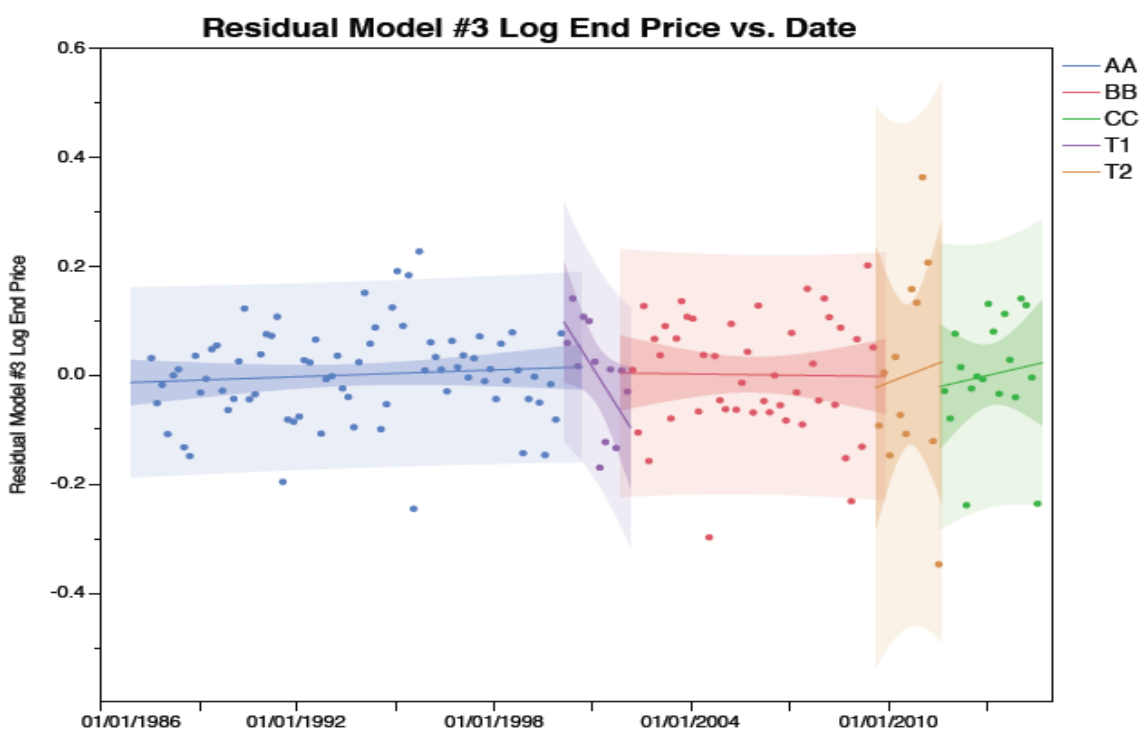
With respect to significance, the current S/U ratio was not significant but the following S/U ratio was significant (α = 10%). The *t-1* lag was the most significant of independent variables, where *t-5* was not significant, showing the high degree autocorrelation in the data. The binary variable, *D*, was overall significant (α = 5%); but individually periods AA and CC were not significantly different. A test for serial correlation, Durbin's alternative statistic (Wooldridge, 2009, pp. 416-417), regressing the model residuals against the model inclusive of lagged residuals was conducted ($\beta_6 = 0.2950$). The results indicate no significant autocorrelation in the model.

Table 3 presents a pair-wise F-test comparison of residual variances for each period of the model with transitions. When other factors are considered, specifically the effect of previous prices and economic indicators, the significance of regulatory shifts upon volatility is depleted. Period AA volatility is significantly lower than period BB, but BB is not statistically higher than CC, and AA is only statistically lower than period CC at α = 10%. Under the econometric model only hypothesis 1 is supported and hypothesis 3 is inconclusive.

Table 3: Tests that the Residual Variances are Equal using F Test		
Standard Deviations		
Level	**Count**	**Std Dev**
AA	76	0.0850
T1	12	0.0993
BB	45	0.1065
T2	12	0.1910
CC	18	0.1092
Comparisons*		
F Test	**F Ratio**	**p-Value**
AA < BB	1.57	0.0426
BB > CC	1.05	0.4272
AA < CC	1.65	0.0724

Figure 2 presents the findings of Tables 2 and 3. The most significantly different period of volatility under the model is the period surrounding Dodd-Frank 2010.

Figure 2: Econometric Model for periods with transitions



The descriptive statistical findings (rolling CV) are not consistent with the econometric time series model (residual variance). Given a two-year transition period, nearby cotton futures volatility after CFMA 2000 was significantly higher than before CFMA 2000 for both the descriptive statistic and the econometric model. Given a two-year transition period, nearby cotton futures volatility after Dodd Frank 2010 was significantly higher than before Dodd-Frank 2010 for the descriptive statistic but not for the econometric model. Given two two-year transition periods, nearby cotton futures volatility after Dodd-Frank 2010 was significantly higher than before CFMA 2000 for the descriptive statistic but only for the econometric model at α = 10%. Under the econometric model volatility does rise over the period of study if the transitions periods are removed. This is especially evident if the data is broken down into seven equal periods not segregated by regulatory policy. Overall, the econometric model indicates that (1) previous cotton futures price activity significantly affects future price movement, (2) previous cotton price activity is statistically more significant than expectations of changes in cotton supply and demand and shifts in commodity futures regulatory policy, and (3) cotton economic information is inherent in previous cotton futures price movement.

To further test the significance of regulatory policy on price volatility, a squared residuals analysis was applied (Enders, 2010, pp. 126-127) to an autoregressive model, AR(q), with normal residuals using autoregressive software (Enders, 2010, p. 8). The means of the squares of the residuals are compared to determine differences in volatility across periods. The AR(1,4,5,7,11,12) mean and variance results are presented in Table 4.

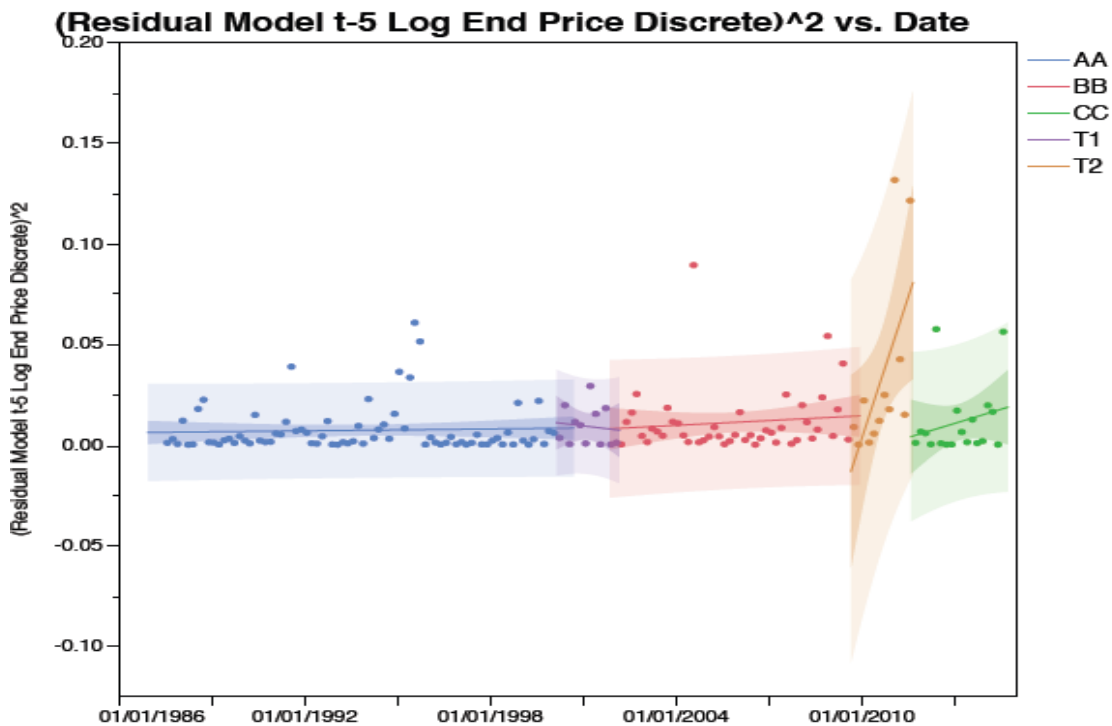
Table 4: Squared Residual Analysis of Autoregressive Model AR(1,4,5,7,11,12)

Log Ending Bi-Monthly Futures Price Mean	
Coefficient (t-ratio)	***Cotton***
Intercept (Period AA)	-0.78**(0.11)
Log Current S/U Ratio	-0.46**(0.17)
Log Following S/U Ratio	0.034 (0.16)
Period T1	-0.22**(0.07)
Period BB	-0.13**(0.06)
Period T2	0.27** (0.08)
Period CC	0.38** (0.09)
R-square	0.85
Log Ending Bi-Monthly Futures Price Variance	
Coefficient	**Cotton**
Intercept (AA)	0.01** (0.00)
Lag Residual^2	-0.12 (0.08)
Period T1	0.01 (0.01)
Period BB	0.00 (0.00)
Period T2	0.03** (0.01)
Period CC	0.00 (0.00)

Note: **denotes significance at the 5% level, and *denotes significance at the 10% level.

The mean of the log bi-monthly price is statistically different for all periods, inclusive of transitions. The mean of the log bi-monthly price squared residuals is not statistically different among any of the periods except for the period surrounding Dodd Frank 2010 (T2). Volatility for the transition period from before to after Dodd Frank 2010's introduction is statistically different from all other periods of study. Thus the results of the squared residual analysis are inconsistent with those of the descriptive statistics but more in line with the econometric model, except there was no statistical difference in the variance from the period before CFMA 2000 to that of the period after. Figure 2 presents the results of the squared residual analysis.

Figure 3: Squared Residual Analysis for periods with transitions



The results indicate that a change in volatility is not solely a result of a shift in regulatory policy to alter market variability but that there are many variables that determine market volatility over a given period of time. The market reaction (increased volatility) to CFMA did not fully occur until 2007 as a result of a lag effect. It appears to have taken some time for financial firms to develop more unregulated OTC products related to commodity futures and educate customers in the less regulated environment of relaxed position limits. Despite the passage of Dodd-Frank (legislative intent to reverse CFMA), historical volatility increased rather than declined. The fact that the market volatility increased can be explained by the failure to implement the policies of Dodd-Frank. However, as Dodd-Frank became more of a reality, volatility levels subsided as shocks were fewer and smaller in magnitude.

Conclusions

The evidence is that commodity futures regulatory policy is not one of gradual and incremental change, but one of long periods of stability interrupted by sporadic bursts of policy activity. Including economic variables and past prices into the equation explaining volatility change appears to deplete the significance of a commodity regulatory policy shift. Commodity market volatility (for just one commodity) may not be the prime factor to induce policy activity. The results do indicate that market behavior, after a change to less-restrictive regulatory policy, is associated with increased cotton futures price volatility. Likewise, after a change to more restrictive regulatory policy, market behavior is associated with decreased cotton futures price volatility. In response to a shift in regulatory policy, market behavior may not change immediately, there is likely to be a time lag before the effect is observed. Traditional methods of measuring volatility indicate that a major shift in commodity regulatory policy is associated with a significant change in cotton futures volatility. Econometric modeling indicates that a policy shift is only a minor factor, if at all, in affecting a change in market variability. There are many other variables affecting cotton futures market volatility aside from commodity regulatory policy. This study found that past price movement is the most significant followed by economic supply and demand estimates.

From a policy theory perspective, this paper is the only known study that measures market volatility in a particular commodity (cotton) futures market in response to major shifts in regulatory policy. Future research should employ other major agricultural markets (grains and oilseeds) as well as government agricultural policies (United States Farm Bills) in order to encompass a more collective effect government policy on market volatility. This research lays the foundation for future study related to changes in commodity futures price volatility over time. Further investigation could focus on policy theory that looks deeper into how policy monopolies and subsystems shape financial and commodity market regulatory policy. Vested interests are at work to steer financial and commodity regulatory policy in their favor.

Applied economic research has addressed the increased participation by speculators, but most research has only focused on one sector of the speculative element, index funds. There are many other elements of speculation besides index funds. As in energy market research (Medlock and Jaffe, 2009), contract volume and open interest (at any given time) do not coincide with world production and consumption numbers (within historical ranges). For the cotton futures market, the growth in non-regulated financial products is also likely to coincide with increased volumes, participation, and volatility. Stockpiling by governments has many industry participants concerned about the ramifications that unregulated monopolistic practices have on the market (McFerron, 2013, Plastina and Ding, 2011). The overall increase in speculative participation relative to the size of the futures market, the domestic cotton market in the United States and the global cotton market, need to be addressed. Most of the recent work has focused just on the 2007-2008 time period; a more longitudinal period of study should reveal more insight. Given the recent market volatility of 2010-2011, research that addressed the issue of causation, economic fundamentals of supply and demand versus increased speculative participation, should be revisited.

The ICE cotton futures market is the industry benchmark for price discovery; it is a function of infinite economic and technical variables. This study and others concentrate on futures markets; but the cash market (the actual cotton that is produced, delivered, and processed) directly affects the commercial trade, and ultimately consumers. When there is divergence between cash and futures markets, futures markets fulfill the needs of speculators and not commercial hedgers. Academics have not focused on this relationship, known as the "basis," because of the insufficient supply of data on cash cotton prices (futures market data is publically available). Where reliable cash data can be sourced, research should investigate the effect that the futures market has on the cash market during periods of sustained volatility.

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