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# Populists versus theorists: Futures markets and the volatility of prices ☆

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**Abstract**

In this paper, the divergence between popular and professional opinion on speculation in general and futures markets in particular is explored. Along the way, a synopsis of prevailing popular attitudes on futures markets is presented, and an outline of a formal model of futures markets and its implications for commodity price volatility are sketched. The heart of the analysis is drawn from the historical record on the establishment and prohibition of futures markets. Briefly, the results presented in this paper strongly suggest that futures markets were associated with—and most likely caused—lower commodity price volatility. The paper concludes with a discussion of potential sources of popular antagonism against futures markets.


*Keywords:* Futures markets; Commodity markets; Commodity price volatility; Speculation

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> "For as long as we fail to treat speculators the way they deserve—with a bullet in the head—we will not get anywhere at all."
> Vladimir Lenin[1]

> "For my part, I wish every one of them [speculators] had his devilish head shot off."
> Abraham Lincoln[2]

## 1. Introduction

Religious and social sentiments have generally aligned themselves strongly against the role of speculators, middlemen, and traders.[3] Only in relatively recent times has some of this stigma begun to wear off, yet popular resentment of such agents remains undeniably widespread. Of course, these same actors are celebrated in the lore of the economics profession. Smith, Walras, Keynes, and countless others have reserved a crucial role for them in the smooth functioning of capitalism. Broadly then, what this paper attempts to address is the role of the speculator in the market. Specifically, the relationship between futures markets, speculation, and commodity price volatility is explored. This particular example is undoubtedly salient: in few other areas do popular views and those of most economists more widely diverge.

The fundamental result of this paper is that futures markets are systematically associated with lower levels of commodity price volatility. The means for arriving at this result is a series of quasi-experiments with futures markets provided by history, namely their establishment as well as prohibition through time. In what follows, the paper provides a brief overview of popular perceptions on the issue of prices and futures markets, specifically in the context of the agrarian movement of the late nineteenth century United States. A model of markets with both storage and futures markets is presented and numerically analyzed. Next, the historical behavior of commodity price volatility is examined. The paper concludes with a brief discussion of the sources of popular antagonism against futures markets.

## 2. Prices and futures markets

Even before the rise of organized commodity exchanges, popular sentiment has, at best, been openly suspicious, but generally, openly hostile to the person of the speculator. Coming in between the producer and ultimate consumer, the role of the speculator—carrying with it sufficient price margins—has always been judged by physiocratic standards: productive of nothing, deserving of nothing. As Abba Lerner explains it, "the extraordinary usefulness of speculation…goes ill with the hostility which people who have to work for their living often develop against the mysterious gains that speculators make in offices while dealing in goods which they would not even recognize" (Lerner, 1944, p. 94).

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[1] Lenin (1964, p. 311).

[2] Quoted in Carpenter (1866, p. 84).

[3] For a representative—but by no means exhaustive—sample, cf. Aquinas (1988, p. 98), Aristotle (1988, p. 15), Luther (1955, p. 245), and Wasail al Shi'ah (p. 266).

This near-universal contempt has probably found no greater expression than that directed towards the various agents on commodity futures markets. Originating from the American Civil-War-era trade in gold, pork, and wheat, a wide range of futures markets began to be established in recognizable form in the immediate post-war period (Emery, 1898; Williams, 1982).[4] The images used to describe the trade on these markets as "an engine of wrong and oppression" (Committee on Agriculture, 1892, p. 322) perpetuated by "a den of speculators whose operations [were]...pernicious" (Hume, 1888, p. 21), and capable of introducing "gradual misery and ruin...upon all classes" (Smith, 1893; p. 3) are prevalent throughout the contemporary literature.

At times, such rhetoric was met with a virtual call to arms. In the late nineteenth century United States, the worsening lot of farmers in the face of adverse weather conditions and increasing domestic and international competition gave way to a period of agrarian unrest culminating in the short-lived Populist Party of the 1890s, the chief economic platforms of which were the establishment of a subtreasury commodity loan program and the outright prohibition of futures markets (Bakken, 1960; Cowing, 1965; Goodwin, 1976). Both of these were designed to ensure the "seasonal stabilization of cotton and grain prices and, as a concomitant, the elimination of unnecessary components of wholesale commodity prices" (Yohe, 1976, p. 573).

The opening salvo against futures came with the Cleburne Demands from the state convention of the Texas Alliance in 1886 which sought to "secure to our people freedom from onerous and shameful abuses" by "condemn[ing] the dealing in futures of all agricultural products...[and] mak[ing] speculation open to swift conviction" (Pollack, 1967; p. xxxiii). The upshot of this agitation was the near passage of the Hatch (or alternatively, Washburn) bill by Congress in 1892.[5] The Hatch bill had as its aim not the outright prohibition of futures contracts, but rather the imposition of a 10% flat-rate tax on all futures transactions in grains and cotton, effectively destroying the margin for speculators but preserving viable—albeit somewhat limited—hedging opportunities for farmers and manufacturers (Committee on Agriculture, 1892). Thus, its aim can be thought of as "throwing sand in the wheels" much like Tobin's (1978) proposed tax on international capital transfers. For all its support, the bill failed due to an issue of timing: passage would have predicated an extension of the 52nd Congress (Hicks, 1931).

On the whole, the charges leveled against futures markets centered on their supposed effects on commodity prices which were seen as the consequence of so-called "fictitious" or "wind dealing". These terms reflect the derogatory view of the chief feature of the newly emergent futures markets, namely—as one detractor bluntly put it—that they "enable[d] people to sell what they did not possess" (In "Responses to" Hooker, 1901, p. 617). As unnatural as this seemed to many, their distrust was only enhanced when the amount of

[4] Notable exceptions to this chronology include the development in the seventeenth century of both the Dutch grain and Japanese rice markets. However, the secondary literature suggests that these markets were informal and sporadic in nature (as in the Dutch case; cf. Barbour, 1966 and de Vries and van der Woude, 1997) or operated under tenuous—and sometimes outright bizarre—circumstances (as in the Japanese case; cf. Hamori et al., 2001; Schaede, 1989; Wakita, 2001), lending doubt to their comparability to modern futures markets.

[5] William H. Hatch was a representative from Missouri and chairman of the Committee on Agriculture responsible for the drafting of the bill. Likewise, William D. Washburn was a senator from Minnesota who sponsored the Hatch bill's counterpart in the upper house. Interestingly, this would be far from the last attempt made to limit, obstruct, or prohibit futures trading—Bakken (1960) counts at least 330 bills introduced to Congress between 1884 and 1953.

"wind wheat" annually traded in the United States surpassed the entire crop in 1872[6] and when it was realized that in the same year actual delivery took place in only 3% of futures trades (Cowing, 1965; Taylor, 1931). More often than not, these sentiments were expressed in nearly moralistic terms:

> All the investment of this capital, all this infinite labor, all the employment of these people throughout the United States...we employ all these people, and all we can offer, after a year, on the markets of the world is 10,000 bushels of wheat, and any young fellow in Chicago who can raise $250 can order his broker to sell as many bushels of wheat as we have grown at the cost of this infinite labor and investment of capital, and yet, so long as the $250 and the broker's lung power is good, they can continue to offer 10,000 bushels every minute in competition with the 10,000 bushels of wheat which we produce...The men who grow cotton or wheat suffer from such competition. It is a destructive competition. These people extend nothing for their product, they have no capital employed, neither do they labor. (Committee on Agriculture, 1892, pp. 14–15).

In a sense, this passage reflects the producer's preoccupation with untimely fluctuations in and consequent uncertainty about the prices of their products—fluctuations which, in this case, were purportedly generated by speculation in commodity markets. Of particular concern to opponents of futures markets at the time was the fear that a large number of short orders could precede harvests, heightening price volatility and forcing injurious terms of trade on farmers (Bemis, 1893; Hicks, 1931; Morgan, 1889). In this regard, the key is the degree to which futures markets affect the inter-seasonal volatility of commodity prices.

Of course, interested parties associated with the trade as well as a number of economists have always been quick to counter these charges.[7] Most of these rejoinders tend to view reservations about "fictitious dealing" as understandable, but nonetheless naïve. This stems from the inviolable law of the futures market that offers to sell short must be counterbalanced by offers to go long, i.e., the value of contracts agreed to by sellers of futures expecting prices to fall must equal the value of contracts agreed to by buyers of futures expecting prices to rise.[8] Thus, the volume of trading is, in a sense, irrelevant as all outcomes should be congruent with the initial equilibrium in the absence of asymmetric information. It is only with the revelation of information through time or individuals with access to superior information which will alter the initial equilibrium—a condition not dependent on the operation of futures markets.[9]

[6] Within the decade, it amounted to nearly 10 times annual production (Hoffman, 1941).

[7] A notable example of the contrarian view of economists is seen in the United States Grain Futures Act of 1922 which sought to impose government standards on the grading, discounting, and contracting of futures in grain markets. Soon after, the Act was challenged and "affidavits were filed by 22 nationally known economists, each of whom declared his belief that, with infrequent and minor exceptions, futures trading had a marked tendency to stabilize prices" (Baer and Saxon, 1949, p. 69). The most prominent among these 22 were John Bates Clark, Irving Fisher, Wesley Clark Mitchell, Abbot Payton Usher, and Allyn Young.

[8] That is, the "bears" of a market could not push prices down indefinitely. This has been a long-standing source of confusion: as one apocryphal story has it, bears on the Chicago onions futures market in the 1950s were responsible for "negative" prices. That is, farmers had to pay dealers to dispose of their stocks, who then promptly dumped carloads of onions and sold the burlap sacks the onions came in.

[9] For a formal proof of this statement, see Kawai, 1983.

With respect to the level of prices, a number of studies affirm the role of futures markets in narrowing the margin between the wholesale prices paid to farmers and the retail prices paid by consumers (cf. Bowen, 1913; British Association, 1900; Larson, 1926; Report of the Commissioner, 1909; Rothstein, 1960; and Working, 1931). What is more, the various detractors of futures markets were rarely consistent in their stories: in the 1890s, the annual meeting of the National Association of Farmers passed a resolution "condemning future [sic] trading in wheat on the grounds that [it] lowered the price of wheat...Three weeks after this meeting, 500 members of the National Association of American Millers...passed a resolution condemning future [sic] trading on the grounds that it raised the price of wheat." (Boyle, 1921, p. 125).[10] The issue, then, that this paper will address centers on the relationship between the operation of futures markets and the volatility of commodity prices.

This is not to say that the issue of commodity price volatility is a secondary issue for producers. It was a prominent theme in the literature surrounding the agrarian unrest of the United States, as farmers saw moneyed interests "juggl[ing] quotations" and creating and "tak[ing] advantage of fluctuations" (Buck, 1913, pp. 8, 17). Additionally, the welfare losses associated with commodity price volatility have—both to contemporaries of the Populist movement (Emerick, 1896; Lloyd, 1894) and later economists (Massell, 1969, 1970; McKinnon, 1967)—long been known to be sizeable due to the effects on output decisions and, thus, incomes.

## 3. Expectations, futures markets, and commodity price volatility

As has been amply demonstrated before, hedging activity via futures market is functionally equivalent to the storage of goods over a wide range of production and storage characteristics (Newbery and Stiglitz, 1981; Williams, 1986; Williams and Wright, 1991). The implications are, of course, straightforward. Futures markets can be responsible for lower price volatility in the absence of other aggravating factors. What remains less certain is how the introduction of pure speculation into a futures market affects the theoretical results regarding price volatility.

In what follows, an attempt will be made to illustrate the approach of theorists on the issue. Making liberal use of existing work on the subject,[11] predictions are presented on the volatility of commodity prices in the presence of speculative futures markets, modeled as a rational expectations equilibrium.[12] The reasons for this modeling choice are clear. One of the most authoritative experts on futures markets declares that "the perfect futures market [is] defined as one in which the market price would constitute at all times the best estimate that could be made, from currently available information, of what the price would be at the delivery date of the futures contracts." Consequently, realized "futures prices are *reliably* anticipatory" as "they represent close approximations to the best possible current

[10] Baer and Saxon (1949, p. x) likewise note that "at the peak of every inflationary spiral, the Exchanges and speculative operations thereon are blamed for high prices. At the bottom of every deflationary period, they are charged with the responsibility for low prices."

[11] Particularly Nerlove (1958) and Turnovsky (1979, 1983).

[12] In an earlier version of this paper, the absence of futures markets is modeled as an adaptive expectations equilibrium with storage and then compared to the rational expectations equilibrium with storage and a futures market. This exercise yields the prediction that futures markets will be even more strongly associated with lower commodity price volatility.

appraisals of prospects for the future" (Working, 1962, pp. 446–447, italics in original).[13] This, of course, almost exactly corresponds to the definition of rational expectations as given in Muth (1961). Additionally, the assumption of rational expectations in futures markets has been validated in the related empirical literature (cf. Newbold et al., 1999a,b; Stein, 1992).

### 3.1. A Rational Expectations Model (with storage and a futures market)

Consider the system of equations below:

$$D_t = A - aP_t + u_t, \tag{1}$$

$$S_t = \mu[B + bP^f_{t,t-1}] + (1-\mu)[B + (1-\tau)bP^*_{t,t-1}] + v_t, \quad 0 \leqslant \mu \leqslant 1,\ \ 0 \leqslant \tau \leqslant 1, \tag{2}$$

$$I_t = \alpha[P^*_{t+1,t} - P_t], \tag{3}$$

$$P^*_{t,t-1} = P^f_{t,t-1} = E_{t-1}(P_t|\Omega_{t-1}), \tag{4}$$

$$D_t + I_t = S_t + I_{t-1}, \tag{5}$$

where $D_t$ is demand in time $t$, $S_t$ is production in time $t$, $I_t$ is the change in inventory between time $t$ and $t+1$, $P_t$ is the price in time $t$, $P^*_{t,t-1}$ is the expected price in time $t$ formed in time $t-1$, $(a, b, \gamma, \text{alpha})$ are constants, $E(u_t) = E(v_t) = 0$, $E(u_t^2) = \sigma_u^2$, $E(v_t^2) = \sigma_v^2$, and $E(u_t v_t) = 0$. The intuitive basis of this system is quite straightforward: current demand depends on price, supply depends on the previous period's rational-expectations forecast of price in time $t$contingent upon the information set $(\Omega)$ at time $t-1$, inventories rise with expected price differentials, markets must clear by equating current demand and inventory holdings with supply and the previous period's inventory, and supply and demand shocks are random and independently distributed with finite variances. Additionally, producers have the ability to market a portion of their future output $(\mu)$ at a price of $P^f_{t,t-1}$ in time $t-1$ for delivery in time $t$, but they face a proportional transaction cost of $\tau$. Also of note is the fact that the model makes no assumptions on who holds inventories or who engages in futures contracts. Thus, we can as easily think of these functions being taken up by a separate group of speculators as the producers and consumers of the model, i.e., pure speculation is implicitly captured in the model.

Substituting terms in the market clearing condition as well as defining an average long-run price as

$$\bar{P} = \frac{A - B}{a + b} \tag{6}$$

and the deviation of the current price from the long-run price as

[13] For earlier formulations of this view, see Working (1949, 1958).

$$p_t = P_t - \bar{P}. \tag{7}$$

We arrive at the following expression for the behavior of spot prices in terms of conditional expectations:

$$-ap_t + \alpha[E_t(p_{t+1}|\Omega_t) - p_t] + u_t = b(1-\tau+\tau\mu)E_{t-1}(p_t|\Omega_{t-1}) + \alpha[E_{t-1}(p_t|\Omega_{t-1}) - p_{t-1}] + v_t, \tag{8}$$

which, after taking conditional expectations at time $t-1$, becomes

$$\alpha E_{t-1}(p_{t+1}|\Omega_{t-1}) - [2\alpha + a + b(1-\tau+\tau\mu)]E_{t-1}(p_t|\Omega_{t-1}) + \alpha p_{t-1} = 0. \tag{9}$$

From this expression, it can be shown that the asymptotic variance of spot prices in the rational expectations case is equal to

$$\sigma_r^2 = \frac{2\alpha^2\sigma_e^2}{-[\beta^2 + 2\alpha\beta]\theta^2 + [2\alpha^2(a+\beta) + 2\alpha\ \beta(a+2\beta) + \beta^2(a+\beta)]\theta}, \tag{10}$$

where $e_t = u_t - v_t$, $E(e_t) = 0$, and $E(e_t^2) = \sigma_e^2 = \sigma_u^2 + \sigma_v^2$ as before and $\beta = \mathrm{b}(1-\tau+\tau\mu)$ and $\theta = [(\mathrm{a}+\beta)^2 + 4\alpha(\mathrm{a}+\beta)]^{1/2}$.

In this case, increased storage ($\alpha$) as well as an increased response by demand to the current price ($a$) reduces long-run price variance, and an increased response by supply to the expected price ($b$) has ambiguous results. Finally, the long-run price variance is increasing in the proportional transaction cost ($\tau$).

### *3.2. Price volatility in the absence and presence of futures markets*

In the preceding, allowing $\mu$ to equal zero is equivalent to assuming that no futures market exists. Thus, even under the assumption that rational expectations are in effect both before *and* after the introduction of futures, we will observe higher volatility in the no-futures-market equilibrium.

This can be demonstrated by simple numerical analysis which reveals that for all possible combinations on the following ranges of the parameter values, ($0 \leqslant a \leqslant 10$, $0 \leqslant \alpha \leqslant 2$) and ($0 \leqslant b \leqslant 10$, $0 \leqslant \mu \leqslant 1$, $0 \leqslant \tau \leqslant 1$ *or equivalently*, $0 \leqslant \beta \leqslant 10$), Eq. (10) is strictly decreasing in the portion of future output ($\mu$). Thus, the model implies that price volatility should always be less with futures markets than without. This result is equally driven by the $\mu$ term's interaction with the supply and inventory decisions of agents.

Thus, existing models of futures markets do provide some insight on the behavior of commodity price volatility. However, theory is not unambiguous in its predictions about the effect of futures markets on commodity market volatility. More precisely, it does not necessarily provide answers to the following questions: What are reasonable values for all of the model's parameters? Will the results be invariant to the type of commodity considered? And most importantly, will the parameter values themselves remain constant before *and* after the introduction of futures markets? Lacking conclusive answers to these questions, in the next section, we can instead turn to history for instructive case studies. Specifically, the focus will be on the behavior of prices across a wide range of commodities and periods to see if the predictions of the model on price volatility under the two regimes hold up.

## 4. The historical behavior of prices and futures markets

The task at hand is to determine what, if any, effect did futures markets have on the historical behavior of prices.[14] The remainder of the paper considers quasi-experiments with the establishment and prohibition of futures markets through time using a common analytical framework: first, the general level of volatility with and without futures markets is determined; second, standard empirical work on the subject (cf. Hieronymus, 1960; Naik, 1970; and Powers, 1970) outlines two elements of volatility—seasonal and intra-seasonal (e.g., month-to-month) variation—which allows for a rough decomposition of the changes in volatility; finally, an attempt is made to identify the time horizon over which futures market acted.

The criteria used to determine the effect of futures markets on price behavior—in conjunction with standard tests of statistical significance—are the following:

(I) $\sigma_s/\mu_s$, i.e., the coefficient of variation (simply the standard deviation of a sample divided by its mean) of logged spot prices to capture the general volatility effect.

(II) $\frac{\sum_{t=2}^{n} abs(\log(P_t) - \log(P_{t-1}))}{n}$, i.e., the average of the absolute value of the period-to-period change to capture intra-seasonal variation.

(III) $\frac{L(\beta_1, \beta_2, \sigma^2)}{L(\beta, \sigma^2)} = \frac{\exp\left\{-\frac{1}{2\sigma^2}\left[\sum_{t=1}^{T_1}(y_t - x_t'\beta_1)^2 + \sum_{t=T_1+1}^{T_2}(y_t - x_t'\beta_2)^2\right]\right\}}{\exp\left\{-\frac{1}{2\sigma^2}\sum_{t=1}^{T}(y_t - x_t'\beta)^2\right\}}$, i.e., a likelihood ratio test on the existence of a structural break in the deterministic components of prices to capture seasonal variation. More specifically, $k$th-order Fourier approximations of the unknown seasonal functions are estimated in the absence and presence of futures markets with the following regression equation:

$$\log(P_{it}) = \alpha + \sum_{j=1}^{k}[\theta_j \cos(2\pi j m_t/12) + \phi_j \sin(2\pi j m_t/12)] + e_{it}, \tag{11}$$

where $P_{it}$ is the $i$th observation in month $t$, $m_t$ is the month of the year, and $k$ is set to two or four, depending on whether prices are observed monthly or daily, respectively. The residuals from estimating (20) in the absence and presence of futures markets are then compared to the residuals over the entire sample. Thus, the third criteria allows one to test whether there is any dampening (exacerbation) of seasonal fluctuations in commodity prices from the time of the establishment (prohibition) of a particular futures market. This last test is, then, is an important piece of evidence in light of the discussion above as it is precisely the seasonal breaks in commodity prices—especially around harvest times for crops—which have generally been identified as the most damaging to primary producers.

[14] All commodity price data as well as their sources can be found at http://www.sfu.ca/~djacks/data/data.html.

### 4.1. The establishment of future markets, 1859–1985

The first set of markets considered are those for which we can match the initial establishment of futures markets with relevant commodity price data.[15] To give the reader some sense of the underlying behavior of prices, Panels A through D of Fig. 1 show the corresponding monthly time-series before and after the establishment of futures markets—demarcated by the solid vertical line—with all price indices taking a value of 100 at the time that futures trading begins.

Summary statistics based on the three criteria outlined above are presented in Table 1. One can clearly see that there were discernible general volatility effects associated with the establishment of future markets in almost all of the sixteen different commodities, especially in the medium- to long-term, i.e., over 3- and 5-year horizons. More importantly, the results demonstrate that for all sixteen commodities futures markets were associated with a considerable and significant dampening of seasonal effects. On the face of it, then, the results seem to favor the interpretation that futures markets do generally reduce commodity price volatility.

Of course, this type of exercise comes with a caveat: other factors might be expected to have contributed to or be responsible for these changes in price volatility. It can be argued that since the "control" period without futures markets is followed by the "treatment" with futures markets, other time-varying factors could be responsible for the diminishment of commodity price volatility, e.g., improvements in communication technology. This has been a common weakness identified throughout the literature (cf. Chapman and Knoop, 1904, 1906; and Tomek, 1971).[16] To get around this shortcoming, two further policy experiments are explored below, one in which futures markets are switched "off" and one in which futures markets are switched "off" and then back "on". The argument here is that developments in the legislation surrounding futures market is likely to be orthogonal to developments in the general commercial and technological context in which futures markets are imbedded. In other words, it seems reasonable to expect that periods when futures markets are prohibited are not periods of commercial or technological regress.

### 4.2. The prohibition of the Chicago onion futures market, 1958

After extensive testimony and debate, the United States Congress in the fall of 1958 passed Public Law 85–839, otherwise known as the Onions Futures Act.[17] The intent of the Senate Committee on Agriculture and Forestry was clear: given "that speculative activity in the futures markets causes such severe and unwarranted fluctuations in the price

[15] The main sources for the dates of the establishment of futures markets were Baer and Saxon (1949), Duncan (1992), Gold (1975), Hoffman (1932), and Roberts (1985).

[16] One of the best examples of this problem is Boyle (1922) in which the author argues on the basis of a wealth of price data (100,000+ observations) that the establishment of the Chicago Board of Trade (CBOT) futures market was responsible for the marked decrease in price volatility between 1841 and 1921—a time of obvious commercial and technological improvement quite apart from futures markets. More sophisticated "before and after" analysis on the Chicago grain trade does, however, support the contention that the CBOT futures markets reduced commodity price volatility; cf. Netz (1995) and Santos (2002).

[17] The law was "effective, in practice, on 10 November 1959, when a US District Court held the act constitutional and dissolved an injunction that had restrained prior enforcement of the act." Quoted in Working (1960, p. 3). While no appeal was forthcoming, it is an open question to what extent behavior on the futures market was altered between passage and enforcement.

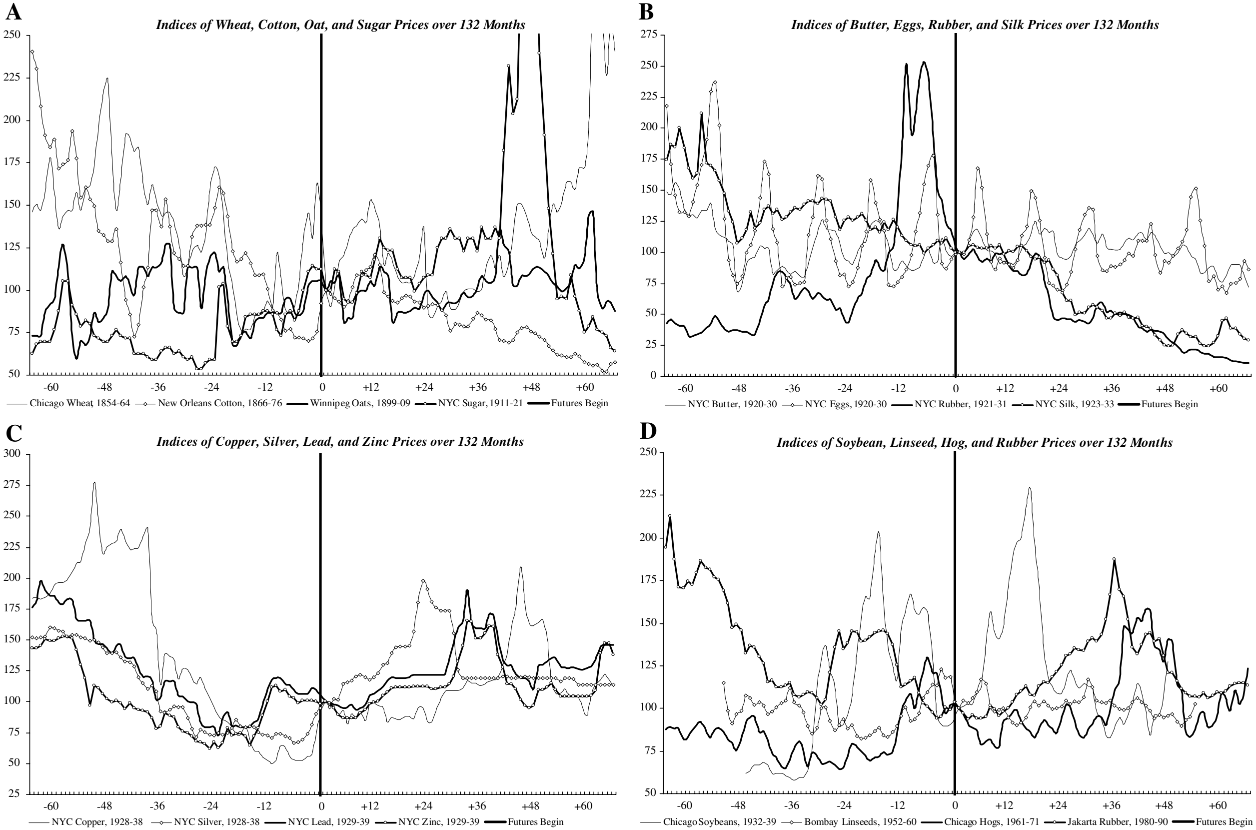


Fig. 1. Indices of commodity prices and the introduction of futures markets.

Table 1
Price volatility in 16 markets before and after the establishment of futures markets

| | 5 YEARS | | 3 YEARS | | 1 YEAR | |
|---|---|---|---|---|---|---|
| **CHICAGO WHEAT, 1854-64 (monthly)** | *Without futures* | *With futures* | *Without futures* | *With futures* | *Without futures* | *With futures* |
| I. Coefficient of variation | 0.0591 | 0.0644 | **0.0577** | **0.0361** | **0.0549** | **0.0337** |
| II. Average monthly change | **0.0895** | **0.0779** | **0.0935** | **0.0770** | **0.1036** | **0.0850** |
| III. Likelihood ratio test (all years, k=2) | | | **2.3335** | | | |
| **NEW ORLEANS COTTON, 1866-76 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0977** | **0.0772** | **0.0837** | **0.0454** | **0.0662** | **0.0292** |
| II. Average monthly change | **0.0682** | **0.0331** | **0.0655** | **0.0350** | **0.0497** | **0.0426** |
| III. Likelihood ratio test (all years, k=2) | | | **3.9567** | | | |
| **WINNIPEG OATS, 1899-1909 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0528** | **0.0343** | **0.0486** | **0.0322** | *0.0318* | *0.0320* |
| II. Average monthly change | **0.0815** | **0.0553** | **0.0708** | **0.0530** | *0.0383* | *0.0693* |
| III. Likelihood ratio test (all years, k=2) | | | **2.1724** | | | |
| **NYC SUGAR, 1911-21 (monthly)** | | | | | | |
| I. Coefficient of variation | *0.1361* | *0.1938* | **0.1563** | **0.0882** | **0.0826** | **0.0580** |
| II. Average monthly change | *0.0597* | *0.0732* | **0.0607** | **0.0429** | *0.0524* | *0.0571* |
| III. Likelihood ratio test (all years, k=2) | | | **3.6360** | | | |
| **NYC BUTTER, 1920-30 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0487** | **0.0325** | **0.0366** | **0.0229** | **0.0295** | **0.0262** |
| II. Average monthly change | **0.0666** | **0.0473** | **0.0665** | **0.0451** | **0.0665** | **0.0461** |
| III. Likelihood ratio test (all years, k=2) | | | **2.1252** | | | |
| **NYC EGGS, 1920-30 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0902** | **0.0634** | **0.0778** | **0.0618** | **0.0797** | **0.0587** |
| II. Average monthly change | **0.1391** | **0.1015** | **0.1392** | **0.0991** | **0.1328** | **0.1100** |
| III. Likelihood ratio test (all years, k=2) | | | **2.4587** | | | |
| **NYC RUBBER, 1921-31 (monthly)** | | | | | | |
| I. Coefficient of variation | *0.1740* | *0.2371* | **0.1365** | **0.1035** | **0.0913** | **0.0195** |
| II. Average monthly change | **0.1022** | **0.0630** | **0.1135** | **0.0616** | **0.1427** | **0.0452** |
| III. Likelihood ratio test (all years, k=2) | | | **2.3668** | | | |
| **NYC SILK, 1923-33 (monthly)** | | | | | | |
| I. Coefficient of variation | *0.0962* | *0.5120* | *0.0619* | *0.2662* | **0.0426** | **0.0206** |
| II. Average monthly change | *0.0510* | *0.0678* | *0.0359* | *0.0478* | **0.0408** | **0.0234** |
| III. Likelihood ratio test (all years, k=2) | | | **5.5591** | | | |
| **NYC COPPER, 1928-38 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.2099** | **0.0860** | **0.1909** | **0.0558** | **0.0852** | **0.0279** |
| II. Average monthly change | **0.0651** | **0.0564** | **0.0811** | **0.0456** | **0.0857** | **0.0591** |
| III. Likelihood ratio test (all years, k=2) | | | **2.7353** | | | |
| **NYC SILVER, 1928-38 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0853** | **0.0415** | *0.0455* | *0.0479* | *0.0278* | *0.0317* |
| II. Average monthly change | **0.0331** | **0.0238** | **0.0440** | **0.0342** | **0.0366** | **0.0329** |
| III. Likelihood ratio test (all years, k=2) | | | **2.4190** | | | |
| **NYC LEAD, 1929-39 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.1852** | **0.1051** | *0.1195* | *0.1279* | **0.1002** | **0.0655** |
| II. Average monthly change | **0.0387** | **0.0307** | **0.0450** | **0.0341** | **0.0342** | **0.0241** |
| III. Likelihood ratio test (all years, k=2) | | | **6.0309** | | | |
| **NYC ZINC, 1929-39 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.1719** | **0.1017** | **0.1306** | **0.1139** | **0.1110** | **0.0598** |
| II. Average monthly change | **0.0480** | **0.0341** | **0.0504** | **0.0323** | **0.0498** | **0.0236** |
| III. Likelihood ratio test (all years, k=2) | | | **3.3138** | | | |
| **CHICAGO SOYBEANS, 1932-9 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0907** | **0.0589** | **0.0714** | **0.0607** | **0.0596** | **0.0431** |
| II. Average monthly change | **0.0856** | **0.0732** | **0.1043** | **0.0680** | **0.0722** | **0.0670** |
| III. Likelihood ratio test (all years, k=2) | | | **1.3403** | | | |
| **BOMBAY LINSEED, 1952-60 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0261** | **0.0148** | **0.0304** | **0.0157** | **0.0313** | **0.0181** |
| II. Average monthly change | **0.0456** | **0.0303** | **0.0418** | **0.0329** | **0.0456** | **0.0381** |
| III. Likelihood ratio test (all years, k=2) | | | **2.5052** | | | |
| **CHICAGO LIVE HOGS, 1961-71 (monthly)** | | | | | | |
| I. Coefficient of variation | 0.0637 | 0.0674 | **0.0783** | **0.0638** | **0.0660** | **0.0309** |
| II. Average monthly change | 0.0525 | 0.0598 | **0.0580** | **0.0514** | **0.0642** | **0.0433** |
| III. Likelihood ratio test (all years, k=2) | | | **2.4375** | | | |
| **JAKARTA RUBBER, 1980-90 (monthly)** | | | | | | |
| I. Coefficient of variation | **0.0545** | **0.0433** | *0.0380* | *0.0503* | **0.0406** | **0.0166** |
| II. Average monthly change | **0.0384** | **0.0307** | *0.0355* | *0.0358* | **0.0373** | **0.0276** |
| III. Likelihood ratio test (all years, k=2) | | | **2.2213** | | | |
| **Significant at the 10% level** | **Significant at the 5% level** | | **Significant at the 1% level** | | **Significant at the .1% level** | |

Note: Figures in bold are those consistent with the hypothesis of dampened price volatility in the presence of futures markets; significance for criteria I–II refers to *t*-tests on differences in means; significance for criterion III refers to an *F*-test for pooled and non-pooled estimates.

Table 2
Price volatility in the Chicago onion market before and after the prohibition of futures markets

| | 5 YEARS | | 3 YEARS | | 1 YEAR | |
|---|---|---|---|---|---|---|
| CHICAGO ONIONS, 1953-63 (monthly) | With futures | Without futures | With futures | Without futures | With futures | Without futures |
| I. Coefficient of variation | *0.0978* | *0.0691* | *0.0770* | *0.0708* | **0.0631** | **0.1027** |
| II. Average monthly change | **0.1926** | **0.1996** | **0.1883** | **0.1942** | **0.1633** | **0.2543** |
| III. Likelihood ratio test (all years, k=2) | | | 3.8744 | | | |

**Significant at the 10% level** **Significant at the .1% level**

Note: Figures in bold are those consistent with the hypothesis of dampened price volatility in the presence of futures markets; significance for criteria I–II refers to $t$-tests on differences in means; significance for criterion III refers to an $F$-test for pooled and non-pooled estimates.

of cash onions...[a] complete prohibition of onion futures trading in order to assure the orderly flow of onions in interstate commerce" was enacted (United States Congress, 1958, p. 1). Beyond its admittedly obscure nature, this law is significant in that it marks the first and only time in the history of the United States that futures trading in any commodity was banned.

Much of the impetus to the bill's passage could be explained by a basic lack of knowledge on the workings of the fresh onion market.[18] The ability to store crops from year to year is for all practical purposes nonexistent. This condition gives way to a natural and sometimes large adjustment in price as the harvest approaches—allowing new information to be processed by market participants—and existing inventories are changed. The finding that there was appreciable price volatility in this particular case should have come as no surprise (Commodity Exchange Authority, 1957). But as one noted commentator on the proceedings observed, "it seems clear that futures trading in onions was prohibited simply because too few members of Congress believed that the onion futures market was, on balance, economically useful" (Working, 1963, p. 16).

Previous work on the topic of price behavior before and after the passage of the Onions Futures Act has lent support to both sides—some finding an aggravation of onion spot prices after passage (Gray, 1963) and some finding no effect at all (Economic Research Service, 1973). As Table 2 shows, there is reason to believe that futures markets were again associated with lower levels of price volatility. Although the coefficient of variation only weakly corroborates this interpretation, the other two tests provide strong support. Moreover, the coefficient of variation may be unduly affected by the massive increase in the average price of onions over the period from $1.30 to nearly $2.50 per 50 pound sack, clearly seen in Fig. 2. Another aggravating factor in the statistics for the 5-year horizon has been identified by earlier researchers: the aftermath of the Korean War and the accompanying drop in war-time procurements by the Department of Defense. Making due allowance for these concerns, it seems that the combined evidence on the average monthly movement of prices—which, of course, makes no recourse to the highly variable figures for average price—and the likelihood-ratio test—which is also significant given the highly seasonal nature of the onions market—is in accord with the interpretation of dampening effects of futures markets on commodity price volatility.

[18] We might note as well the enthusiastic support of a junior representative from Michigan, one Gerald R. Ford, hoping to appease globe-onion growing constituents.

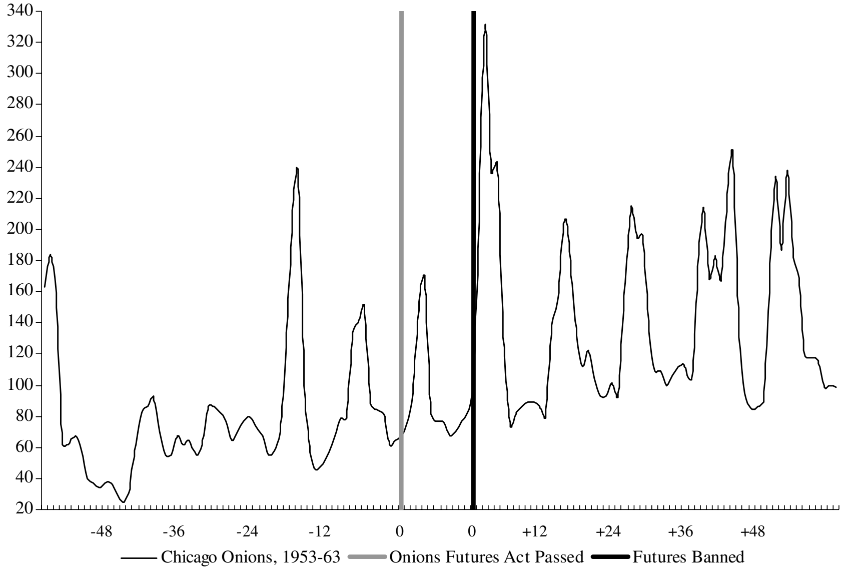


Fig. 2. Index of onion prices over 132 months.

### *4.3. The prohibition and rehabilitation of the Berlin wheat futures market, 1897–1900*

In the wake of a disastrous harvest in 1891 at home and Russia, grain consumers in the German Reich suffered an increase in both the level and volatility of prices. Public agitation against speculative ventures on the Bourse was met with open arms, given the dominance of landed, i.e., Agrarian, interests in the Reichstag at the time (Lexis, 1897).

An Imperial Commission was established late in the year to investigate the workings and effects of the various mercantile, produce, and stock exchanges of the land. Hearings and debate were closed in November, 1893, and a bill based on the Commission's Report appeared in the Reichstag in December, 1895, which was passed in June, 1896 (Emery, 1898). The Exchange Act of 1896 treated the Berlin Produce Exchange in particularly severe fashion. From January 1, 1897, the Produce Exchange was forced to incorporate representatives of agricultural and milling interests into its executive committees, the publication of contract future and spot prices was prohibited, and dealing in grain futures was banned outright (Flux, 1900).

As a result, purely speculative transactions fell into insignificance (United States Department of State, 1900; Hooker, 1901). The consequences were disastrous: "Through its important and direct connection with the provinces and foreign countries, Berlin was formerly one of the most influential markets of Europe, but [after] the law against grain futures went into force, it dropped to the rank of a small provincial market" (United States Department of State, 1900, p. 6). With time, it became apparent that the Exchange Act constituted "a drastic and radical piece of class legislation" (United States Department of State, 1900, p. 4) with the aim of forwarding the interests of the Agrarians alone in "breaking the powerful influence [of] the Produce Exchange" (Quoted in Reports from the Canadian Government (1904, p. 24)). It also became apparent that it had seemingly failed to accomplish its most touted benefit, the stabilization of commodity prices. With a changing political composition of the Reichstag and growing hostility to Agrarian

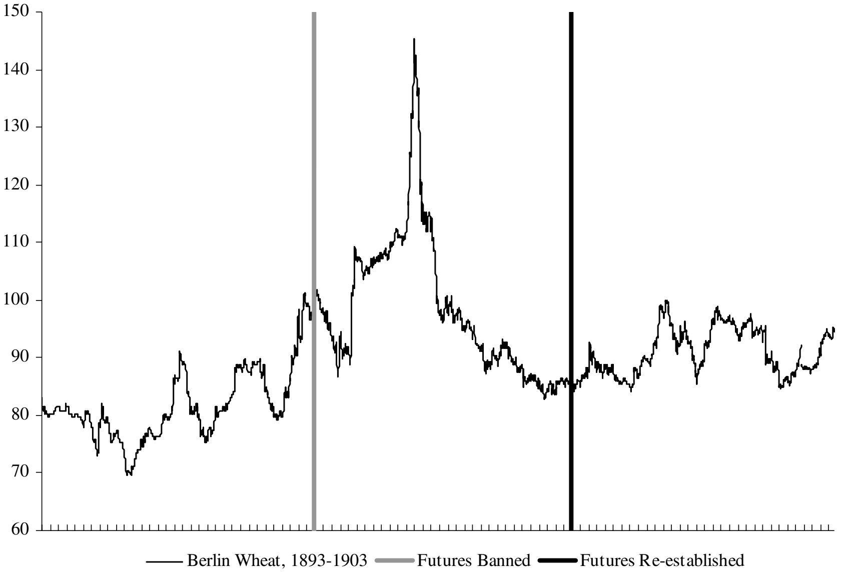


Fig. 3. Index of wheat prices over 4015 days.

interests, the Exchange Act was rescinded early in 1900. In April of that year, the Berlin futures market in grain was reopened.

Having traced this particularly interesting experiment with futures markets, a return to the question at hand is in order, namely what was the response of prices to changes in the organization of futures markets. As before, the time-series behavior of prices is analyzed over varying horizons—this time over 3- and 1-year windows—but with higher frequency (daily) data, allowing for greater power in the statistical tests on commodity price volatility.[19]

The time-series behavior of prices is depicted in Fig. 3. It should be borne in mind that the relevant comparisons should now be made between the middle and the outlying sections of the figure—whereas before, the comparison was always one half versus the other. As can clearly be seen, spot prices were much more volatile during the intermediate period with its lack of a functioning wheat futures market in Berlin. The statistics on wheat price volatility presented in Table 3 also confirm this view. On all accounts, futures markets were strongly associated with dampened commodity price volatility, regardless of the time horizon considered.

An even clearer picture of the effects of the German experience with futures markets emerges if we consider contemporaneous developments in international markets. In Table 4, price data from Liverpool and New York City—two cities linked to, but not having, prominent futures markets in wheat—suggests that the prohibition of futures markets in Berlin *raised* the volatility of wheat prices when the volatility of wheat prices was *declining* in world markets and that the rehabilitation of futures markets in Berlin *lowered* the volatility of wheat prices when the volatility of wheat prices was *increasing* in world markets. This asymmetry in the performance of the Berlin market vis-à-vis the world market,

[19] The use of a 1-year time horizon also allows us to fully separate out any noise arising from the Spanish–American War from April 1898 to March 1899.

Table 3
Price volatility in the Berlin wheat market before and after the prohibition of futures markets

| | | *Three-Year Horizon* | | |
|---|---|---|---|---|
| **BERLIN WHEAT, 1893-1903 (daily)** | *With futures (10/93-12/96)* | *Without futures (01/97-03/00)* | *With futures (04/00-06/03)* | |
| I. Coefficient of variation | 0.0150 | 0.0224 | 0.0087 | |
| II. Average monthly change | 0.0034 | 0.0052 | 0.0038 | |
| III. Likelihood ratio tests: | | | | |
| a.) k=2 | 2.4101 | | | |
| b.) k=4 | 2.4172 | | | |
| | | | *One-Year Horizon* | |
| | *With futures (01/96-12/96)* | *Without futures (01/97-12/97)* | *Without futures (04/99-03/00)* | *With futures (04/00-03/01)* |
| I. Coefficient of variation | 0.0129 | 0.0131 | 0.0058 | 0.0041 |
| II. Average monthly change | 0.0040 | 0.0049 | 0.0045 | 0.0037 |
| III. Likelihood ratio tests: | | | | |
| a.) k=2 | 8.4067 | | 2.2442 | |
| b.) k=4 | 10.5035 | | 2.3360 | |
| | **Significant at the 5% level** | **Significant at the 1% level** | **Significant at the .1% level** | |

Note: Figures in bold are those consistent with the hypothesis of dampened price volatility in the presence of futures markets; significance for criteria I–II refers to *t*-tests on differences in means; significance for criterion III refers to an *F*-test for pooled and non-pooled estimates.

Table 4
Wheat price volatility in international markets, 1896–1901 (coefficient of variation of logged daily prices)

| | From January 1896 to December 1896] | From January 1897 to December 1897 | From April 1899 to March 1900 | From April 1900 to March 1901 |
|---|---|---|---|---|
| Berlin | 0.01286 | 0.01308 | 0.00577 | 0.00412 |
| Liverpool | 0.02307 | 0.02244 | 0.00551 | 0.00565 |
| New York city | 0.02389 | 0.02085 | 0.00797 | 0.01044 |

Note. All differences in reported coefficients of variation (both across cities and time) are significant at least the 10% level.

thus, indirectly highlights the role played by futures markets in determining the volatility of prices and directly rebuts the Agrarians' claim that "since gambling in options and futures had been prohibited, corn prices in Germany were remarkably free from the fluctuations experienced in foreign markets gambling in options and futures" (Quoted in Reports from the Canadian Government (1904, p. 24)).[20]

Finally, the high frequency data for the Berlin market allows for a further and more powerful test of the effects of futures markets on commodity price volatility. Leaving some of the details for Appendix A, we can follow the lead of Kokoszka and Leipus (2000). Making the reasonable assumption that the behavior of commodity prices can be approximated by a generalized autoregressive conditional heteroskedastic (GARCH) data generating process (cf. Bollerslev et al., 1992; Deb et al., 1996), it is possible to calculate a change-point estimator which allows us to identify shifts in the underlying variance of commodity prices. The estimates of the change-points are reported in Table 5. The results are encouraging as the Kokoszka and Leipus test identifies seven statistically significant breaks in the variance of Berlin wheat prices. Of these, the four breaks with the highest

[20] It should also be noted that there was no change in German protectionism during the period from 1896 to 1901.

Table 5
Change points in wheat price volatility, 1893–1903

| Date | KL test value: | Notable developments: |
|---|---|---|
| April 20, 1895 | 1.4887 | |
| September 30, 1896 | 2.8265 | Exchange Act passed in June 1896; in effect from January 1, 1897 |
| June 18, 1897 | 2.2594 | |
| April 2, 1898 | 2.3182 | Spanish American War begins on April 20, 1898 |
| August 9, 1898 | 2.7211 | Spanish American Peace Protocol signed on August 12, 1898 |
| February 2, 1900 | 2.5662 | Exchange Act rescinded January 1900; futures traded from April 1900 |
| March 19, 1901 | 2.2725 | |

Note. Critical values for KT test are 1.22 for a 90% confidence level and 1.36 for a 95% confidence interval.

reported levels of statistical significance correspond in timing with either the events surrounding the Berlin Produce Exchange or with the Spanish–American War. Given that statistical significance in this case corresponds to the largest absolute changes in price volatility by construction, the results suggest that the volatility dampening effects of futures markets are, indeed, quite prevalent.

## 5. Conclusion

In considering the relationship of commodity futures markets and prices, this paper has tried to reconcile the divergence between popular and, roughly speaking, professional opinion on the perceived effects of futures markets on the level of commodity price volatility. Along the way, a rough—but reasonably representative—synopsis of prevailing popular attitudes on futures markets was considered, and an outline of a formal model of futures markets and its implications for commodity price volatility were sketched. The heart of the analysis was drawn from the historical record on the establishment and prohibition of futures markets. Bringing an explicitly empirical approach to the question, this paper allows for a few positive conclusions. At a minimum, there is no evidence for the claim that futures markets are associated with higher commodity price volatility. Indeed, the results presented in this paper strongly suggest the opposite: futures markets were associated with, and most likely caused, lower commodity price volatility.

So, if futures markets were not responsible for heightened commodity price volatility—as demonstrated in this study—or diminished prices to primary producers—as demonstrated by others, what explains popular opposition to their existence and operation? There are a few leads provided by the voluminous literature on agrarian discontent in the late 19 century United States. One view clearly implicates the producers themselves. Thus, North (1966) writes that "what was fundamentally at stake...[was that the farmer] found himself competing in a world market in which the fluctuations in price made no apparent sense to him" (p. 142). That is, producers were, in some sense, ignorant. Others are much more frank in their assessment:

> Not only were the farmers deficient in technical education, but as a class they lacked that knowledge of a more general nature which the best interest of their business demanded. They knew little of the conditions and prospects of the various crops throughout the country, and the probable future condition of the markets; they were

> ignorant of many of the usages of business; and the lack of knowledge of simple economic principles and their application to the politico-economic problems of the day made it difficult for them to reason intelligently in matters in which their own interest were at stake. (Buck, 1913, p. 38)

Certainly, this—coupled with indignation over the handsome profits generated by agents—could provide impetus to popular agitation against futures markets. What is less certain is how producers could remain ignorant of the benefits of futures markets—in terms of hedging and price discovery opportunities—for so long.

Another interpretation holds that "farmers were objecting to the *increasing importance of prices*; that they were protesting a system in which they had to *pay* for transport and money rather than the specific *prices* of transport and money" (Mayhew, 1972, p. 469, italics in original). In this view, ignorance on the part of producers plays little part. Instead, agrarian discontent was "a reaction to new, technologically superior inputs which replaced traditional inputs and which could be acquired *only* with money, and a reaction to the new need for cash to buy consumer goods which could not be supplied on-the-farm in the Plains area" (Mayhew, 1972, p. 469). This view has some intuitive appeal, yet there seems to be little sentiment to this effect from the contemporary populist literature. Furthermore, as Pashigian (1986, 1988) documents, some Midwest farmers continued the fight against futures markets well into the 1920s and 1930s. These later agitators may have been holdouts from days long gone. More likely, they were not and had formed their experiences and expectations of farming within a system of highly commercialized agriculture.

A more fruitful approach might be found in explaining opposition to futures markets in the context of the concentration of economic power. The ruinous economic effects of "monopoly" were central to almost all complaints in the populist literature. The anti-competitive behavior of "combinations" was seen as pressing on all margins of farm life, and nowhere could this more clearly be seen than in the operations of the futures markets where the bulls and bears conspired against the common man by exploiting—and of course, heightening—the volatility of commodity prices (cf. Martin, 1873; Morgan, 1889). Part of this misunderstanding about the effects of futures markets on commodity price volatility is probably explainable by the "monopoly" of information held by purchasing agents, who often pointed to volatile conditions in the futures markets in determining purchasing terms at the local level (Hicks, 1931; Peffer, 1891). Thus, Pashigian (1988) provides limited evidence that opposition to futures markets in Midwestern states in the 1920s was correlated with the prevalence of line elevators which may have been operating as local cartels. Merchants were also quick to point out that farmers—thanks to the telegraph, newspapers, and the radio—were now aware of more profitable decisions with respect to production, marketing, and storage on the basis of futures market prices (Baer and Saxon, 1949). From this vantage point, it may be possible to generalize from the experience of the United States and make the claim that the combination of a growing familiarity with futures markets coupled with better access to information on prevailing market conditions explains the how initial opposition to futures markets is moderated over time.

Empirically assessing the validity of this statement along with linking the effects of futures markets with the process of spatial market integration remain tasks for future research. An additional and more ambitious task will be in evaluating the full set of economic wrongs identified by the agrarian reformers of the late-nineteenth century.

## Appendix A. GARCH models and the Kokoszka and Leipus Test

Beginning with the work of Engle (1982) and especially Bollerslev (1986), the generalized autoregressive conditional heteroskedastic (GARCH) framework has proved to be an extremely robust approach to modeling the volatility of time series data. This success is mainly attributable to its recognition of the difference between unconditional and conditional variances and its incorporation of long memory in the data generating process and a flexible lag structure. In general, where $e_t$ is the $t$th error term from a regression model, the GARCH($p, q$) model assumes that the conditional variance equals

$$\sigma_t^2 = E(e_t^2|\Omega_t) = \alpha + \sum_{i=1}^{p} \gamma_i e_{t-i}^2 + \sum_{j=1}^{q} \delta_j \sigma_{t-j}^2. \tag{A.1}$$

Thus, the conditional variance depends on its own past values as well as lagged values of the residual term. Even in a very parsimonious GARCH(1, 1) specification, the time-series behavior of commodity prices is captured particularly well as noted by others (Deb et al., 1996).

The innovation introduced by Kokoszka and Leipus (2000) is a means for estimating the change point, $k*$, in the volatility of time series data which follows a GARCH process. Specifically, the estimator is constructed by calculating the series of cumulative sums for logged prices

$$C_k = \frac{k(n-k)}{n^2}\left(\frac{1}{k}\sum_{j=1}^{k}(\ln(P_j))^2 - \frac{1}{n-k}\sum_{j=k+1}^{n}(\ln(P_j))^2\right). \tag{A.2}$$

The Kokoszka and Leipus estimator of the change point is given by

$$\hat{k} = \min\left\{k : |C_k| = \max_{1\leqslant j\leqslant n} |C_j|\right\}. \tag{A.3}$$

The normalized test

$$\sup\{|C_k(k)|\}/\hat{\sigma} \tag{A.4}$$

is asymptotically distributed as a Kolmogorov–Smirnov process, where $\hat{\sigma}$ is an estimate of the long-run variance. The estimator conveniently allows for an iterative approach for identifying multiple breaks of indeterminate length in volatility. The general procedure is to begin with the full time series and determine the first break. This first break is then used to partition the series into two sub-series. The estimator is then calculated for the two sub-series, establishing the second and third break points which are in turn used to determine the fourth through seventh breaks, and so on. This splitting procedure is then stopped whenever a break proves to be statistically insignificant.

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