Populists v. Theorists: Futures Markets and the Volatility of Prices*

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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 the outlines of formal models of futures markets and their implications for commodity price volatility are sketched. The heart of the analysis is a series of "natural" experiments provided by history. Briefly, the results presented in this paper strongly suggest that futures markets were associated with, and most likely caused, lower commodity price volatility.

"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]

Introduction

Religious and social sentiments have generally aligned themselves strongly against the role of speculators, middlemen, and traders *writ large*.[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 agents 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 middleman in the market. Specifically, the relationship between futures markets, speculation, and commodity price volatility is explored. This particular example is undoubtedly salient: in probably no other area do popular views and those of most economists more widely diverge.

The fundamental result of this paper is that futures markets are systematically related with lower levels of commodity price volatility. The means for establishing this result is a series of "natural" experiments in the establishment and prohibition of futures markets through time. In what follows, the paper provides a brief overview of popular perceptions of the issue of prices and futures markets. Next, models of markets with storage and with both storage and futures

[1] Lenin, V.I. (1964), *Complete Collected Works, vol. 35*. Moscow, p. 311.
[2] Quoted in Carpenter, F. (1866), *Six Months at the White House with Abraham Lincoln*. New York: Hurd, 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).

markets are presented and numerically analyzed. Finally, the historical behavior of commodity price volatility is examined.

Prices and Futures Markets

Even before the rise of organized commodity exchanges, popular sentiment has always been, at best, openly suspicious and, generally, openly hostile to the person of the middleman. Coming in between the producer and ultimate consumer, the role of the middleman—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).

This near-universal opprobrium has probably found no greater expression than that directed towards the various operators on commodity futures markets. Originating from the Civil-War-era trade in grains, gold, and pork, futures markets began to be established in recognizable form in the immediate post-Civil War period (Emery, 1898; Williams, 1982).[4] The images used to describe the trade as "an engine of wrong and oppression" (Committee on Agriculture, 1892, p. 322) perpetuated by "a den of speculators whose operations are…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 on the subject.

[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; see 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.

At times, such rhetoric was met with a virtual call to arms. In the late nineteenth century United States, for instance, the worsening lot of farmers in the face of adverse weather conditions and increasing domestic and international competition gave way to the opening of the Granger Uprising in 1886, one of the chief platforms of which was the outright prohibition of futures markets (Bakken, 1960; Cowing, 1965). In typical populist fashion, the San Francisco Chronicle at the time called commodity speculation "a vicious occupation" and advocated forcing "gamblers to use counters other than wheat, the essential crop for so many farmers" (quoted in Cowing, 1965, p. 17).

The upshot of this agitation was the near passage of the Hatch (or alternatively, Washburn) bill in the Congress of 1892.[5] The Hatch bill had as its aim not the outright prohibition of futures contracts, but rather the imposition of a 10 percent flat-rate tax on all futures transactions in grains and cotton, effectively destroying the margin for speculators but preserving viable—albeit somewhat circumscribed—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.

On the whole, the charges leveled against futures markets centered on their supposed effects on both the level and variation of commodity prices and were seen as a natural 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 it "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

[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.

of "wind wheat" traded in the United States surpassed the annual crop in 1872[6] and when it was realized that actual delivery took place in only 3 percent 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, the raiser of cotton and the grower of tobacco…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).

Of particular concern to opponents of futures markets was the fear that a large number of short orders could precede harvests, heightening price volatility and forcing injurious terms of trade on farmers.

Of course, interested parties associated with the trade as well as a number of economists have always been quick to counter these conclusions.[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). 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

[6] Within the decade, it amounted to nearly ten 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 twenty-two 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). Most notable among these twenty-two were John Bates Clark, Irving Fisher, Wesley Clark Mitchell, Abbot Payton Usher, and Allyn Young.

information through time or individuals with access to superior information which will alter the initial equilibrium—a condition not unique to the operation of futures markets.[8]

With respect to the question of the level of prices, a number of *ex-post* studies affirm the role of futures markets in narrowing the margin between the price paid to farmers and the price paid by consumers (cf. British Association, 1900; Brown, 1913; 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).[9] The question, then, that this paper will address centers on the relationship between the operation of futures markets and the volatility of commodity prices.

Expectations, Futures Markets, and Commodity Price Volatility

As has been amply demonstrated before, it can be taken as given that 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; and 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

[8] For a formal proof of a like statement, see Kawai, 1983.
[9] 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."

less certain is how the introduction of pure speculators into the 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,[10] predictions are presented on the relative volatility of commodity prices in the absence of futures markets—modeled as an adaptive expectations equilibrium with storage—and in the presence of speculative futures markets—modeled as a rational expectations equilibrium. 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" because "they represent close approximations to the best possible current appraisals of prospects for the future" (Working, 1962, pp. 446-7, italics in original).[11] This, of course, almost exactly corresponds to the classic formulation of rational expectations as expounded in Muth (1961).

An Adaptive Expectations Model (with storage but no futures market)

Consider the system of equations below.

(1) $D_t = A - aP_t + u_t,\ \ a \geq 0,$

(2) $S_t = B + bP^*_{t,t-1} + v_t,\ \ b \geq 0,$

(3) $P^*_{t,t-1} - P^*_{t-1,t-2} = \gamma[P_{t-1} - P^*_{t-1,t-2}],\ \ 0 \leq \gamma \leq 1,$

[10] Particularly Nerlove, 1958; Turnovsky, 1979, 1983.
[11] For earlier formulations of this view, see Working, 1949, 1958.

(4) $I_t = \alpha[P^*_{t+1,t} - P_t], \ \ \alpha > 0,$

(5) $D_t + I_t = S_t + I_{t-1},$

where $D_t =$ demand in time *t*, $S_t =$ production in time *t*, $I_t =$ augmentation to inventory between time *t* and *t+1*, $P_t =$ price in time *t*, $P^*_{t,t-1} =$ expected price in time *t* formed in time *t-1*, $(a, \ b, \ \gamma, \ \alpha)$ 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 adaptive-expectations forecast of price, 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.

By substituting into the market clearing condition (5) and eliminating the expected price terms, we arrive at the following equation which describes the price dynamics of the system.

$$(6) \quad \begin{aligned} &\gamma A - a[P_t - (1-\gamma)P_{t-1}] + u_t - (1-\gamma)u_{t-1} + \alpha\gamma P_t - \alpha[P_t - (1-\gamma)P_{t-1}] = \\ &B\gamma + b\gamma P_{t-1} + v_t - (1-\gamma)v_{t-1} + \alpha\gamma P_{t-1} - \alpha[P_{t-1} - (1-\gamma)P_{t-2}]. \end{aligned}$$

The average long-run market clearing price can be defined as

$$(7) \quad \overline{P} = \frac{A-B}{a+b},$$

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

$$(8) \quad p_t = P_t - \overline{P}.$$

Rewriting (6) in deviation terms, we arrive at

$$(9) \quad p_t + \left[\frac{\gamma b - (a+2\alpha)(1-\gamma)}{a+\alpha(1-\gamma)}\right]p_{t-1} + \left[\frac{\alpha(1-\gamma)}{a+\alpha(1-\gamma)}\right]p_{t-2} = \frac{e_t - (1-\gamma)e_{t-1}}{a+\alpha(1-\gamma)}, \text{ where}$$

$e_t = u_t - v_t, \ \ E(e_t) = 0,$ and $E(e_t^2) = \sigma_e^2 = \sigma_u^2 + \sigma_v^2.$

Assuming $\gamma > 0$ and $a(2-\gamma) - \gamma b + 4\alpha(1-\gamma) > 0$ for stability in equilibrium, the finite asymptotic variance of spot prices in the adaptive expectations case is given by the following expression:

(10) $$\sigma_a^2 = \frac{\{\gamma[a + 2\alpha(1-\gamma)] + 2(a+b)(1-\gamma)\}\sigma_e^2}{a(a+b)[a(2-\gamma) - \gamma b + 4\alpha(1-\gamma)]}.$$

Thus, it can be shown that increased storage (α) as well as increased response by demand to price (a) reduces long-run price variance. Conversely, more responsive expectations (γ) raise long-run price variance while an increased response by supply to expected price (b) has ambiguous results.

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

In the specification that follows, futures contracts are assumed to take a particular form, namely producers enter a contract at the time of the production decision for future delivery once production has taken place. The model is summarized by the following set of equations.

(11) $D_t = A - aP_t + u_t,$

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

(13) $I_t = \alpha[P^*_{t+1,t} - P_t],$

(14) $P^*_{t,t-1} = P^f_{t,t-1} = E_{t-1}(P_t \mid \Omega_{t-1}),$

(15) $D_t + I_t = S_t + I_{t-1},$

where demand (11) and the market clearing condition (15) are as before and the term $E_{t-1}(P_t \mid \Omega_{t-1})$ in equations (14) represents the rational-expectations prediction of price in time *t* contingent upon the information set (Ω) at time *t-1*. The remaining equations, (12) and (13), incorporate the new rational-expectations price forecast into the inventory and production decisions as before. One notable alteration is that producers now can market a portion of their future output (μ) 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 τ. 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.

Following the example set above of substituting terms in the market clearing condition as well as defining an average long-run price (7) and deviations from average long-run price (8), we arrive at the following expression for the behavior of spot prices in terms of conditional expectations:

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

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

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

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

(18) $\sigma_r^2 = \dfrac{2\alpha^2\sigma_e^2}{-[\beta^2 + 2\alpha\beta]\theta^2 + [2\alpha^2(a+\beta) + 2\alpha\beta(a+2\beta) + \beta^2(a+\beta)]\theta}$, 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 $\beta = b(1-\tau+\tau\mu)$ and

$\theta = [(a+\beta)^2 + 4\alpha(a+\beta)]^{1/2}$.

Forming the ratio of spot price volatility under rational expectations (denoted with an *r*) and adaptive expectations (denoted with an *a*), we find that

(19) $\dfrac{\sigma_{p,r}^2}{\sigma_{p,a}^2} = \dfrac{\sigma_{p,r}^2}{\sigma_{p,a}^2}\left(a, \alpha, \beta(b, \mu, \tau), \gamma\right)$,

as the σ_e^2 terms cancel out if we assume identical shocks under the two models.

Numerical analysis of this ratio reveals that for all possible combinations on the following plausible ranges of the parameter values, $(0 \le a \le 10,\ 0 \le \alpha \le 2,\ .25 \le \gamma \le 1)$ and $(0 \le b \le 10,\ 0 \le \mu \le 1,\ 0 \le \tau \le 1\ \textit{or equivalently},\ 0 \le \beta \le 10)$, the ratio is less than unity, i.e. the models jointly imply that price volatility should be less with futures markets than without. It is only when γ, the adaptive expectations adjustment parameter, approaches zero that we see the ratio ever exceed one, as illustrated in Figures 1 through 3.[12]

Thus, existing models of futures markets do provide some insight and testable predictions on the behavior of commodity price volatility. However, what they do not necessarily provide are 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 will instead look at the evidence on the behavior of prices across a wide range of commodities and periods to see if the predictions of the model hold up.

[12] Beck (1976) uses a value of γ equal to .5 and α equal to 1.25 which, in turn, are based on the estimates of Nerlove (1958) and Working (1953). These values provide the set points used in Figures 1 through 3. Likewise, Duncan (1992) reports values for τ in the neighborhood of .025, implying that the value of the elasticity of supply (b) will be the deciding variable in β.

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. The remainder of the paper considers various "natural" experiments on this common theme. At all times, though, use is made of a general analytical framework: first, the level of volatility with and without futures markets is determined; second, standard empirical work on the subject (cf. Hieronymous, 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 are the following:

(I) $\frac{\sigma_s}{\mu_s}$, 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) $\frac{L(\beta_1, \beta_2, \sigma^2)}{L(\beta, \sigma^2)} = \frac{\exp\{-\frac{1}{2\sigma^2}[\sum_{t=1}^{T_1}(y_t - x_t^{'}\beta_1)^2 + \sum_{t=T_1+1}^{T_2}(y_t - x_t^{'}\beta_2)^2]\}}{\exp\{-\frac{1}{2\sigma^2}\sum_{t=1}^{T}(y_t - x_t^{'}\beta)^2\}}$, 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:

$$(20)\ \log(P_{it}) = \alpha + \sum_{j=1}^{k}[\theta_j \cos(2\pi j m_t/12) + \phi_j \sin(2\pi j m_t/12)] + e_{it},$$

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.

The Establishment of Future Markets, 1865-1985

The first set of markets considered are those for which we can match the initial establishment of futures markets with relevant commodity price data.[13] To give the reader some sense of the underlying behavior of prices, Figures 4 through 7 show the corresponding time-series before and after the establishment of futures markets (demarcated by the solid vertical line).

Summary statistics based on the three criteria outlined above are presented in Table 1 below. One can clearly see that there were discernible 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 three and five year horizons). More importantly, the results demonstrate that for all sixteen commodities considered futures markets were associated with a

[13] 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).

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 is somewhat unsatisfying. Other factors might be expected to have contributed to or be responsible for these changes in price volatility, especially given that futures markets are only observed at a *later* date than the control periods. This has been a common weakness identified throughout the literature (cf. Chapman and Knoop, 1904, 1906; and Tomek, 1971).[14] To supplement these exercises, 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 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.[15] 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 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

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[14] One of the best examples of this problem is Boyle, *Chicago Wheat Prices*, in which the author argues on the basis of an enormous 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 technological and commercial 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).

[15] The law was "effective, in practice, on 10 November 1959, when a U.S. 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.

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 onion market. The practice of carrying 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 below shows, there is reason to believe that futures markets were again associated with lower levels of price volatility. Even though one of the three statistics (namely, the coefficient of variation) only weakly corroborates this interpretation, one might note that this result is primarily generated from 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 Figure 8 below. Another aggravating factor in the statistics for the five-year horizon is one identified by earlier researchers: the aftermath of the Korean War and the accompanying drop in war-time procurements by the Department of Defense. After accounting 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.

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 both in 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 their executive committees, the publication of contract future and spot prices was prohibited, and the dealing in grain futures was banned outright (Flux, 1900).

As a result, purely speculative transactions fell into insignificance (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" (Department of State, 1900, p. 6). With time, it became apparent that the Exchange Act constituted "a drastic and radical piece of class legislation" with the aim of forwarding the interests of the Agrarians alone (*Ibid*, p. 4). It also became apparent that it had seemingly failed to accomplish its most touted benefits, the stabilization of commodity prices. With a changing political composition of the Reichstag and growing hostility to Agrarian interests, the Exchange Act was rescinded early in 1900. In April of that year, the futures market in grain was reopened in Berlin.

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 three- and one-year windows—but with more high frequency (daily) data, allowing for higher power in our tests on commodity price volatility.[16]

The time-series behavior of prices is depicted in Figure 9 below. 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). A casual glance seems to confirm the prevailing view on futures markets. Indeed, 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 suggests that the prohibition of futures markets in Berlin *raised* the volatility of wheat prices when the volatility of wheat prices was *declining* in

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

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, thus, indirectly highlights the role played by futures markets in determining the volatility of prices.[17]

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 II, 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 construct a change-point estimator which allows us to identify shifts in the underlying variance of commodity prices. The results of this exercise are reported in Table 5 and are encouraging. 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 reported levels of statistical significance correspond in timing with either the events surrounding the Berlin Produce Exchange or with the Spanish-American War, suggesting that the volatility dampening effects of futures markets are, indeed, quite strong.

Conclusion

In considering the relationship of commodity futures markets and prices, this paper has tried to reconcile a divergence between popular and, roughly speaking, professional opinion. This divergence is the perceived effects of futures markets on level of commodity price

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

volatility. Along the way, a rough—but representative—synopsis of prevailing popular attitudes on futures markets was considered, and the outlines of formal models of futures markets and their implications for commodity price volatility were sketched. The heart of the analysis was a series of "natural" experiments provided by history. Bringing an explicitly empirical approach to these experiments, 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. A task remaining for future research, of course, is to determine the exact mechanisms by which futures markets were able to affect this result, whether it be through heightened sensitivity in production or in storage.

APPENDIX I: COMMODITY PRICE SOURCES

Berlin, wheat, daily prices (marks per 1000 kg. of mittel-qualität domestic), 1893-1903: *Vierteljahrshefte zur Statistik des Deutschen Reichs*. Berlin: Verlag von Puttkammer & Mühlbrecht, various years.

Bombay, linseeds, monthly prices (constant rupees per 100 kg. of average quality domestic), 1952-1961: A.S. Naik, *Effects of Futures Trading on Prices*. Bombay: Somaiya, 1970.

Chicago, live hogs, monthly prices (dollars per head of heavy packers), 1961-1971: Global Financial Database.

Chicago, onions, monthly prices (cents per 50 pound sack of Michigan globes), 1953-1963: Chicago Mercantile Exchange Statistical Department, *Chicago Mercantile Exchange Year Book*. Chicago: Chicago Mercantile Exchange, various years.

Chicago, soybeans, monthly prices (dollars per bushel), 1932-1939: Commodity Research Bureau, *Commodity Yearbook*. Chicago: various years.

Chicago, wheat, monthly prices (cents per bushel), 1854-1864: NBER Macrohistory Database.

Jakarta, rubber, monthly prices (U.S. cents per pound of No. 1 smoked FOB Maylaysian/ Singapore sheets): IMF Primary Commodity Prices Database.

Liverpool, wheat, daily prices (marks per 1000 kg. of mittel-qualität), 1896-1901: *Vierteljahrshefte zur Statistik des Deutschen Reichs*. Berlin: Verlag von Puttkammer & Mühlbrecht, various years.

New Orleans, cotton, monthly prices (cents per pound of middling), 1866-76: *Report of the Commissioner of Corporations on Cotton Exchanges, Part IV: Effect of Future Contracts on Prices of Cotton*. Washington: Government Printing Office, 1909.

New York City, butter, monthly prices (cents per pound of salted, domestic), 1920-30: NBER Macrohistory Database.

New York City, copper, monthly prices (cents per pound of copper, electrolyte wire): Global Financial Database.

New York City, eggs, monthly prices (cents per fresh dozen), 1920-30: NBER Macrohistory Database.

New York City, lead, monthly prices (cents per pound of common grade, desilverized pig lead): NBER Macrohistory Database.

New York City, rubber, monthly prices (cents per pound of ribbed and smoked Para Island Plantation sheets), 1921-31: Global Financial Database.

New York City, silk, monthly prices (dollars per pound of Japanese double extra-crack, raw white), 1923-1933: NBER Macrohistory Database.

New York City, silver, monthly prices (cents per ounce): Global Financial Database.

New York City, sugar, monthly prices (cents per pound of raw, 96 degree centrifugal cane sugar), 1909-19: Global Financial Database.

New York City, wheat, daily prices (marks per 1000 kg. of mittel-qualität), 1896-1901: *Vierteljahrshefte zur Statistik des Deutschen Reichs*. Berlin: Verlag von Puttkammer & Mühlbrecht, various years.

New York City, zinc, monthly prices (cents per pound of common grade, slab zinc): NBER Macrohistory Database.

Winnipeg, oats, monthly prices (cents per bushel of no. 2 white), 1899-1909: R.H. Coats, *Wholesale Prices in Canada, 1890-1909.* Ottawa: Government Printing Bureau, 1910.

APPENDIX II: GARCH Models and the Kokoszka and Leipus Test

Beginning with the work of Engle (1982) and especially Bollerslev (1986), the 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 t^{th} error term from a regression model, the GARCH(p,q) model assumes that the conditional variance equals

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

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,

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

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

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

The normalized test

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

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. This splitting procedure is, then, stopped whenever a break proves to be statistically insignificant.

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Figure 1: Ratio of Commodity Price Volatility against Elasticity of Supply and Elasticity of Demand

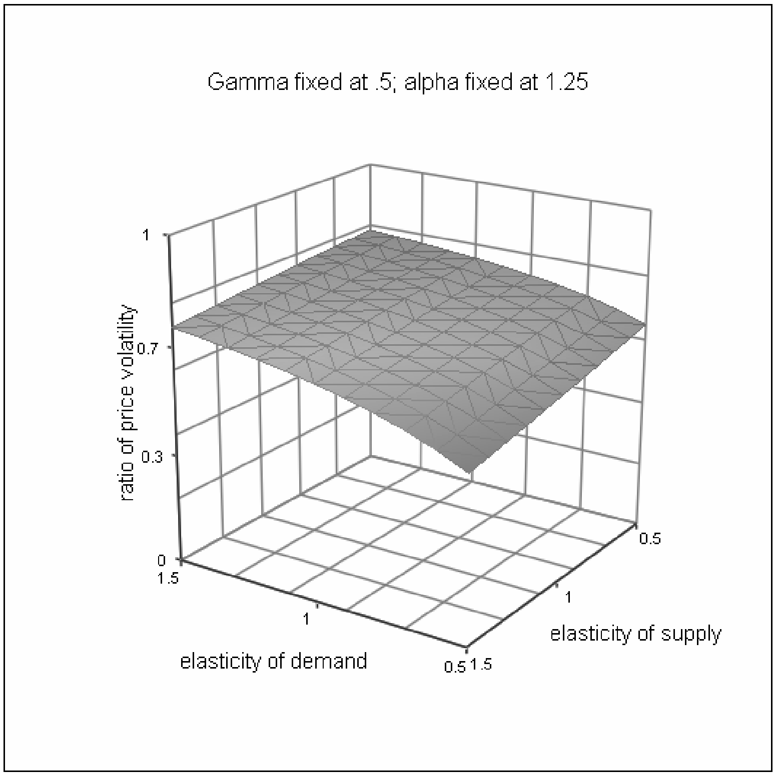


Figure 2: Ratio of Commodity Price Volatility against Elasticity of Demand and Adaptive Expectations Parameter

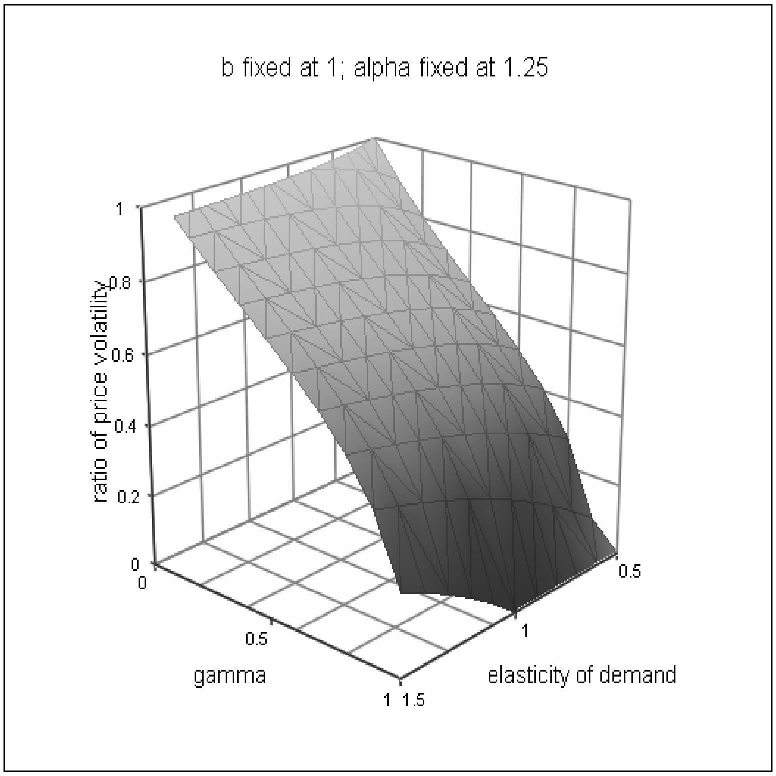
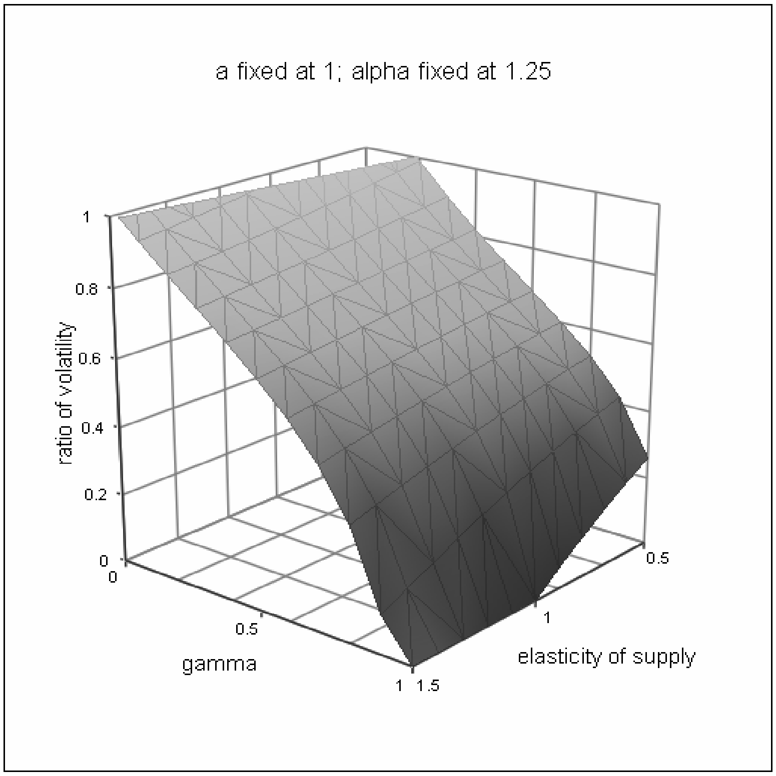


Figure 3: Ratio of Commodity Price Volatility against Elasticity of Supply and Adaptive Expectations Parameter



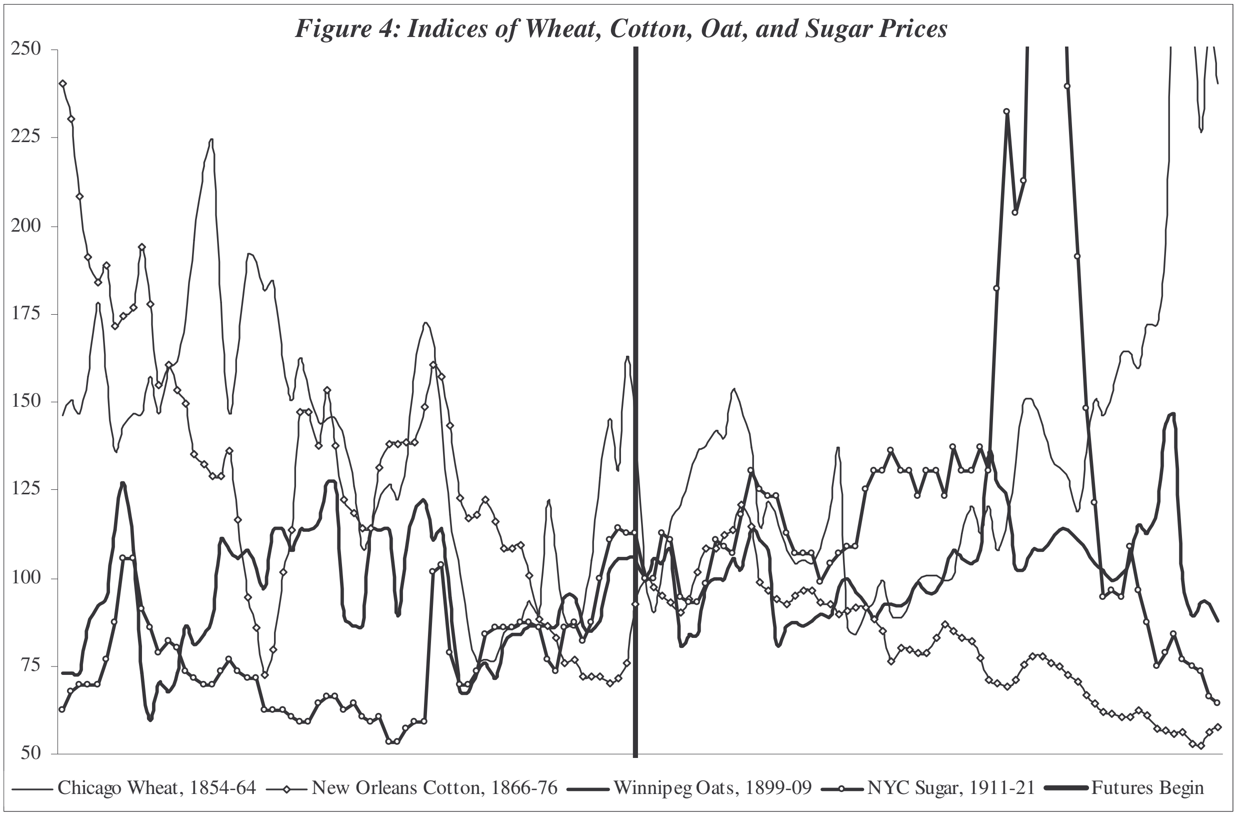
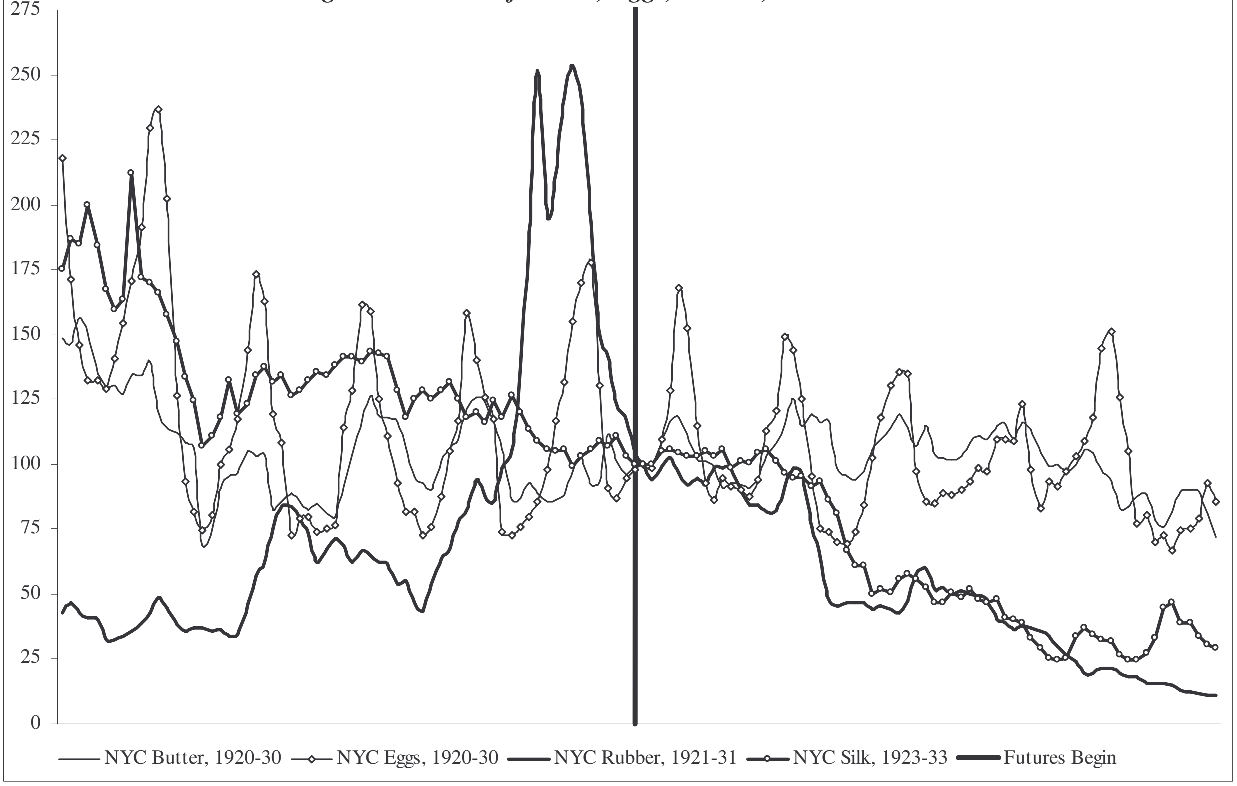


Figure 4: Indices of Wheat, Cotton, Oat, and Sugar Prices
250
225
200
175
150
125
100
75
50
Chicago Wheat, 1854-64
New Orleans Cotton, 1866-76
Winnipeg Oats, 1899-09
NYC Sugar, 1911-21
Futures Begin

Figure 5: Indices of Butter, Eggs, Rubber, and Silk Prices



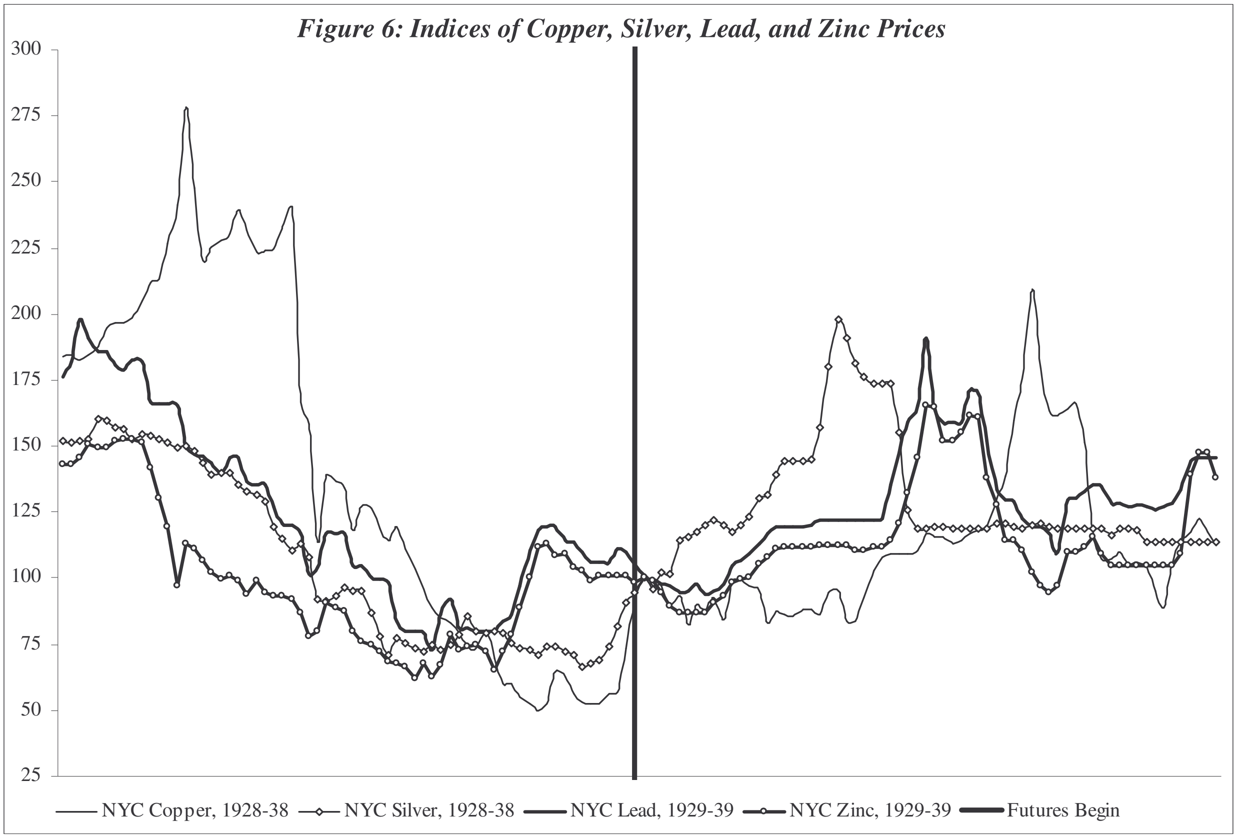


Figure 6: Indices of Copper, Silver, Lead, and Zinc Prices
300
275
250
225
200
175
150
125
100
75
50
25
NYC Copper, 1928-38
NYC Silver, 1928-38
NYC Lead, 1929-39
NYC Zinc, 1929-39
Futures Begin

Figure 7: Indices of Soybean, Linseed, Hog, and Rubber Prices

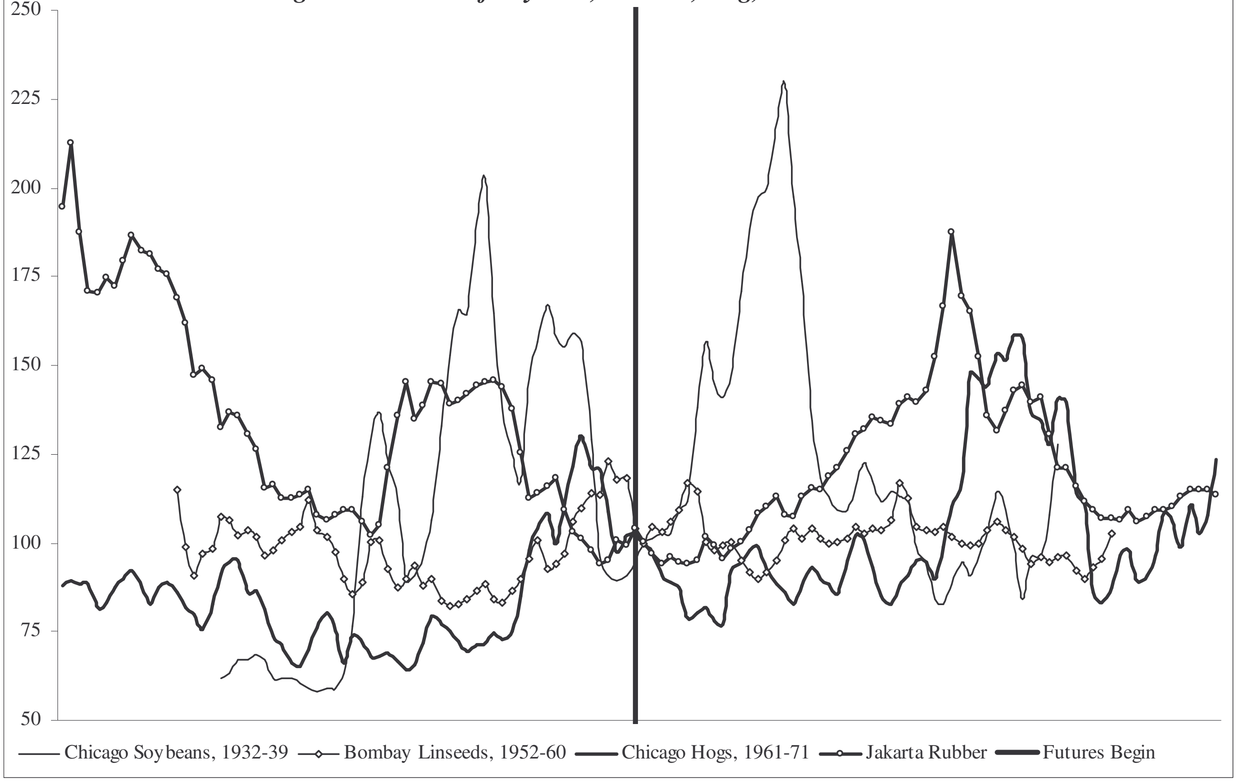


TABLE 1: PRICE VOLATILITY IN SIXTEEN MARKETS BEFORE & AFTER THE ESTABLISHMENT OF FUTURES MARKETS

	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

NB: 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.

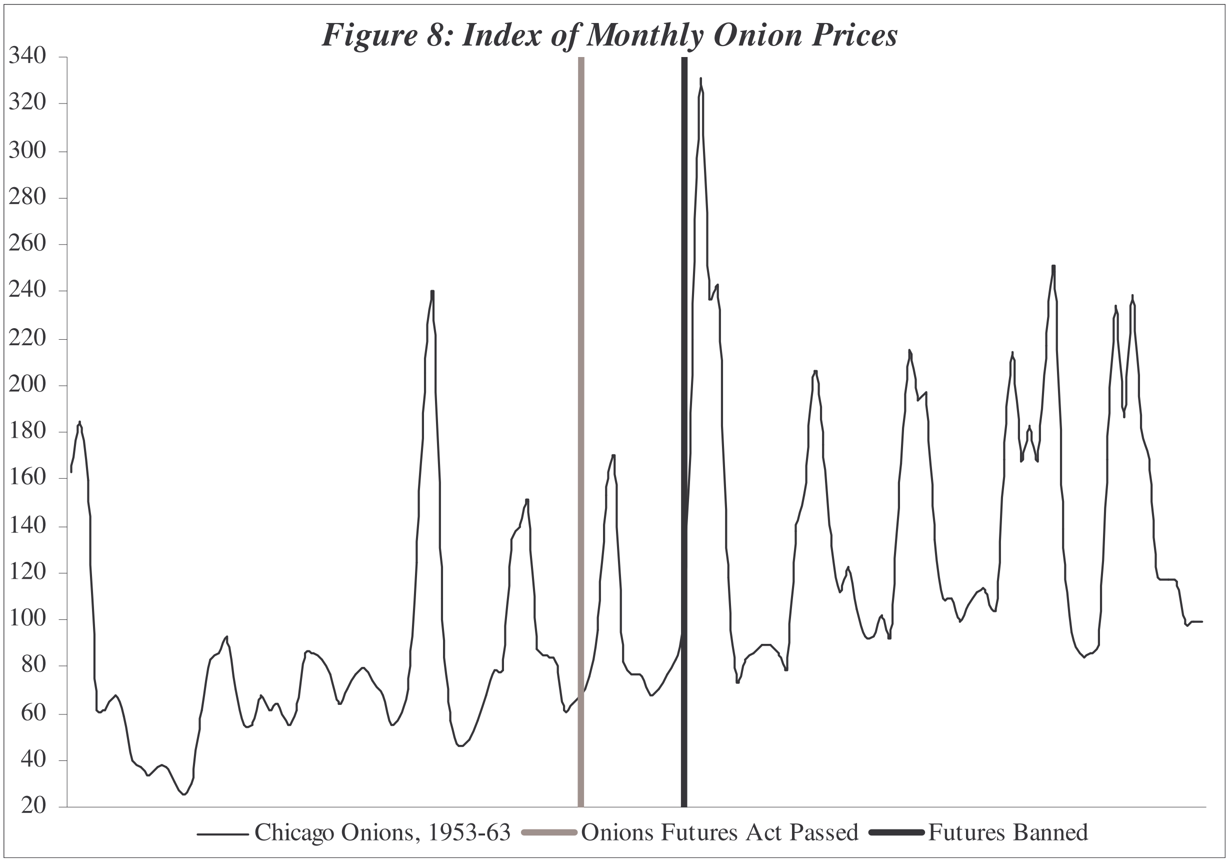


Figure 8: Index of Monthly Onion Prices
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
Chicago Onions, 1953-63
Onions Futures Act Passed
Futures Banned

TABLE 2: PRICE VOLATILITY IN THE CHICAGO ONION MARKET BEFORE & 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**

NB: 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.

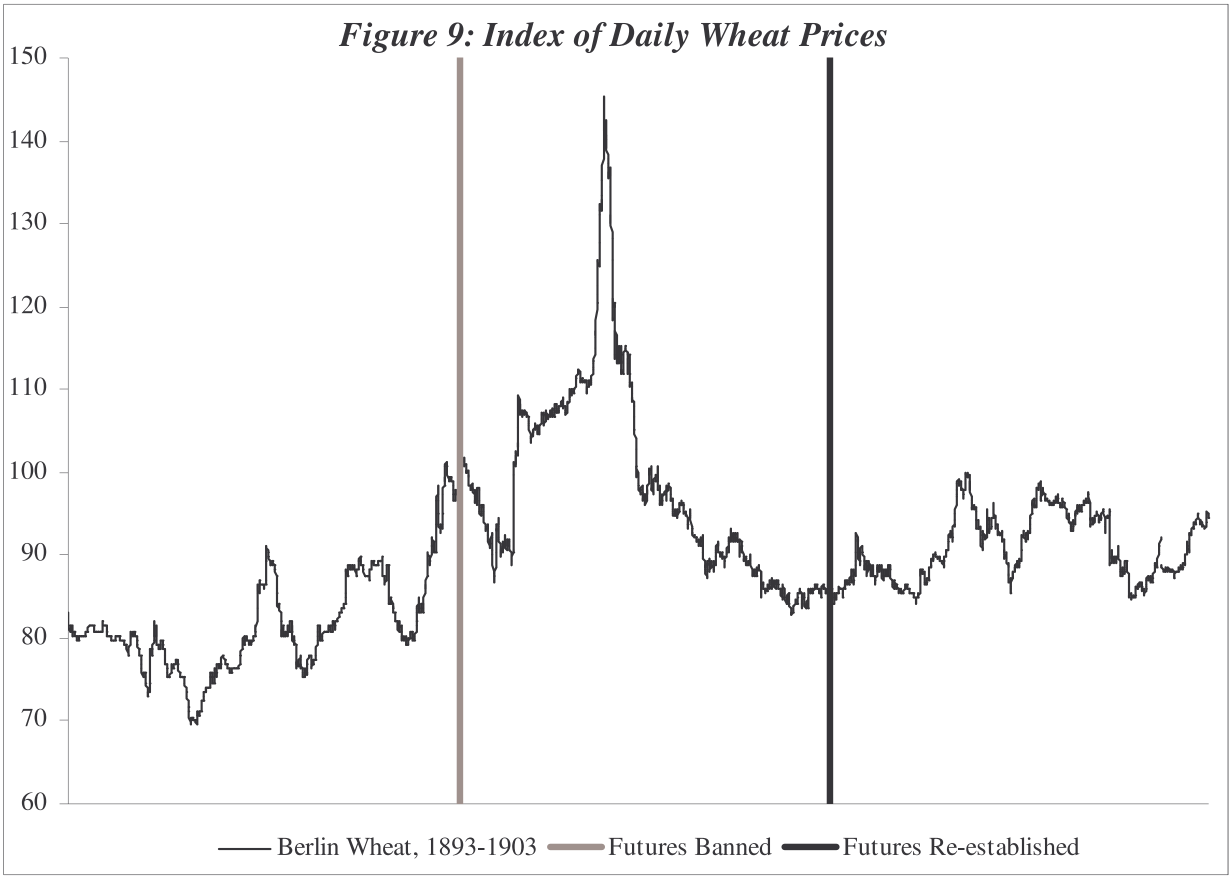


Figure 9: Index of Daily Wheat Prices
150
140
130
120
110
100
90
80
70
60
Berlin Wheat, 1893-1903
Futures Banned
Futures Re-established

TABLE 3: PRICE VOLATILITY IN THE BERLIN WHEAT MARKET BEFORE & 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**

NB: 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**

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

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
Februrary 2, 1900	2.5662	Exchange Act rescinded January 1900; futures traded from April 1900
March 19, 1901	2.2725	

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