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A Survey of 50 Years of Commodity Price Analysis, and a Look Ahead to the Next 50

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Commodity prices research examines how well prices reveal information, allocate resources, and transfer risk. This review surveys 50 years of work across 11 themes: price discovery, market integration and efficiency, price transmission, volatility spillovers, forecasting, derivatives and hedging, storability, futures convergence, financialization, policy effects and the informational value of USDA reports. Evidence points to nearly efficient markets, where cash and futures impound news quickly across markets related by space, time, and form. However, short-run frictions sometimes emerge. I discuss how data availability and machine learning will advance our understanding and highlight recent papers already pushing the envelope in this direction.

Key words: basis, convergence, derivatives, efficiency, forecasting, financialization, hedging, transmission

Introduction

Well-functioning commodity markets are prerequisites for farm profitability and food security. When markets function efficiently and prices reflect fundamentals, producers receive reliable signals for planting and storage decisions and consumers face fewer, shorter price spikes. For that reason, agricultural economists have focused their study of commodity markets and prices on “market efficiency,” broadly defined, trying to answer whether prices do the allocative work society needs them to do. Common themes recur:

- Do arbitrage opportunities persist without an obvious cost or policy barrier?
- Do prices in related markets—across space, time, and form—move together?
- Which markets are first to impound and convey information?
- Is the playing field level, or do certain firms, regions, or supply-chain tiers possess market power?
- Have new policies—like biofuel mandates, export restrictions, tariffs, or other programs—improved efficiency or simply shifted economic rents?
- Are new players changing the market environment in ways that will impact current producers and consumers?
- Do producers and consumers of commodities have access to efficiently priced derivative products for risk management?

Half a century of research has worked to answer these questions and more. In the remainder of this article I identify 11 themes that have organized this effort. Table 1 groups them by the method. The left column shows topics typically analyzed with time-series econometrics techniques: price discovery, market integration and price efficiency, price transmission, volatility spillovers, and forecasting. Much of this research operates on the assumption that efficient markets exhibit a certain

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Table 1. Major Research Themes on Commodity Prices

Mostly Time Series Econometrics	Varied
Price Discovery	Derivatives, Risk Management, and Hedging
Market Integration and Price Efficiency	Implications of Storability
Price Transmission	Futures Market Performance and Convergence
Volatility Spillovers	Financialization and Speculation
Price and Volatility Forecasting	Government Policy
	USDA Reports' Impacts on Futures Prices

Notes: Research themes divided into typical methodological groups. 'Varied' column contains event studies, Granger causality tests, theory, simulation, and other methods.

kind of price dynamic, and time series models reveal whether specific price dynamics are consistent with these assumptions.

The right column collects topics that generally rely on various methods, like event studies, Granger causality tests, theory, simulation, and other methods: implications of storability, futures market performance and convergence, financialization of and speculation in commodity futures, government policy, price response to USDA reports, and derivatives and risk management.

I review each of these themes and distill key findings that have advanced our understanding. It is important to note that since this review covers a wide scope, my treatment of any one theme is not deep enough to be considered comprehensive review. Unfortunately, dozens more papers could have been included for most themes. Given space constraints, I necessarily omit many valuable contributions. Rather than provide a comprehensive review of any one theme, my goal is to provide a broad survey of the commodity price analysis literature.

I also give my view on where future research on commodity markets and price analysis should focus. While most themes we have studied over the last half century will remain relevant, new data and methods will allow us to find new insights. Also, there will surely be unexpected challenges that arise that will require research to find solutions (as was the case in the last half century with the nonconvergence of futures markets and the concern over speculators).

Fifty Years of Innovations in the Study of Commodity Markets

To set the stage for the review, Figure 1 shows a word cloud generated based on the text that follows, with larger words being those that appearing more frequently. It shows at a glance concepts that come up frequently in this research.

It is obvious from the word cloud that corn and soybeans markets receive the most frequent treatment, even though significant attention is paid to other commodities like wheat, rice, cattle, and hogs. Futures markets are a focus because, on one hand, they provide price discovery and risk transfer for participants and, on the other hand, public markets provide ample data for research. We also see concepts like basis, volatility, efficiency, forecasts, price discovery and transmission, liquidity, shocks and USDA reports appearing prominently.

Price Discovery

Price discovery takes place as buyers and sellers willingly agree to transact at a certain price and other market participants observe and update their views based on this information. Market participants never want to be on the wrong end of transacting at stale prices, so research has long been interested in uncovering where price discovery takes place in commodity markets. The location of price discovery is defined by the market that impounds new information first into prices (Garbade and Silber, 1983). Early empirical work on agricultural commodities consistently shows that the futures market incorporates new information ahead of its cash market counterpart. Using daily data from 1976–1982, Brorsen, Bailey, and Richardson (1984) document a clear price discovery in the

the value of high-frequency information for tracing how and where price discovery occurs in global commodity markets.

Other work uses high frequency CME price data for 2008–2015. Hu et al. (2020) quantify how information flows along the forward curve for a storable commodity (corn) and a nonstorable one (live cattle). Two stylized facts emerge. First, the nearby contract dominates so long as its volume share exceeds 50%: Once relative liquidity tips in favor of the next-deferred, leadership degrades quickly in the case of corn and gradually in the case of live cattle, validating volume-based rather than calendar-date roll rules for constructing continuous series. Second, storability matters: Corn exhibits stronger and more persistent nearby leadership, while cattle shows a flatter, continuous change in leadership that reflects the absence of storage arbitrage and the forward-looking nature of each delivery month.

Market Integration and Price Efficiency

Spatial and vertical linkages in agricultural commodity prices hinge on the twin forces of arbitrage and transaction costs. The classical benchmark is the Law of One Price: In the absence of frictions, price differences should equal transfer costs. Therefore, it is impossible to determine whether a market is integrated without observing transfer costs and/or trade flows. McNew and Fackler (1997) show that simple cointegration between regional corn prices is insufficient to determine integration; unless one observes both the (unseen) autarky price and a stationary transfer cost, cointegration may exist even when profitable arbitrage is impossible. Their Monte Carlo experiments reveal that low transport charges make full integration likely, whereas high charges isolate regions.

Barrett (2001) argues similarly. Spatial market integration should be judged by whether grain can and does move between locations, a flow-based concept, whereas market efficiency is a price-based equilibrium condition. Treating the two as interchangeable, he argues, leads to false inferences when the data contain no information on trade costs or volumes. Building on that conceptual separation, Barrett and Li (2002) embed prices, observed freight charges, and actual shipment volumes in a maximum-likelihood mixture model that nests spatial regimes, perfect integration, segmented equilibrium, and segmented disequilibrium.

Since the grain trade is global, research has extended the integration question from regions to countries. Using monthly data for 2000–2013, Chen and Saghalian (2016) demonstrate that export prices in Thailand, Vietnam, and the United States share a single long-run equilibrium, but adjustment is asymmetric: The Vietnam price drops quickly when its price exceeds the parity band, while Thailand and the United States act as price leaders. Overall, the authors find that global rice markets are efficient and there is no significant evidence of collusion despite the fact that there are only a few major market participants.

While integration studies tend to explore relationships across space, there has also been a lot of work in testing whether agricultural futures markets are efficient in a martingale sense (Samuelson, 1965) or in a semi-strong form sense (Fama, 1970). Rausser and Carter (1983) found that ARIMA models outperformed futures markets as forecasts for soybeans and soybean meal but not for soybean oil. They conclude that it seems there are opportunities for excess risk adjusted returns in the soybean complex.

(Carter, 1984, p. 1) defines price efficiency as occurring when “new information concerning supply or demand is discounted accurately and rapidly into the futures price.” Carter investigates the efficiency of Winnipeg barley (a thinly traded contract) and Chicago corn (an actively traded contract) with three weak-form tests: martingale, Gray’s risk-premium regression, and a comparative forecasting exercise. Corn passes each test, whereas the barley contract fails the martingale and risk-premium test and delivers inferior forecasts of harvest prices at planting time compared to the corn contract. Carter’s work showed the importance of market depth and information flow: Efficiency in futures prices requires liquidity and active trader participation.

McKenzie and Holt (2002) find that live cattle, hogs, corn, and soybean meal are efficient in the long run, but cattle, hogs and corn futures display short-run inefficiencies that suggest that short-run time-varying risk premiums might exist. Wang and Ke (2005) test the efficiency of Chinese wheat and soybean futures markets. They find weak short-term efficiency in the soybean market, but the wheat market is inefficient.

Price Transmission

Price transmission work aims to understand how shocks in one market are propagated to other markets; these are often modeled as vector autoregressions (VARs) or structural vector autoregressions (SVARs). Sometimes the variables are the price of the same commodity in different locations, as was also the case in the spatial integration and price efficiency research presented in the subsection above, but not always. For example different commodities that have a production relationship, such as the crude oil crack spread or the soybean crush spread, may exhibit properties where shocks to one market are transmitted to other markets. Still other cases can model how decisions such as planting and storage taken in one time period impact the price at a later time period.

Ghanem and Smith (2022) advocate the SVAR as a system-wide framework for tracing dynamic causal effects in agricultural commodity networks. They treat the world grain market as an interlinked system of supply, demand, and inventory shocks. They demonstrate the importance of careful identification strategies and show the relationship between SVAR and the IV estimator, popular in microeconometrics. Further, they demonstrate that even if some structural assumptions are misspecified, identification of particular causal channels can remain valid depending on where they lie in the causal chain. Their SVAR application reveals that global demand shocks explain a larger share of short-run price volatility than previously suggested by single-equation IV studies, while inventory feedback dampens long-run effects.

Von Cramon-Taubadel and Goowin (2021) provide a comprehensive review of price transmission studies and conclude that price transmission is context specific: Advances in logistics and information technology tighten some price links, but vertical coordination and private contracts increasingly obscure others. Sophisticated nonlinear models (threshold VECM, smooth-transition error correction, or state-dependent pass-through) can accommodate regime switches and unobservable costs, yet increasing vertical coordination makes many of the parts of the system unobservable to the researcher. The review thus cautions that methodological sophistication must be matched by data quality; otherwise, inference about price transmission is difficult.

Volatility Spillovers

The literature on the relationship between energy and agricultural markets reveals increased complexity, largely driven by the rise of biofuel production. A dominant theme is the establishment of a strong linkage between these sectors, starting with the period following the US Renewable Fuel Standard (RFS) in 2005 (Nazlioglu, Erdem, and Soytaş, 2013; Teterin, Brooks, and Enders, 2016; Du, Yu, and Hayes, 2011). This integration has led to significant, complex, and often asymmetric volatility spillovers. The direction of this transmission is a central question, with a consensus that volatility spills from corn to ethanol (Gardebroeck and Hernandez, 2013; Trujillo-Barrera, Mallory, and Garcia, 2012).

The transmission from crude oil to agricultural markets is more nuanced, with some studies finding no major direct cross-volatility effects from oil to corn (Gardebroeck and Hernandez, 2013), while others identify significant spillovers (Wu, Guan, and Myers, 2011). The exploration of asymmetry reveals that market responses are complex, with positive and negative price changes generating inconsistent spillover effects (Saghaian et al., 2018; Wang and Li, 2021). The impact of biofuels is also observed in co-product markets, such as distiller's dried grains, where strong

volatility spillovers from corn and soybean meal are observed (Etienne, Trujillo-Barrera, and Hoffman, 2017).

Multivariate GARCH models, particularly the BEKK specification, are popular for their ability to model spillover effects directly (Gardebroek and Hernandez, 2013; Saghaian et al., 2018). Other methodologies include spillover indices based on VAR models (Xiarchos and Burnett, 2018), Bayesian methods for complex model estimation (Du, Yu, and Hayes, 2011), and models that account for time-varying parameters and structural breaks (Teterin, Brooks, and Enders, 2016; Liu and Gong, 2020).

Volatility spillovers can happen between countries as well. The emergence of Brazil as a major grain producer, for example, fundamentally shifts global grain dynamics, inverting the direction of volatility spillovers with the United States (Avileis and Mallory, 2022).

Price and Volatility Forecasting

The literature on price forecasting in agricultural economics is vast. After all optimal resource allocation and marketing decisions would benefit greatly from access to adequate forecasts. Nevertheless, forecasting price is very difficult (Taylor, 1988). While this result suggests that markets are efficient, it is frustrating for market participants, whose livelihood depends on prices that very nearly approximate a random walk.

Brandt and Bessler (1983) do find a modest improvement of exponential smoothing and ARIMA models over expert forecasts. They also find improvement from forecast combinations, a well-known result (Bates and Granger, 1969; Fomby and Samanta, 1993). Similarly, Trujillo-Barrera, Garcia, and Mallory (2016) conduct out-of-sample tests of USDA hog outlooks that reveal a simple equal-weight averaging of alternative models can reduce RMSE by 6%–12% at horizons from one to four quarters, adding to evidence that parsimonious model combinations often outperform complex, adaptively weighted ones (Colino et al., 2012). Xu (2020) models corn cash price locations with three types of VARs and several forecast combination methods. They find informative value in forecasting cash prices and also confirm forecast improvement in forecast combination. Gerlow, Irwin, and Liu (1993) argue that economic metrics like whether a forecast generates greater profits or returns are more relevant than purely statistical metrics, like root mean squared error and mean absolute error. They show that the best forecasting models chosen based on economic criteria are different than the best models chosen by statistical criteria.

Forecasting basis is a primary challenge as well. Variability in basis levels can have a major impact on farm profitability. However, for many locations and commodities there is a strong seasonal trend in basis, which suggests that forecasting basis may be a more feasible task than forecasting price levels. Sanders and Manfredo (2006) put several time series forecasting techniques to the test on soybeans, soybean oil, and soybean meal basis. They found little improvement to forecasting with time series econometric techniques compared to naïve methods like a 5-year average. Thompson et al. (2019) highlight the benefit of simple moving average forecasts for basis. They argue that for many farmers, implementing time series econometric techniques is not practical; given evidence from Sanders and Manfredo (2006), they examine which moving average approaches work best in forecasting Eastern Corn Belt corn and soybean basis. They find that moving average forecasts provide improvement over naïve methods at short forecast horizons. They also note that the accuracy of corn and soybean basis forecasts deteriorates significantly during summer months.

For hard red spring wheat in the northern United States, forecasts that incorporate contemporaneous futures prices, protein content, and harvest timing prove superior to traditional 3–5 year historical averages. The systematic strength of the basis at elevators closer to Pacific Northwest export terminals underscores the importance of including spatial demand and supply patterns as well as quality premia into forecasting models (Bekkerman, Brester, and Taylor, 2016).

Price volatility is also forecastable and has been the object of research in agricultural economics. In the context of feeder and live cattle returns, Brittain, Garcia, and Irwin (2011) show that a larger

variance risk premium exists in live cattle than feeder cattle. Option-implied forward volatilities across corn, soybeans, wheat, and hogs contain significant information about future realized variance (Egelkraut and Garcia, 2006). However, this relationship is state-dependent: Low implied values tend to over-predict future variance, while high implied values under-predict it except for corn and soybeans, where volatility forecasts are unbiased and efficient.

Finally, Karali and Thurman (2010) offer a detailed analysis of the components of grain futures price volatility. They find that while the Samuelson effect (volatility increases as a contract approaches maturity) is present, there are also significant seasonal patterns in volatility, with peaks corresponding to key periods in the crop cycle, such as planting and harvesting.

Derivatives, Risk Management, and Hedging

Producers and consumers of commodities frequently use forward, futures, and options contracts for hedging (risk management) purposes. There has been much research on whether these products are fairly priced and testing whether strategies that use these derivative products reduce risk and preserve returns. Lapan and Moschini (1994) show how a producer with CARA utility and facing risk in price, basis, and yield has optimal hedge that depends on risk attitude, in contrast to the typical mean–variance result. In contrast, Garcia, Adam, and Hauser (1994) use a simulation study to show the usefulness of the mean-variance framework, even across various assumptions about risk preference of hog producers who hedge with options contracts. Lence (1996) shows that if producers face production uncertainty and if they consider alternative investments for the cash used to finance hedge positions, then hedging generates negligible benefits.

In later work, Jacobs, Li, and Hayes (2018) develop a theoretical model of optimal hedging that includes producers who consider a reference price like a moving average. The evidence is mixed on whether using a reference price is beneficial or not, but they show producers do seem to base hedging activity on a reference price using proprietary data on farmer hedge positions.

Shi and Isengildina-Massa (2022) simulate the cost of hedging with futures contracts due to margin requirements and other costs. They find that market volatility is a major driver of hedging costs. Belasco (2008) simulates the ability of cattle feedlots to reduce revenue risk through the use of forward price contracts and revenue insurance products. They show that these risk management products can reduce the standard deviation of profits substantially. However, as was the case in Shi and Isengildina-Massa, the degree to which risk can be reduced depends on price volatility.

Implications of Storability

Working (1948, 1949) considered backwardation or “inverse carrying charges” in commodity futures and showed that firms hold stocks of wheat even when the futures curve is in backwardation. He developed the “Working curve,” which used the concept of convenience yield to explain the relationship between firms’ stockholding behavior and the futures price spread.

The empirical validity of the Working curve has been contested, however. Joseph, Irwin, and Garcia (2016) provide an extensive review of the evolution of this literature spanning 7 decades. Then, using 1990–2010 data for Chicago Board of Trade (CBOT) corn, soybeans, wheat and Kansas City Board of Trade (KCBT) wheat, the authors show that storage under backwardation is still pervasive: The Working curve emerges in all markets considered but is clearest in KCBT wheat and soybeans. Further, convenience yield is corroborated by the near absence of traders holding shipping certificates (which are financial instruments and cannot provide the holder a convenience yield) during backwardation.

While storage ensures linkages between the spot and deferred prices of a commodity, storage can also generate links between related commodities. Mallory, Irwin, and Hayes (2012) show that corn futures adjust to ethanol shocks through the storage channel: When mandated ethanol demand is expected to increase the long-run price of ethanol, this impacts deferred corn futures prices through a long-run (no profit) equilibrium.

In addition to commercial storage activity, each year significant stocks are held on US farms; however, given limited availability of data, there has not been much research into farmers' stock-holding activities. Using panel data for thousands of Illinois farms, Janzen, Paulson, and Tsay (2024) exploit cross-farm variation in weighted-average cost of capital to test whether higher opportunity costs depress inventories. Two-way fixed-effects and panel-quantile regressions reveal that roughly half of farms adjust stocks in line with theory, while a sizable group holds grain for reasons beyond other profit. These reasons might be tax avoidance strategies or other factors that are unobserved by the researchers. The authors suggest that farmer stock holding activity may have impacts on aggregate prices, but given lack of data availability, they leave this as a topic for further inquiry should data become available.

Futures Market Performance and Convergence

A well-functioning futures contract will see the cash price at a futures delivery point equal the futures price at maturity after adjusting for grade, location, and transaction costs. Beginning in 2005, however, CBOT contracts for corn, soybeans, and soft red winter wheat began to “disconnect,” with futures settling above elevator bids by 20¢–40¢ per bushel, a disturbing development that threatened the efficacy of the futures contracts to perform their price discovery and risk transfer functions.

As the industry digested the issue and looked for culprits, it was suggested that increasing financialization of commodity futures may be to blame as index funds increased trading activity for purely speculative purposes. Irwin et al. (2011) show that there was no evidence that speculative trader activity was connected to the nonconvergence issue.

Building on that insight, Garcia, Irwin, and Smith (2015) develop a dynamic rational expectations model of commodity storage that explains how institutional structure of the delivery system contributed to the problem. When the price of physical storage at delivery locations exceeded the exchange mandated maximum allowable storage rate, the cash and futures contract failed to converge. Ultimately, the exchange introduced variable storage rates on shipping certificates, which has resolved the issue of nonconvergence.

Karali, McNew, and Thurman (2018) explore the spatial consequences of the nonconvergence period. They analyze basis at nondelivery locations and find that the basis relationships between nondelivery locations and delivery locations are not affected by nonconvergence of the futures price.

Financialization and Speculation in Commodity Markets

The 2000s ushered in a tidal wave of institutional money into long-only commodity index products which coincided with the commodity super-cycle of 2007–2009. This led to concern that speculators were causing the price of key commodities to deviate from their fundamental value. Empirically, however, it has been difficult to verify a link between speculative flows and prices levels divorced from fundamentals.

Suspicion of index fund speculative activity causing the super-cycle has been fueled by observed increased correlations among commodity markets. Using a difference-in-differences design that contrasts commodities inside major indices with those left out, Tang and Xiong (2012) show that after 2004, returns on indexed contracts had increased correlation with crude oil and with each other, whereas nonindexed contracts did not. The result is robust to controls for carry, interest rates, and demand shocks. However, Carter, Rausser, and Smith (2011) compare the most recent commodity boom (2007–2008) with the earlier boom of (1973–1974). They conclude that both episodes experienced a series of contemporaneous fundamental supply and demand shocks as well as macro shocks that happened during periods of low inventories.

Although research has been conducted finding both support for and against this claim, Irwin and Sanders (2011), Irwin and Sanders (2012), and Irwin (2013) and the work cited therein find that the “Master hypothesis” (index funds caused a 2007–2008 bubble) lacks sufficient statistical and economic support.

Complementary evidence from disaggregated Commodity Futures Trading Commission (CFTC) Commitments of Traders data supports Irwin and co-authors' view. Fishe and Smith (2019) find that managed-money (speculative) traders systematically add to net long positions when prices rise, whereas commercial firms (hedgers) take the opposite side, supplying liquidity. However, these trading dynamics do not drive prices significantly away from fundamentals.

Government Policy

Studying the impacts of government policy decisions has always been an active part of agricultural economics literature. Through the 2010s, research on biofuel policy, namely the Renewable Fuel Standard (RFS), was a key area of focus. More recently, especially since the election of US President Donald Trump in 2016, trade policy—particularly the 2018 Chinese retaliatory tariffs on US soybeans—has generated a lot of research.

Starting with work on impacts of the RFS, a central theme measures how increased production and consumption of biofuels have affected agricultural commodity markets like corn, soybeans, and wheat. For instance, Mallory, Hayes, and Babcock (2011) implement a partial equilibrium model of crude oil, ethanol, and corn, soybeans, wheat, and switchgrass markets. They show that increased demand for corn from ethanol production raises all three row crop prices, since the crops compete for acreage, with substantial price effects if a large cellulosic ethanol mandate is implemented. McPhail and Babcock (2012) show that US biofuel policy increased both corn and gasoline price volatility. Similarly, Myers et al. (2014) estimate the long-run and short-run co-movements in energy and agricultural biofuel feedstock prices, demonstrating the tightened linkage between these markets following the expansion of biofuel production.

Carter, Rausser, and Smith (2017) employ a partially identified SVAR which allows them to estimate separately the effects of transitory versus persistent shocks. They incorporate a rational storage model, which allows transitory shocks to be buffered by inventory drawdowns but not persistent shocks. They estimate that the 2007 Renewable Fuel Standard boosted the corn price level by about 30% between 2006 and 2014.

Turning discussion to impacts to the soybean market of Chinese retaliatory tariffs, several studies reveal the reshuffling of global trade patterns and consequences to domestic producers. Adjemian, Smith, and He (2021) estimate the market effect of the soybean tariffs, quantifying the price impacts in both the US and Brazil. Using the relative price of a substitute method, they find that US Gulf soybean prices were \$0.74/bu lower, while Brazilian soybean prices were \$0.97/bu higher compared to what they would have been without the tariff.

Cowley et al. (2020) provide another account of the reshuffling in soybean markets following the Chinese tariffs, illustrating the adjustments in global trade flows and documenting an initial drop in US soybean futures prices of 20%. The welfare implications for farmers are a key area of investigation. Janzen and Hendricks (2020) question whether farmers are “made whole” by trade aid, analyzing whether the Market Facilitation Program (MFP) payments fully compensate farmers for the price impacts that resulted from the soybean tariff. They find that in the short run and in aggregate, payments to farmers exceeded the lost value generated by lower prices, but the situation is nuanced when you consider that not all farms are identical. Some farms received less program payments than revenue lost due to lower prices. Sabala and Devadoss (2019) complement these studies by analyzing the broader impacts of the Chinese tariff on world soybean markets, highlighting the global nature of these shocks. They find that China experiences losses due to the higher soybean prices they face, the US loses due to lower prices and lower export quantities, Brazil gains from higher prices and higher export volumes, and Canada loses as some of its export volumes to the European Union are displaced by US exports.

USDA Report Value and Impact on Commodity Prices

The impact that USDA reports have on cash and futures prices of important commodities is an active area of research. The USDA regularly releases information to the public about the situation and outlook of various commodities. The reports are widely followed because they contain pertinent updates about production, demand, inventories and other key details that can move market prices.

A long-standing question in the agricultural economics literature has been to evaluate the value of these reports to the public, as they are produced at significant expense to the taxpayer and, increasingly, private firms have stepped in to provide similar information (at a cost to subscribers). The value of USDA reports is often measured by futures price reaction to report releases, with the assumption that price reactions following release indicates that the report contain new and valuable information for market participants.

A large body of research examines the market impact of USDA reports over several decades. Massa, Karali, and Irwin (2024) survey 74 of these studies and distill their main findings. Their synthesis shows that USDA releases still move prices and that futures markets absorb the information within minutes, confirming both the reports' informational value and the efficiency of futures price discovery.

Massa, Karali, and Irwin (2024) urge continued public support for the work done by the USDA to develop and deliver situation and outlook reports, noting that USDA reports are key to leveling the playing field for all market participants by ensuring they have access to basic information about our commodity markets.

Trajectory of Commodity Prices Research Over the Next Half Century

The preceding review highlighted the myriad topics of inquiry the literature has focused on over the last 50 years. This section looks forward to the trajectory of commodity price research over the next half century. At the heart of all the topics we explored earlier is the need to verify and document the economic efficiency of commodity markets. Since consumption of food and energy commodities is essential for human survival and well-being, research on the smooth functioning of commodity markets will always be needed and has motivated all 11 of the research topic areas discussed. Therefore, I expect continued research in these classic areas, as up-to-date assessment on the functioning of commodity markets remains a core task.

Another theme that emerges from the preceding discussion is that when market structure changes or crisis occurs, agricultural economists step up to the plate to investigate and offer solutions. For example, when the RFS was implemented in the mid-2000s and when the trade war with China broke out in 2018, both had profound impacts on global commodity markets, which has been documented by researchers. Such research is crucial to policy evaluation and helps steer public knowledge toward both the clear and subtle impacts of policy. Similarly, when the price discovery and risk transfer functions of futures markets were threatened by convergence issues, researchers got to work investigating the cause, ultimately suggesting variable storage rates that eliminated the problem.

There is no way to foresee what future issues will challenge the efficient functioning of markets to incentivize efficient production, transformation, and distribution of commodities. However, one thing is certain: When challenges arise, the work of agricultural economists on the causes of and solutions to these issues will be crucial.

Another certainty is that each year we will grow richer in data that allow new techniques to be wielded and insights to be gained. More and more market price and trade flow data become available from spot markets around the globe. Weather observation and forecast data for more locations become available all the time. Alternative economic indicators can be examined to help explain consumer behavior. The environment for applied research has never been more rich from a data availability perspective, and will likely keep getting better.

Richer data means a richer set of models that might usefully explain behavior and outcomes. Statistical and machine learning techniques provide the ability to implement complex models, and researchers have begun using these frameworks to tackle classic questions and attain new insights. I now highlight recent work pushing the envelope with statistical and machine learning techniques in the area of commodity price analysis.

High-Dimensional Data

As we saw earlier, exploring the interconnectedness of markets through integration, price transmission, and volatility spillovers has been the focus of much research. This early research typically faced trade-offs in terms of the complexity of relationships possible to model. Approaches using VAR, VECM, or GARCH models were limited in the number of markets that could be simultaneously considered due to the “curse of dimensionality” present in these econometric methods.

Statistical learning techniques expand the possibilities. Mallory et al. (2025) explore spatial plus vertical price relationships present among Chinese piglet, hog, and pork markets. To overcome the curse of dimensionality, they use a VAR fitted by penalized regression to capture the high-dimensional relationships and then joint impulse response functions to show how shocks to a subset of markets are transmitted up and down the vertical levels of the pork production pipeline.

While regularization techniques permit modeling the relationships among a larger number of markets directly, in other cases it may be appropriate to use dimension reduction techniques like principal component analysis or dynamic time warping (DTW) to identify clusters of markets that behave most similarly to one another. Then, more traditional econometric techniques can be applied to the clusters. Liu et al. (2023) apply DTW to Chinese provincial egg prices and find three clusters, which appear to mostly be driven by egg production versus importation.

Modeling Nonlinearities

Agricultural economists have been interested in modeling nonlinearities in price relationships for some time, but most achieve nonlinearity through threshold, regime switching, or smooth transition models. Goodwin (2025) and Choe and Goodwin (2025), in contrast, introduce the semiparametric generalized additive model to estimate integration in the US cannabis and US corn regional cash markets, respectively. Both papers show highly nonlinear responses to lagged differentials in regional prices, which would not be accurately categorized by threshold, regime switching, or smooth transition linear models.

Traoré, Jimbira, and Sall (2022) use recursive partitioning trees to model nonlinearities in price transmission of the rice market in Senegal. Specifically, recursive partitioning trees are used to identify (potentially multiple) thresholds and allow for instability and structural change tests.

Copula methods allow for the estimation of joint probability distribution functions of two or more random variables. Some copulas can capture asymmetry in the tails or measure time varying dependencies, making them an interesting choice for modeling price transmission or intermarket price dynamics, generally. Ahmed (2018) estimate a battery of copula methods to estimate the static and time-varying vertical price transmission of the tomato sector in Egypt after the Arab Spring movement, and Li and Chavas (2023) use a quantile VAR plus a copula to model asymmetries in the relationship between soybean spot and futures markets.

Additionally, methods for estimating copulas in high-dimensional settings like those presented in Schellhase and Spanhel (2018) and Müller and Czado (2019) provide opportunities for agricultural economists to explore high-dimensional relationships further through this lens.

Price and Volatility Forecasting

Statistical and machine learning methods are gaining popularity in commodity price forecasting, with a lot of work being done by financial engineers in addition to agricultural economists. Xu and

Zhang (2021) fit univariate and bivariate neural networks incorporating futures prices to forecast cash prices from 500 locations across 16 US states.

Herrera et al. (2019) compare random forests, neural networks, and econometric methods in forecasting crude oil, coal, and natural gas energy prices. They found random forests outperform other model types they considered, especially in long-term forecasts. Atalan (2023) forecasts drinking milk prices in Turkey with a battery of random forest, gradient boosting, support vector machine, neural network, and AdaBoost models. They also find random forest outperforms other models considered.

Yue et al. (2025) forecast prices of Chinese futures prices for soybean, silver, maize, and cotton nearby contracts. They compare the performance of ARIMA, convolutional neural network long short term memory (CNN-LSTM), and CNN-LSTM Kolmogorov–Arnold network (CNN-LSTM-KAN) models. They find that both the CNN-LSTM and CNN-LSTM-KAN outperform ARIMA on the test set, but the CNN-LSTM-KAN performs slightly better—especially during volatility events.

We saw in the previous section that research shows combinations of individual forecasts often outperform the best individual model. Ramsey and Adjemian (2024) show that advancements in machine learning methods for forecast combination can outperform simple averages of forecasts, where previous studies often showed complex combination methods have a difficult time beating simple forecast averages.

Conclusions

This review has identified 11 major lines of inquiry that have shaped commodity price analysis during the past 50 years and will, in modified form, shape it into the next 50. At its root, each theme asks whether prices in agricultural and energy commodity markets perform the tasks economic theory assumes of them: revealing information, allocating resources, and transferring risk.

The accumulated evidence implies cash prices and their derivative markets are nearly efficient. Most cash and futures markets impound information quickly and provide information to each other. Markets related to one another through space, time, or form tend to move together, as one would expect if traders quickly capitalize and remove emerging arbitrage opportunities.

Nonetheless, market interconnectedness is a double-edged sword. While integration, price transmission and volatility spillovers imply information efficiency, flows between related markets and increasing global and food versus fuel connections can sometimes import shocks. Also episodes such as the mid-2010s nonconvergence of grain futures and the 2007–2008 food price spike remind us that even mature markets can experience damaging periods of genuine dysfunction or loss of public confidence.

Looking ahead, two forces will expand the frontier of empirical work. First, the data environment is deepening. Second, the empirical toolkit is broadening. Statistical and machine learning techniques can effectively use high-dimensional panels that commodity data now generate. While advances in causal machine learning frameworks promise the ability to make inferences about policy and market interventions.

The opportunity, and the obligation, for agricultural economists is to wield these methods at the field's established themes. The agenda that follows from this review is therefore evolutionary, not revolutionary. Classic questions about price discovery, transmission, integration, and risk management require continual retesting as market environments change, both domestically and abroad. Most importantly, when the next crisis hits commodity markets, researchers should be ready to make quick use of the tools discussed herein, and new tools that will evolve in the meantime, to ensure markets continue to serve both the prosperity of producers and the well-being of consumers.

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