The Agricultural Commodity Market: Volatility, Prices and Fundamental Factors

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ABSTRACT

This paper examines the functioning of agricultural commodity markets as a hybrid system in which the real dimension—production, logistics and spot trading—coexists with and is continuously influenced by the financial dimension of standardized and OTC derivatives. Taking Pareto optimality as its theoretical point of departure, the analysis demonstrates the limits of allocative efficiency in the agricultural sector: the presence of externalities, public goods and informational, financial and contractual asymmetries prevents markets from spontaneously achieving efficiency, thereby requiring corrective intervention by public policymakers. The recognition of agricultural externalities, reflected in the preparatory documents of the Common Agricultural Policy, illustrates why the remuneration of public goods becomes a necessary political choice.

The study then explores the principal drivers of price volatility. It shows how derivatives, originally intended as hedging instruments, can amplify price dynamics when capital inflows are substantial, and how the growing financialization of commodities has strengthened the correlation between agricultural prices and equity indices, eroding diversification benefits and gradually decoupling price formation from underlying supply and demand fundamentals. Particular attention is devoted to supply-side determinants (diminishing returns, the centrality of land, the price-taker condition of farmers), demand-side factors (dietary transition, demographic pressures) and the systemic oil–wheat linkage, alongside the role of biofuels, climatic factors and geopolitical shocks.

The Covid-19 pandemic is interpreted as a systemic shock that disrupted supply chains, reshaped demand across consumption channels and widened spot–futures spreads, demonstrating that market discipline alone cannot ensure stability and inclusiveness. The paper concludes by proposing an integrated mitigation strategy—shortening supply chains, fostering producer aggregation, enhancing data transparency and strengthening risk-management mechanisms—aimed at reinforcing supply-chain resilience and securing shared, long-term food security.

Keywords: COVID-19, agricultural commodities, price volatility, financialization, food security

INTRODUCTION

This paper investigates the functioning of agricultural commodity markets, understood as a hybrid system in which the real dimension of production, logistics and spot trading interacts with the financial dimension of derivatives and speculative capital. The aim is to examine how price volatility and food insecurity emerge from the interplay between market fundamentals, financialization and public policy. After outlining the theoretical framework of market efficiency and its limits, the analysis turns to the determinants of price formation and, finally, to the systemic effects of the Covid-19 pandemic on global food security.

THEORETICAL FRAMEWORK

From this perspective, the principal theoretical paradigm is that of Pareto optimality, namely a condition in which it is impossible to improve the position of one individual without worsening that of another. It should be clarified,

however, that this paradigm constitutes an ideal theoretical benchmark, useful as an analytical point of comparison rather than as a description of the actual functioning of markets. Real agricultural markets, in fact, operate under conditions that are structurally far removed from perfect competition—owing to the presence of externalities, information asymmetries, market power, and barriers to entry—so that the departure from the Pareto optimum does not represent an anomaly, but rather the ordinary condition within which the following analysis is framed. The pursuit of allocative efficiency, in turn, makes it possible to achieve the maximum level of production attainable with the resources available. Accordingly, in an economy based on production, consumption and exchange, Pareto optimality requires:

- allocative efficiency in consumption – that is, equality of the marginal rate of substitution for every pair of goods, reflecting the opportunity cost of one good in terms of another;
- allocative efficiency in production – that is, equality of the marginal rate of transformation for every pair of production factors across different outputs, indicating the rate at which one input may be substituted for another;
- general allocative efficiency – that is, equality between the marginal rate of substitution and the marginal rate of transformation.

Indeed, if these two marginal rates were to differ, it would always be possible, given the same aggregate quantity of goods, to improve the utility of at least one player through the exchange of goods, thereby implying that the economy was not operating under conditions of Pareto optimality.

In other words, an economically efficient situation arises if:

- the economic system as a whole operates under strongly competitive conditions (that is, if competition in every market is very intense and, in the limiting case, perfect);
- the market system is complete, such that a competitive market exists for every economically relevant good or service;
- the competitive economy is in a state of equilibrium, a condition which, at least in abstract terms, is theoretically possible [1].

A complete and highly competitive market economy may therefore achieve a condition of overall efficiency, in which all resources are allocated and utilised optimally. The central issue, however, concerns the ability of such a competitive economy to attain and maintain a state of equilibrium. In this respect, economic theory has not demonstrated that a competitive economy, starting from a condition of disequilibrium, will necessarily reach an equilibrium configuration solely through the operation of market forces. Consequently, even where an economy is competitive, this does not necessarily imply that it is in a state of equilibrium, nor that it can achieve equilibrium within a short period of time [2].

This is because the Pareto criterion of optimality is not universally valid: it depends upon the initial allocation of goods among individuals, meaning that the final market outcome may be Pareto-optimal while at the same time being entirely inequitable [3].

In summary, the condition described above raises two fundamental questions regarding the capacity of the market, on the one hand, to achieve efficiency and, on the other hand, to attain any given distribution of utility pursued through public policy. The State’s central role is therefore to implement the redistribution of initial economic resources, thereby regulating income and welfare distribution in order to enable the market system to achieve an equilibrium that is both fair and efficient.

Nevertheless, it is evident that intervention by policymakers may also prove insufficient to achieve equilibrium. First, even after the redistribution of initial economic resources has taken place, the economy must still activate the mechanisms necessary to restore equilibrium autonomously, yet there is no guarantee that such a capacity

actually exists. Secondly, the choices made by the State regarding the preferred model of redistribution should ideally be based upon the collection and processing of an enormous volume of information, such that policymakers inevitably rely on incomplete information and imperfect analytical instruments. Finally, the achievement of efficiency requires not only a competitive economy but also a complete one, namely an economy free from externalities[1] and significant public goods[2] for which no market price exists.

It is therefore evident that, whenever the agricultural sector exhibits externalities to which a value must be assigned, there is a risk of creating market distortions.

In particular, a clear inefficiency arises when an externality encourages the excessive consumption of the good that generates it. This implies, first, an overproduction of goods associated with negative externalities (since those who benefit are different from those who bear the costs). As a further consequence, there is also an underproduction of goods generating positive externalities (because in this case the costs are borne by the decision-maker, whether producer or consumer of the good), as demonstrated by the case of agriculture.

Consequently, in order to restore market efficiency, the only viable solution proposed in the preparatory documents of the Common Agricultural Policy (CAP) is to assign value to public goods, that is, assigning property rights over goods generating positive externalities to specific actors (in this case, agricultural producers), together with adequate remuneration for their production. Put simply: the production of public goods must be paid for. This political choice would make it possible to overcome the excesses and shortages of production previously described.

Indeed, the "non-excludability" of public goods (namely, the impossibility of excluding individuals from their consumption) prevents efficiency from being achieved through the creation of a dedicated market for such goods. Even if a market for a public good could be established, its functioning would nevertheless be undermined by the difficulty of enforcing property rights over the good itself, precisely because of its non-excludable nature.

The Agricultural Commodity Market: Efficiency, Volatility and Financialization

The agricultural commodity market constitutes a hybrid system in which the real dimension (production, logistics and spot trading) coexists with and is influenced by the financial dimension (including standardised and OTC derivatives).

The use of financial instruments, particularly derivatives aimed at ensuring a reasonable degree of supply security for processing industries and final consumption, is widespread within real markets, to the extent that prices are strongly influenced by the use of deferred contracts relating to future production (the so-called forward contracts and futures contracts) [6]. In other words, these contracts, predominantly financial in nature, not only guarantee compliance with contractual agreements between the parties but also serve to reduce, or even eliminate, the risks arising from price volatility. They thereby limit the possibility that one of the contracting

[1] Externalities are defined by Pearce and Turner [4] as follows: "An external cost [benefit] exists when the following two conditions prevail: 1) an activity by one agent causes a loss [gain] of welfare to another agent; 2) the loss [gain] of welfare is uncompensated [unpaid]" [5].
In practice, a good may be defined as public if it possesses the following two characteristics:

- non-rivalry, whereby the consumption of any quantity of the good by one individual does not reduce its availability to others
- non-excludability, whereby it is neither technically nor economically feasible to exclude an individual from consuming the public good.

From a theoretical perspective, public goods may therefore be regarded as a particular form of externality, more specifically as non-depletable externalities [1].

[2] "Con il termine beni pubblici ci si riferisce a quei beni e servizi che possiedono le caratteristiche di non perfetta esclusione e non perfetta rivalità nel loro consumo o utilizzo, il che implica che la fruizione di tali beni non può essere circoscritta ad un individuo, e che la fruizione di questi beni da parte di un soggetto non preclude le possibilità di fruizione da parte di un altro" (The term *public goods* refers to goods and services characterised by imperfect excludability and imperfect rivalry in their consumption or use, implying that access to such goods cannot be restricted to a single individual and that the consumption of these goods by one person does not prevent their consumption by others.) [5].

parties may have to bear the difference between the current value of the commodity and the value prevailing at the time the contract is executed, by fixing in advance the conditions of exchange.

The use of derivatives, by making it possible to establish today the terms of future exchange, ultimately influences price dynamics whenever the volume of contracts becomes sufficiently large, encouraging convergence between the price agreed in the contract and the price effectively observed in the market.

The underlying reasons for this mechanism are well known: expectations of rising commodity prices represent an attractive profit opportunity for financial capital, such that capital inflows tend to reinforce expectations of rising prices, while outflows reinforce expectations of decline. These dynamics are confirmed by the effects generated by the substantial liquidity injections implemented by the US Federal Reserve in support of the recovery of the American economy following the financial crisis: the considerable volume of monetary resources injected into the market provided a significant stimulus to speculative purchasing activity.

It may therefore be argued that both the volatility and the direction of price movements are driven primarily by market fundamentals. The decisions taken by professional investors merely amplify these effects, entering into an already established trend and influencing the speed with which prices return to levels consistent with underlying supply and demand fundamentals.

Spatial and temporal arbitrage connect different trading locations and time horizons, facilitating the transmission of price signals across geographically distant or temporally separated markets. These mechanisms, which are characteristic of the microstructure of agricultural markets, may perform a stabilising function by reducing price discrepancies across time and space. However, in the presence of low inventory levels or logistical constraints, arbitrage activity may amplify fluctuations, thereby increasing short-term volatility. Their effectiveness therefore depends on prevailing market conditions, the degree of integration among trading venues and the overall informational efficiency of the system.

The so-called “speculative bubbles” are characterised by a rapid increase in prices generated by purchases that cannot be explained by underlying economic fundamentals and are instead typically associated with “imitative” or “herd” behaviour. Once price trends reverse, however, market participants generally realign themselves with fundamentals, rapidly selling assets previously acquired [7].

It is widely recognised, both in the academic literature and among market participants, that investment in commodities represents an attractive opportunity for portfolio diversification, particularly for portfolios composed exclusively of financial assets and therefore characterised by relatively homogeneous risk-return conditions [8].

Moreover, investment in commodities has historically offered several advantages, including [9]:

- protection of portfolios against unexpected inflationary events, benefiting from rising commodity prices while avoiding declines in equity valuations;
- the potential long-term appreciation of invested wealth resulting from the natural increase in commodity prices over time;
- the achievement of positive economic returns, derived from active portfolio management, in the presence of informational asymmetries, particularly by exploiting arbitrage opportunities across different trading venues;
- the possibility of benefiting from the absence of correlation between commodity portfolios and portfolios composed of equities and bonds.

In practice, particularly with regard to this final point, it should be noted that data observed in recent years reveal an anomalous relationship between stock market indices and commodity market indices. Under normal conditions, these two markets tend to move in opposite directions, reflecting the widely held assumption that

commodities constitute an attractive investment opportunity especially when financial assets exhibit negative trends. By contrast, the existence of correlated movements between the two markets reduces the ability of commodities to serve as an effective instrument for portfolio diversification.

Contrary to the arguments outlined above, the aforementioned correlation between stock market indices suggests that increases in commodity prices cannot be explained solely by underlying supply and demand fundamentals, but rather may partly reflect speculative behaviour. Such dynamics artificially influence the decisions of producers and investors, encouraging productive investment under the expectation of achieving returns higher than those ultimately attainable once prices once again accurately reflect the relative scarcity of a commodity and realign with supply and demand conditions.

The correlation between commodities and equity indices tends to increase during periods characterised by a strong presence of financial investors, particularly index funds and institutional investors. This integration across different asset classes has generated alternating phases of co-movement and decoupling, thereby affecting the capacity of agricultural markets to perform their traditional risk-hedging function. In this context, financialization operates as a transmission channel between real and financial markets, amplifying or attenuating volatility depending on macroeconomic conditions and investors' willingness to assume risk.

The dynamics described above have fuelled a broad academic debate on the role of financialization in the formation of agricultural prices, a debate that remains unresolved to this day. The literature is organized around two opposing strands, whose synthesis is essential for any assessment of the phenomenon.

The contemporary debate originates from the testimony delivered by Michael Masters before the United States Senate in 2008 [10]. On that occasion, Masters introduced the concept of index speculators—investors who purchase futures contracts not for hedging purposes, but in order to gain financial exposure to an asset class—interpreting the inflow of capital into futures markets as a genuine bubble, capable of pushing prices above the levels justified by fundamentals.

A substantial critical strand supports this interpretation. UNCTAD [11] documents how financialization has increased the permeability of agricultural markets to signals originating from the energy, equity and currency sectors: since index traders replicate baskets that include energy, metals and agricultural products, shocks affecting one segment are transmitted to the others through financial mechanisms, thereby amplifying and synchronizing price reactions. Empirically, Tang and Xiong [12] show that the massive entry of index investors acted as a systemic multiplier of the shocks observed in 2006–2008, intensifying correlations, volatility and cross-market transmission well beyond what could be explained by real fundamentals. From a theoretical perspective, the model developed by Basak and Pavlova [13] provides an explanation of the mechanism: index funds do not necessarily generate autonomous bubbles, but they amplify and diffuse shocks, making agricultural markets more sensitive to external dynamics and less closely aligned with fundamentals.

This interpretation is opposed by the neoclassical approach, whose cornerstone is represented by the contributions of Irwin and Sanders [14]. First, the authors argue that the temporal correlation between capital inflows and rising prices does not demonstrate any causal relationship. They also point to empirical evidence that is difficult to reconcile with the bubble hypothesis: if futures prices had been artificially pushed above equilibrium levels, an accumulation of physical inventories should have been observed, whereas between 2006 and 2008 inventories were actually declining. Along similar lines, Brunetti and Büyükşahin [15] conclude that speculators, far from being destabilizing agents, contribute to reducing volatility and to the efficient formation of prices by providing the liquidity necessary for risk transfer.

The literature therefore presents a mixed body of evidence, in which neither of the two strands can be said to prevail conclusively. This ambivalence, however, does not imply indeterminacy; rather, it indicates that the effect of financialization is conditional on the prevailing market regime. Under normal conditions, the presence of financial operators increases liquidity and supports price discovery, consistently with the arguments advanced by the neoclassical strand. In periods of market stress—characterized by large and sudden inflows of capital, such as those recorded in 2007–2008 and during the acute phases of the pandemic—that the same financial presence tends to become a factor of amplification, increasing volatility and weakening the link between prices

and real fundamentals. It is within this conditional framework that the reflections developed in the present work are situated.

Further confirmation of this conditional interpretation is provided by the most recent empirical literature. Studies based on dynamic conditional correlation models show that the interaction between agricultural commodities and financial assets has increased the transmission of volatility across markets—particularly for maize and for other highly traded commodities—while also confirming that this effect does not occur in a mechanically uniform way across different products or over different periods [16]. This evidence reinforces the need to avoid a binary interpretation of the phenomenon: financial investors may enhance liquidity and price discovery under normal market conditions, whereas the same channels may transmit non-fundamental shocks when portfolio rebalancing operations, margin calls, or index-related flows occur in conjunction with disruptions in physical markets.

In order for commodity markets to function efficiently, transparently and to generate reliable prices, it is essential that they remain sufficiently liquid, that is, characterised by a significant volume of transactions such that prices are not conditioned by a limited number of trades. Achieving this objective requires the participation of a large number of investors, including both professional financial operators, in particular, and commercial participants, although neither group is alone sufficient to ensure the proper functioning of the market. Indeed, while financial operators provide the necessary liquidity and thereby support high trading volumes by acting as counterparties, commercial participants are necessary to ensure that market prices remain aligned with underlying economic fundamentals.

Moreover, there are additional factors capable of explaining sharp increases in prices and which therefore warrant consideration:

- the continuous shift in global demand from services towards material goods, driven by the growing weight of emerging economies in global GDP;
- the increase in international trade resulting from the relocation of certain stages of the production process in pursuit of lower labour costs, leading to the vertical disintegration of value chains;
- the strong correlation between energy prices and the prices of other commodities, making it possible to observe similar patterns in the demand dynamics of different goods.

In fact, fluctuations in crude oil prices tend to be transmitted to cereals and other agricultural commodities through production energy costs, logistics and the prices of inputs such as fertilisers and transport. Historical indices reveal a clear comovement between oil and wheat prices (the oil–wheat link), highlighting how energy continues to represent a systemic source of volatility for agricultural markets, particularly during cycles of rising production costs and geopolitical tension. Nevertheless, beyond differing conjunctural contexts, the formation of agricultural commodity prices fundamentally depends on supply and demand trends. Therefore, a more thorough analysis of agricultural market dynamics requires, at this point, a closer examination of certain distinctive characteristics of these two variables.

With regard to supply, it is first necessary to recall David Ricardo’s law of diminishing returns, which also applies to the agricultural sector and, as is well known, describes the short-run production function. This law demonstrates that, all other things being equal, the progressive addition of further units of a factor of production initially generates a more than proportional increase in output, after which output continues to grow, albeit at a less than proportional rate relative to the additional input employed. In other words, a technical relationship exists between inputs and outputs, such that within any production system the addition of a factor of production—be it land, labour or capital—does not continuously correspond to an equally proportional increase in production. Applied to the agricultural context, this evidently constrains the supply capacity of the entire system, preventing unlimited growth and consequently hindering the achievement of food security, particularly given that the incremental availability of certain productive factors (above all land) cannot easily be altered, even in the long term. More specifically, over recent decades, growth in agricultural production has depended more on improvements in yields than on the expansion of cultivated areas, which have diminished as a consequence of urbanization, soil degradation and land-use conversion. As a result, long-term equilibrium has become

increasingly dependent upon innovation rather than the extension of agricultural land. It should also be noted that agricultural production is predominantly biological in nature, a feature that significantly influences the related production processes. Furthermore, the time interval between production, processing and market entry is relatively short, thereby limiting—except in a small number of cases and for brief periods—the use of management instruments associated with storage and preservation processes.

Another important issue concerns the natural character of the resources employed in production, among which land is clearly the most significant factor.

Finally, it should be recalled that the production decisions of agricultural entrepreneurs are heavily conditioned by expected prices. It may therefore reasonably be argued that farmers possess no real capacity to influence or determine the price of the goods and/or services they produce, to the extent that they may properly be defined as price takers.

In addition to the factors highlighted above, several other determinants of the supply structure also deserve consideration, in particular:

- trends in production costs (including the prices of seeds, energy, fertilisers, etc.);
- the profitability of alternative crops or productions (for example, corn rather than soybeans);
- the profitability of joint products (for example, meat and wool in sheep farming);
- the level of available stocks;
- the number of suppliers operating within the market;
- possible technological changes;
- the need to incorporate economies of scale into production, thereby rendering “dispersed production” inefficient while favouring greater concentration of production activities.

This latter point, in particular, explains the tendency of each country to specialise in the production of specific brands within a given product category, rather than across different types of products. As a necessary consequence, the largest share of trade tends to occur between similar countries characterised by distinct productive specialisations in branded goods [17].

As an immediate consequence of this situation, groups of similar countries tend to form trade blocs, adopting a monopolistic stance towards other countries and imposing their own prices [18].

Turning now to consider the demand side, it is likewise possible to identify a series of characteristics capable of influencing the relationship between price and quantity demanded, bearing in mind that, for ordinary goods, the demand function is generally downward sloping: as prices increase, the quantity demanded declines. Demand pressures are driven by population growth and rising incomes, accompanied by a reconfiguration of consumption patterns towards higher consumption of animal proteins, which intensifies competition between crops intended for direct human consumption and those used for animal feed. This dietary transition, supported by the expansion of the global middle class, increases demand for cereals and oilseeds for livestock production, thereby contributing to greater pressure on international agricultural prices.

More specifically, the principal determinants of demand include:

- consumer tastes and preferences, which generally favour a wide variety of brands;
- demographic factors, particularly the structure and size of the population;
- the level of income and its distribution across the population;

- the availability and price of substitute goods (goods regarded by consumers as alternatives to one another);
- the availability and price of complementary goods (those consumed together);
- expectations regarding future price changes.

While it is true that the joint interaction of supply and demand serves to determine the equilibrium price, other variables that are "exogenous" to the market must also be taken into account, insofar as they are capable of influencing the determination of the exchange value of a good. These include weather forecasts, the political situation and governmental decisions in producing countries, as well as the possible presence of embargoes, wars or pandemics. Among the non-economic determinants, climatic factors—such as heatwaves, extreme rainfall, droughts and cyclones—are assuming an increasingly important role, directly affecting agricultural yields, crop quality and consequently market prices. Such events act as powerful multipliers of volatility, amplifying short-term price fluctuations and intensifying production-related uncertainties. The growing frequency and intensity of extreme events associated with climate change increasingly destabilise market expectations and reduce the predictability of future yields. Similarly, issues relating to the environmental impact resulting from trade in goods, together with the rapid expansion of electronic commerce, must by no means be regarded as marginal.

In essence, what emerges from the foregoing considerations is that the combined effect of these factors renders price a highly volatile variable, characterised by pronounced fluctuations, even on a daily basis. This implies that producers may obtain significantly different selling conditions depending on the precise moment at which they choose to sell their products.

The experience of recent years has confirmed that food commodity markets have become increasingly vulnerable and subject to extreme price variability [19]. This circumstance appears to be linked to the occurrence of three major developments:

- The globalisation of markets. Indeed, it is well known that the agricultural commodities sector was among the first to experience competition on a global rather than merely local scale, thereby extending its potential negative effects to the world's most fragile and impoverished countries and populations. Decisions taken by a single country or market operator within a specific region ultimately affect other economies and social groups, often with amplified consequences;
- Market integration. Unlike in the past—as noted above—price levels are no longer determined solely by the macroeconomic variables of the agricultural sector. Although market fundamentals continue to underpin equilibrium conditions, short-term price volatility is increasingly influenced and intensified by a range of exogenous factors, among which speculation, particularly financial speculation, plays a decisive role. This has produced a gradual separation between the productive system and the mechanisms of price formation, thereby making the planning of entrepreneurial activities and investment decisions increasingly difficult;
- The role of public policies. The measures thus far adopted by many countries, especially the more advanced economies, to counteract price volatility have not proved effective and, in some cases, have even been counterproductive. As repeatedly emphasised throughout this discussion, there is a pressing need for coordinated and shared policy interventions aimed at avoiding conflicting measures that would merely exacerbate the already pronounced vulnerability of agricultural commodity markets.

The latest market data highlight the importance of analysing individual commodities rather than relying solely on aggregated food price indices. In May 2026, the FAO Food Price Index stood at 130.8 points, remaining broadly unchanged from the previous month (-0.2%), while still exceeding its level of a year earlier by 2.9% [20]. Beneath this aggregate stability, however, the FAO Cereal Price Index reached 114.3 points, rising by 2.6% month-on-month and by 4.9% year-on-year. This underscores how overall price stability can mask acute pressures within specific market segments.

Table 1. Selected Market Indicators Relevant to Agricultural Price Volatility (May 2026)

Indicator	Observation (May 2026)	Implications for the Analysis
FAO Food Price Index	130.8 points; -0.2% month-on-month; +2.9% year-on-year	Aggregate stability may conceal commodity-specific market pressures.
FAO Cereal Price Index	114.3 points; +2.6% month-on-month; +4.9% year-on-year	Cereals remain a key channel of price volatility.
Wheat	+3.4% month-on-month; +7.8% year-on-year	Weather-related shocks and input cost increases are rapidly transmitted to prices.
Maize	+1.9% month-on-month	Import demand, tighter supply conditions, and higher energy costs continue to support prices.
Rice (FAO All Rice Price Index)	+2.7% month-on-month	Weather-related concerns and crude oil-linked costs are strengthening price quotations.

Source: Authors' calculations based on FAO Food Price Index data, May 2026 release.

Alongside the structural relationship between energy and agricultural prices, a further element of interconnection is represented by the development of biofuels, promoted through the energy policies of the United States and the European Union. The growing demand for agricultural raw materials intended for the production of bioethanol and biodiesel has diverted cultivable land away from food production, altering the composition of supply and contributing to rising prices and increased volatility. The allocation of agricultural resources towards energy uses has affected the levels of global market equilibrium, thereby intensifying the tensions between food security and energy security [21].

These geopolitical dynamics are also reflected in the structure of contractual relationships and in producers' capacity to access markets.

A number of policy proposals have been advanced with the aim of correcting the vulnerability of food commodity markets. All of them, however, require concrete intervention and a coordinating role on the part of the major international organisations operating within the agricultural sector (FAO, IFAD and WFP), as well as those more generally concerned with economic development (the World Bank and the IMF) and international trade (the WTO).

In schematic terms, such medium- to long-term interventions concern:

- market monitoring, with the aim of enabling timely intervention in, or even the prevention of, agricultural price crises;
- the elimination, or at least the reduction, of all policies restricting imports and exports between countries;
- the control of supply levels, in order to optimise the management of production flows within the market;
- the adoption of appropriate policies to support and stabilise farmers' incomes.

Export restrictions, land grabbing and geopolitical shocks directly affect the availability of food commodities and the level of stocks, thereby altering the international transmission of prices. Such dynamics contribute to increased volatility and generate structural imbalances between exporting and importing countries, exacerbating the food insecurity of economies that are more dependent on imports. These phenomena, together with national strategies aimed at food self-sufficiency and policies of resource hoarding, demonstrate how agricultural markets respond not only to economic logics but also to geopolitical interests and strategic security considerations.

When this condition of market vulnerability is combined with the fragility of the entrepreneurial structure of the agricultural sector—composed predominantly of small and micro-sized enterprises—it becomes clear how

difficult it is for producers to assert their position within the market itself. This difficulty also derives from the structural asymmetry in bargaining power that places agricultural enterprises in a position of weakness, in particular in relation to intermediaries, who are generally endowed with considerable financial resources. Such a condition may even compel the weakest farmers, when purchasing production inputs, to buy through cash payments, especially considering that the goods traded are typically highly perishable and characterised by inherently short production and transport cycles. For purchasers, paying cash upfront means being unable either to plan adequately the cost of inputs or to protect themselves against the risk of price fluctuations.

Conversely, continuing to consider this condition of weak bargaining power, when the weaker party—which is always the agricultural entrepreneur—acts as seller, recent years have witnessed the opposite phenomenon, namely the progressive widening of the gap between the prices paid to producers, often set even below production costs, and the purchase prices paid by buyers, whether processing firms or final consumers. In practice, the revenue guaranteed to producers is excessively low and bears no relation to the final selling price. The latter is normally determined by commercial intermediaries at a much higher level, one that is clearly disadvantageous to consumers and designed primarily to remunerate, in an inequitable manner, only certain segments of the supply chain. Moreover, contractual weakness concerns not only relations between countries but also those between the actors within the supply chain, pushing prices to levels that are ultimately unsustainable for operators who, unlike large-scale retail distributors, are unable to benefit from economies of scale or other logistical advantages [22]. Consequently, the prices received by sellers are excessively low and economically unsustainable, while those faced by buyers are excessively high in relation to the costs sustained. In this way, the progressive lengthening of the supply chain has, in certain territories, reduced the income-multiplier effects in the agri-food sector.

In response to this situation, recent years have witnessed growing efforts, particularly within the agricultural sector, to promote so-called “alternative supply chains”. These refer to systems of production and distribution organised not around large agro-industrial corporations and large-scale retail distribution, but rather around small and medium-sized enterprises that pursue, alongside the traditional objective of business growth, broader aims of multidimensional sustainability grounded in a strong value-based orientation [23]. Such entrepreneurial structures are characterised by strong territorial embeddedness, centred on socially embedded market relations and therefore committed to promoting equity, direct producer–consumer relationships and product traceability [24]. This supply-chain model emerged and was developed in opposition to the aspects of conventional supply chains considered problematic.

The best-known alternative supply chains include organic farming, fair trade and, more recently, farmers’ markets.[3] However, these organisational forms are not always able to uphold the value-based principles on which they were founded, particularly where economic survival requires adaptation to market pressures associated with economies of scale and price competitiveness. Consequently, in some cases they have come to share a number of characteristics with the dominant supply chain, as illustrated, for example, by organic production carried out by large enterprises and distributed through large-scale retail channels. In such circumstances, some of the core principles underpinning alternative supply chains (notably supply-chain fairness, direct producer–consumer relationships and reduced environmental impact associated with logistics) tend to be partially set aside in order to preserve concrete market opportunities, while nonetheless maintaining, at least to some extent, the social and/or qualitative objectives associated with food production. In practice, this has given rise to a range of “hybrid” arrangements positioned along a continuum between conventional and alternative supply chains, without it yet being possible to determine which of these different organisational models is likely to prevail over the medium to long term [26].

In essence, from whatever perspective one chooses to examine it, the agricultural commodities market appears as a system characterised by a plurality of asymmetries relating to the information available to market participants, the financial resources at their disposal and, ultimately, the bargaining power they possess.

[3] Farmers’ markets are examples of direct producer-to-consumer sales that embody the principles of the “short supply chain”. They emerged and developed as an alternative to the so-called “long supply chain”, in which agricultural products typically pass through one or more intermediaries before reaching consumers [25].

As already noted in relation to financial issues, the asymmetries present in this context once again prevent the achievement of market efficiency, thereby requiring external corrective intervention capable of restoring the mechanisms necessary to attain overall equilibrium.

Accordingly, two possible strategies may be identified to improve the functioning of the market, both of which may once again be regarded as fundamental to the pursuit of sustainability:

- shortening the supply chain by facilitating direct market access and reducing intermediary stages that artificially inflate prices;
- encouraging producer aggregation in order to enter into hedging derivatives contracts on a larger scale, thereby managing volatility and promoting spot–futures convergence.

The advantages associated with "short" supply chains also extend to rural and local development, the protection of productions and their connection with the local area, the preservation of farming and production traditions and the safeguarding of the organoleptic qualities of products [27].

By contrast, the environmental effects of such an organisation of production and distribution, although often regarded as unquestionably positive, are actually more uncertain, as they depend on the ability of operators to develop efficient logistics systems [23].

The "aggregative" solution, proposed as one of the strategies for achieving a sustainable market, requires the creation both of networks linking the various actors within the supply chain and of physical or virtual spaces in which farmers and distributors can interact, with the specific aim of fostering forms of cooperation capable of reducing costs and facilitating knowledge transfer [28].

However, while futures markets have existed for many commodities for several decades, for others trading is only possible on the spot market, through the physical exchange of goods. More specifically, for a derivatives market in commodities to be effectively established and maintained—assuming the existence of a genuine need on the part of farmers, in their dual role as buyers and sellers, to hedge against the risk of price fluctuations—at least three conditions are required [9]:

- the actual delivery, at least in certain circumstances, of the commodity underlying the derivative contract. This requires the good to be storable and capable of warehousing, thus limiting the scope for hedging operations in the case of agricultural products;

- the need to identify, in an objective way, the qualitative and quantitative characteristics of the underlying asset, with the consequent requirement to define in advance the standard characteristics of the commodity to be traded;

- an adequate level of competitiveness within the spot market, allowing the spot price of the commodity to fluctuate freely. The existence of direct or indirect forms of control over prices or supply would, in fact, deprive both the market itself and trading activity of their very rationale.

The first fundamental step, however, is not to regard derivatives markets as arenas reserved exclusively for a limited number of financial operators, or, worse still, to exclude a priori the possibility for agricultural entrepreneurs—including smaller-scale producers—to make use of them. In order to make such markets more transparent and therefore more accessible, one possible approach would be to follow the model adopted in the United States, where the Commodity Futures Trading Commission (CFTC) publishes on a weekly basis the *Commitments of Traders Report* (COT), detailing—as already discussed extensively in the previous section—open positions by category (commercial traders, money managers, swap dealers, reportable investors and non-reportable investors).

In summary, the development of a futures market capable of meeting the needs of a sustainable agricultural entrepreneurial system requires:

- a sufficient volume of transactions to guarantee adequate market liquidity and thereby support efficient market functioning;
- an adequate number of market makers (banks, brokers, etc.) equipped with appropriate operational structures;
- commercial operators (producers, agri-food firms and their associations) possessing sufficient economic and operational scale to sustain market commitments;
- the development of a market "culture" through the expansion of knowledge and targeted training initiatives.

It is evident that, beyond the theoretical soundness of the two aforementioned strategies—direct market access and the collective management of derivative contracts—debate remains open regarding the measurability of their results, particularly in light of the growing complexity of markets and the conditions facing market participants, including evolving consumer preferences.[4] The role of public policymakers is fundamental in achieving this objective, through the adoption of targeted policies designed to encourage coordination among operators of comparable scale.

In particular, it should not be forgotten that the ultimate objective remains that of enabling producers to obtain a selling price capable of adequately remunerating their activity—thereby ensuring their economic survival—in relation to input costs, which must likewise be kept at sustainable levels.

However, similar policies have already been implemented in recent years, albeit without yielding satisfactory results. The first criticisms have come from those who argue that facilitating processes of supply concentration alters the competitive structure of the sector, with all the consequent implications for prices.

Others attribute the failure of such "aggregative" policies to the difficulty of controlling supply, particularly given that farmers are often able to shift from one type of production to another without incurring significant entry or exit costs [29].

Both of these criticisms immediately recall the "theory of contestable markets" [30], and in particular the effects of potential competition in the absence of any form of asymmetry favouring firms already operating in the market.

As is well known, a market may be defined as contestable when the following conditions are satisfied:

- the absence of barriers to entry, whether arising from administrative constraints or other costs, such that new entrants are able to access the same technologies, information and input prices available to firms already operating in the market;
- the absence of sunk costs associated with market exit;
- the requirement that potential competitors be able to enter the market within a shorter period of time than that required for existing firms to adjust their prices in response to the new competition.

A market characterised by these conditions will tend towards efficiency because, on the one hand, inefficient producers will be driven out by competitors capable of producing at lower costs; on the other hand, firms wishing to remain in the market will necessarily have to operate at minimum cost levels and therefore will be unable to earn excess profits without risking replacement by more efficient competitors.

What matters for market equilibrium, therefore, is not so much an increase in the number of firms operating in the market, but rather the condition that potential competition remains unrestricted. Indeed, whatever form the

[4] For a broad and in-depth review of the literature on sustainability assessment within the agricultural supply chain, see the aforementioned [23].

market may take (perfect competition, monopoly, oligopoly, etc.), provided that the above conditions are satisfied, it would still represent the most efficient structure for that particular sector. In other words, the contestability of a market is, in itself, sufficient to ensure its efficiency.

Moreover, the efficiency ensured by market equilibrium also constitutes a sufficient condition for the achievement of sustainable welfare. More specifically, if the quantities produced are entirely absorbed at the equilibrium price and no firm operates at a loss, the market may be considered sustainable. However, while a sustainable market is always efficient, an efficient market configuration is not necessarily sustainable. It may therefore be concluded that equilibrium in a contestable market presupposes sustainability, which in turn presupposes efficiency. Consequently, only certain efficient market configurations are sustainable, and of these, only some are equilibrium configurations [29].

Efficiency and sustainability are therefore linked by a cause-and-effect relationship. This further confirms that, unless intervention is undertaken in agricultural product markets to facilitate direct access for producers and to promote the attainment of sustainable welfare, it is not even possible to envisage the achievement of market equilibrium.

CONCLUSION

The contemporary agricultural market reflects a delicate balance between economic, political and social dynamics. Its sustainability cannot be understood solely in terms of allocative efficiency, but must also encompass objectives of equity, stability and food security.

The Covid-19 pandemic acted as a systemic shock, disrupting supply chains, reducing transport capacity and altering patterns of demand across consumption channels (such as the hospitality and food-service sector [Ho.Re.Ca.] and household consumption). Export restrictions adopted by some countries, together with stockpiling practices in others, further amplified uncertainty, with visible effects on prices and on the spread between spot and futures markets.

From a financial perspective, heightened volatility increased margin requirements and strengthened the correlation between agricultural commodities and other risky assets, thereby reducing opportunities for diversification. The transmission channels through which these dynamics contributed to food insecurity mainly operated at three levels:

1. higher and more volatile consumer prices, with a regressive impact on lower-income groups;
2. reduced predictability of agricultural investment and access to credit;
3. greater vulnerability of net food-importing countries to fluctuations in international prices and exchange rates.

Limited storage capacity, heterogeneous production standards and the fragmentation of producers have made it more difficult both to benefit from favourable price movements and to cushion adverse ones.

In light of these considerations, it becomes necessary to develop mitigation strategies aimed at strengthening the resilience of agricultural supply chains. The stock-to-use ratio is a key indicator for understanding the stability of agricultural markets: low stock levels amplify supply shocks, whereas higher stock levels help absorb them, thereby contributing to short-term price stabilisation. By acting as a buffer mechanism, storage reduces the magnitude of price fluctuations and enables a more gradual adjustment to unexpected changes in production or demand. From this perspective, efficient stock management becomes a crucial element of market sustainability, as it helps ensure continuity of supply and mitigate the effects of external shocks.

On this basis, the political and economic response must be oriented towards an integrated mitigation strategy requiring a coordinated set of measures: strengthening risk-hedging mechanisms for small and medium-sized producers; investment in logistics, storage infrastructure and supply-chain digitalisation; promotion of data transparency (with regard to stocks, market positions and trade flows); and enhanced policy coordination in order

to reduce the use of export restrictions. At the same time, it is essential to support access to food for vulnerable groups and ensure that shock waves originating in global markets do not translate into local food crises.

Before assessing the practical feasibility of such measures, it is necessary to establish a clear hierarchy of priorities. Since financialization primarily affects the transmission and amplification of shocks, whereas logistical, contractual and organisational weaknesses determine the ability of producers and consumers to absorb them, the foremost policy priority should be strengthening supply-chain resilience. Financial market regulation remains essential, but it should be conceived as a complementary instrument: its role is to preserve the transparency of price discovery and access to risk-management tools, rather than to substitute for investments in storage capacity, logistics, producer aggregation and food-access policies. In other words, the issue is not to exclude financial operators from futures markets—whose presence is often necessary to ensure adequate liquidity—but rather to prevent financial dynamics from prevailing over the informational function of prices.

The mitigation strategies discussed thus far nevertheless raise important questions regarding their practical implementation. Among the most frequently proposed approaches is the shortening of the supply chain. By facilitating direct access for producers—appropriately organised so as to achieve a minimum efficient scale—to final markets, this strategy seeks to eliminate the multiple layers of intermediation that dissipate value and contribute to prices that are simultaneously too low for producers and too high for consumers. This logic of disintermediation is analogous to that pursued in more advanced financial markets in the relationship between providers and users of capital. Alongside this approach is the collective management of derivative contracts, aimed at equipping producers with instruments to hedge against price volatility.

Notwithstanding their theoretical validity, the outcomes achievable through such strategies remain difficult to measure, particularly in light of the growing complexity of markets and the heterogeneity of the conditions under which economic agents operate. Moreover, these are by no means novel instruments: similar aggregation policies have already been implemented in the past without generating results widely regarded as satisfactory. The reasons for their limited success are manifold. On the one hand, facilitating supply concentration may alter the competitive structure of the sector, with potentially non-neutral effects on prices. On the other hand, the difficulty of controlling supply is exacerbated by the ability of farmers to switch from one crop to another without incurring significant entry or exit costs. In the light of the theory of contestable markets, this circumstance weakens the effectiveness of any attempt at coordinated market management.

Furthermore, the feasibility of these measures varies according to the physical characteristics of the commodity concerned. For storable and standardisable commodities—such as wheat, maize, rice and soybeans—the most realistic strategy consists of combining warehouse receipt systems, certified storage facilities, producer organisations and collective hedging mechanisms. Aggregation is particularly important in this context, since small-scale producers rarely possess the scale required to meet margin calls, standardise contract quality or manage basis risk. Cooperatives, consortia and food hubs can therefore act as intermediaries between individual farms and futures markets, enabling risk sharing without requiring every farmer to become a financial market participant. For perishable products, or for commodities lacking liquid derivatives markets, a different set of interventions is required. In such cases, the direct use of futures contracts is often impracticable, and resilience depends instead on investments in cold-chain infrastructure, local processing capacity, pre-season contracting arrangements, price-indexed supply agreements, digital traceability systems and shorter marketing channels. The viability of short supply chains, in particular, should not be assessed solely in terms of the physical distance between producers and consumers, but rather according to the system’s ability to reduce information asymmetries, payment delays, logistical inefficiencies and the gap between farm-gate and retail prices.

It follows that the practicability of these measures depends to a decisive extent on the role of public policy. Policymakers are required not only to encourage coordination among operators of comparable size, but also to provide smaller producers with the bargaining power, skills and resources that they would otherwise lack, while simultaneously addressing the factors that generate the gap between sustainable prices and market prices. In the absence of such preconditions, mitigation strategies risk remaining theoretical aspirations rather than genuinely implementable solutions.

A further condition for feasibility concerns financing. Storage facilities, digital platforms, insurance schemes and collective hedging arrangements all require working capital. Public intervention may therefore be justified not only through direct subsidies, but also through guarantee funds, concessional credit lines, support for margin requirements, public-private partnerships in storage infrastructure, and technical assistance aimed at fostering a culture of risk management. Instruments of this kind would reduce the fixed costs of market participation and enable even smaller producers to benefit from tools that would otherwise remain accessible only to large commercial operators.

Ultimately, the sustainability of agricultural markets does not arise automatically from allocative efficiency. Rather, it requires an institutional framework capable of reconciling distributive equity, producer profitability and the affordability of food.

Finally, if these strategies are to move beyond mere statements of intent, their effectiveness must be assessed through measurable indicators. These may include the stock-to-use ratio for major cereals, the share of output marketed through producer organisations, the gap between farm-gate and retail prices, the magnitude of storage losses, the proportion of producers with access to forward or futures contracts, the cost of fertilisers relative to crop prices, and the frequency of export restrictions during periods of market stress. Indicators of this kind would enable policymakers to distinguish between strategies that merely redistribute rents within the supply chain and those that genuinely reduce systemic vulnerability.

In conclusion, the efficiency and resilience of agricultural markets depend on the interaction between market fundamentals, financial market microstructure and governance. The pandemic demonstrated that market discipline alone is insufficient to ensure stability and inclusiveness. What is required are is the development of institutional frameworks and risk-management instruments capable of supporting the supply chain—particularly smaller producers—and of guaranteeing sustainable growth and shared food security over the long term.

Ethical Approval

This study did not involve human participants or animals; therefore, ethical approval was not required.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data Availability

Data sharing is not applicable to this article, as no new datasets were generated or analysed. All sources used are publicly available and cited in the references.

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