Capital Markets

Digital Intelligence Strategy: Quantifying the Nature of Rising Food Prices

Food Series Deep Dive, Part 1

RBC Elements™

Driving insights through data

DIGITAL INTELLIGENCE STRATEGY RESEARCH | MAY 26, 2022

For Required Digital Intelligence Strategy Research Conflicts Disclosures, see page 17.
For Required Equity Research Non-U.S. Analyst and Conflicts Disclosures, see page 19.

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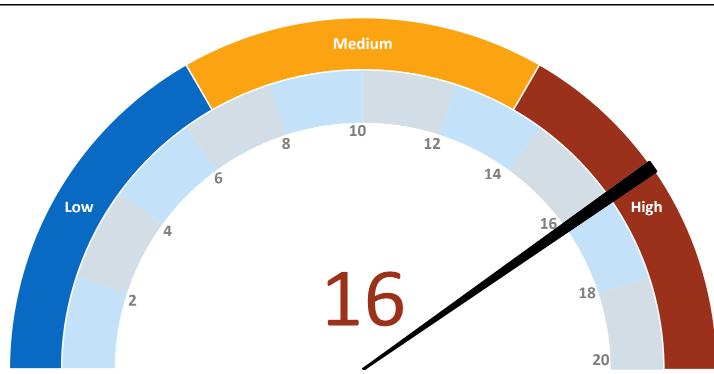
Digital Intelligence Strategy: Quantifying the Nature of Rising Food Prices

Food Series Deep Dive, Part 1

- Soaring food prices are not a secret. Europe's breadbasket is an active warzone, droughts in Brazil may sap supply, protectionist policies in Asia are tightening global agriculture exports, and rising costs of fertilizers are wreaking havoc on planting decisions.
- Global food prices are rising, but how quickly and how will we know when and whether food prices have peaked? We introduce our **Food Input Index** (FIX), which is currently at 16 on a scale of 1 to 20, with a score of 20 representing maximum upward pressure on drivers of the food supply chain. The goal of FIX, which updates weekly, is not to opine on why the input costs are changing; clearly, inputs ranging from diesel and fertilizer prices to plastics and truck spot rates, and others, will oscillate for fundamental reasons. Rather, we focus on how the inputs drive the FIX, as a way to quantify how the food landscape is evolving. The current 16 marks the highest rank since the origin of our data in 2019. For context, the FIX averaged 2.2 from 2019 through 2020 and increased from entry in Jan'21 at 4.75 to exit in Dec'21 at 12.
- **Spot trucking** and **freight rates** have edged 15–20% lower year to date, but the primary drivers of the acceleration of the FIX lie within the prices of plastics and diesel, both of which have more than doubled. Agriculture prices, including **fertilizers** and **futures prices** (wheat, corn, and soybeans) have also inflected meaningfully higher. That said, volatile farm prices impact the end consumer less today than historically has been the case, and the **USDA's Food Dollar** corroborates our view. The findings suggest that of every dollar spent on food, only 16 cents is attributable to changes in the raw farm inputs; this compares to 41 cents in 1950. Inputs such as energy, transportation, packaging, and processing have dramatically increased as a percentage of the food supply chain over recent decades.
- We dissect the food supply chain from farm to retail by quantifying the relationship between **raw input prices** and the trickle-down to consumers at the **grocery store**. We collaborate with **RBC Elements™**, our in-house data science team, to quantify the cost pass-throughs for the food supply chain from farm to wholesale prices and from wholesale to retail. This decomposition allows us to study components of the relationship and ascertain the portions of the supply chain that are passing through or absorbing the higher food costs.
- Grocery prices have increased, yet our work suggests that retail items have likely yet to fully reflect **higher input costs**. The pass-through from farm to retail differs by item and supply chain. Goods requiring a higher degree of processing, such as bread (8.3% passed through over 1–4 months), typically see smaller pass-throughs that take longer. Items requiring less processing, such as beef (35.3% over 1–6 months) and milk (24.3% over 1–2 months), see both larger and faster pass-throughs, on a relative basis, from farm to retailer.
- Most importantly, we partner with our **equity analysts** (Andrew Wong – Fertilizers, Arun Viswanathan – Chemicals & Packaging, and James Edwardes Jones – European Consumer Staples) to highlight sector-level color on input costs that impact food prices (pages 12–15).

Figure 1 – RBC Food Input Index (FIX)



Source: RBC Capital Markets, CRU, Bloomberg, AAA, DAT, Polymer Update, Drewry

All values in US Dollars unless otherwise noted.

Priced as of prior trading day's market close, ET (unless otherwise stated).

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See RBC Elements page at the end of this note.

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Introduction: Full Grocery Cart, Empty Wallet

Food inflation is currently at 40-year highs and rising.

Wheat futures have rallied more than 75% over the last 12 months, and a bushel of corn is nearly 20% more expensive. Food inflation has risen to the highest point in over 40 years. As such, several major agriculture-producing nations have banned exports of certain crops, sparking dialogue about food protectionism that is likely to accelerate the degree of global scarcity. Tightening global food supply, punctuated by Russia's invasion of Ukraine, has led to escalating pricing that is eating into the wallets of consumers at the same time that global energy prices are also soaring. Few instances make an average household feel less affluent than when the affordability of food and energy come into question. As part of our Digital Intelligence Strategy framework, we attempt to tackle the most pressing market issues using data science and alternative data. This note, which focus on food, follows the recent geospatial intelligence-led exercise that included the tracking of 135,000 US retail gas stations, in real time, to assess demand destruction as prices punch in at record levels.

War, drought, protectionist policies, and supply chain constraints are all adding to current upward price pressures.

Soaring grocery bills are not a secret. Europe's breadbasket is consumed by war, droughts in Brazil may sap supply, protectionist policies in Asia are tightening global agriculture exports, and rising costs of fertilizers are wreaking havoc on planting decisions, globally. The US CPI Urban Consumers Food Index has risen by more than 8% over the last 12 months. The bottom line is that the entire global food supply chain is seeing price escalation.

G7 agriculture ministers are sounding alarm bells on the increasing risk of a global hunger crisis. To manage food security, several major global exporters have taken decisive steps over recent weeks to ring-fence domestic supply by implementing restrictions or outright bans on exports. This is the case with palm oil in Indonesia and wheat in India. Indonesia is the global leader in palm oil sales and India is a top 10 global wheat exporter. The threat to global food security is clearly at stake, as recent developments have sparked a wide-ranging wave of food protectionism. If additional producers declare a degree of nationalistic market obligation and take similar steps in an attempt to shield their domestic population from soaring food inflation, the threat of civilians taking to the streets is significant.

Regional food shortages have already spurred civil unrest and we have yet to hit peak prices or supply constraints.

A cut to government subsidies triggered price spikes across various flour-based products, leading to mass street protests spanning at least half a dozen provinces in Iran earlier this month. The subsidy cut led to multi-fold price increases across key items central to the Iranian cuisine. Clearly, this does not bode well for a country where nearly half of the population lives below the poverty line. This intensification led the government to impose disruptions to, and at times a near total shutdown, of mobile internet.

Figure 2 – RBC Food Input Index (FIX)

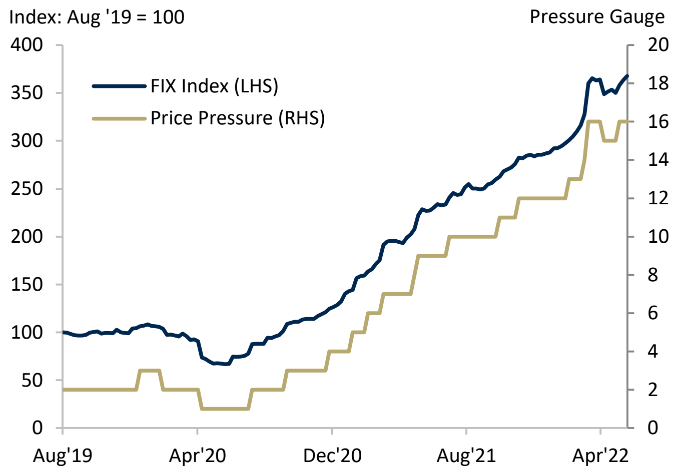
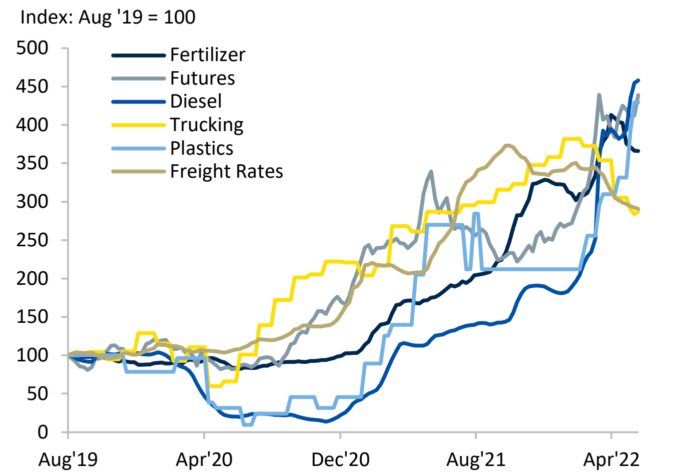


Figure 3 – Food Input Index Components



Source: RBC Capital Markets, CRU, Bloomberg, AAA, DAT, Polymer Update, Drewry

RBC's Food Input Index (FIX) provides weekly insights into the pace and direction of key food input costs.

Following our recent note that leveraged geospatial intelligence to monitor real-time shifts in societal behavior given record gasoline prices (*Full Tank, Empty Wallet*), this report uses alternative data to unpack the hidden societal trends in a world of rising food prices. In this note, we aspire to shed light on this theme through various data-intensive exercises.

First, we introduce our Food Input Index (FIX). This is a weekly measure that aims to quantify major input costs into the food vertical, evaluating the direction, pace, and scale of food price pressure on a scale of 1 to 20. Second, and the most computationally rigorous exercise that we have undertaken, we study the historical relationship between farm prices (physical proxy for agriculture futures prices) and retail grocery store pricing to ascertain how a change in raw input prices will trickle down to consumers and when.

Part 1: Introducing the RBC Food Input Index (FIX)

The FIX index currently reads 16 out of 20, with 20 representing maximum input cost pressures.

Food prices are rising. But how quickly? What's the rate of change? And, how will we quantify when and whether food prices have peaked? We introduce our Food Input Index (FIX), which is currently clocking in at a 16 on a scale of 1 to 20, with a score of 20 representing perceived maximum upward pressure on inputs to the food supply chain (see Figures 1 and 2).

The FIX is a measure that incorporates weekly inputs with the aim of quantifying the evolution of key drivers of food prices, and while there undoubtedly exist regional nuisances that feed into prices that consumers pay, the purpose of our index is to capture the bulk of major inputs influencing the broad direction of prices. Similar to our GOAT and GOAL mobility indices, our vision is to create a one-stop-shop leading quantifier to identify rate of change and inflection points as it pertains to food pricing, rather than a definitive, surgical quantitative measure.

Like our GOAT & GOAL mobility indices, FIX serves as a one-stop shop for monitoring the direction of food input costs.

In short, the pace, velocity, and directional trend drive the interpretation value. The bottom line is that if the inputs comprising the FIX are increasing or decreasing, logic would suggest that food prices are likely to follow. See the Appendix (page 10) for index components, construction, and additional details.

Our goal for the FIX is not to opine on why the input costs are changing; rather, we acknowledge that the inputs, ranging from diesel and fertilizer prices to plastics and truck spot rates, will oscillate for individual fundamental reasons. We are focused on how the inputs into the composite index (weights calculated based on the USDA's Food Dollar Series) drive the output of the FIX, as a way to quantify rate of change for our readers as to how the food landscape is evolving over time.

Current FIX reading of 16 is the highest level seen since data initiation in 2019.

As mentioned, the FIX currently registers at 16 on the 20-point scale. This is the highest point seen since the origination of our data in 2019. For context, the FIX averaged 2.2 from the initiation of our index until the end of 2020 and rose to average 8.9 in 2021. The FIX averaged 4.75 in Jan'21 and ended the year at 12.

Prices of diesel and plastics are leading the index higher, while trucking spot rates fall.

A visual portrayal of the components comprising the FIX is shown in Figure 3. Since the beginning of the year, spot trucking spot rates and freight rates have edged 15–20% lower, but the primary drivers of the acceleration of the FIX lie within the prices of plastics and diesel, both which have more than doubled. Farming prices, including fertilizers and futures prices (wheat, corn, and soybeans), have also inflected meaningfully higher, particular since Russia invaded Ukraine. See the Appendix for more on the USDA Food Dollar, after which we loosely model the index weights.

The composition of our FIX is interesting in that the components that make up food pricing, such as energy and packaging, have become an increasingly larger input cost for the food process. See "Diluting of Farm Values Over Time" on page 9 for more.

Part 2: Farm to Grocery Store – Price Pass-Through

UN World Food Price Index up 29.9% YoY. Vegetable oils lead – up 46% YoY.

The United Nations Food and Agriculture World Food Price Index (FFPI), which is a measure of changes in international prices of a basket of food commodities, is punching in at levels near record highs. April levels clocked in a sliver below the all-time peak set in March, but the 12-month rolling average of YoY changes has increased by a staggering 29.9%. The index consists of five sub-indices: vegetable oil (+46%, YoY Chg), cereals (+34.3%), dairy (+23.5%), sugar (+21.8%), and meat (+16.8%). During the early days of Russia's invasion of Ukraine, the Food and Agriculture Organization warned that the conflict between Russia and Ukraine could spike prices by 20%. Since the beginning of the invasion, the FFPI has increased by 12%.

The key question remains how do record-setting farm prices impact both food wholesalers and retail consumers? Further, what is the downstream pass-through time lag? In this section, we aim to unpack how much of a change in raw input prices will trickle down to consumers, and when.

Figure 4 – UN World Food Price Index

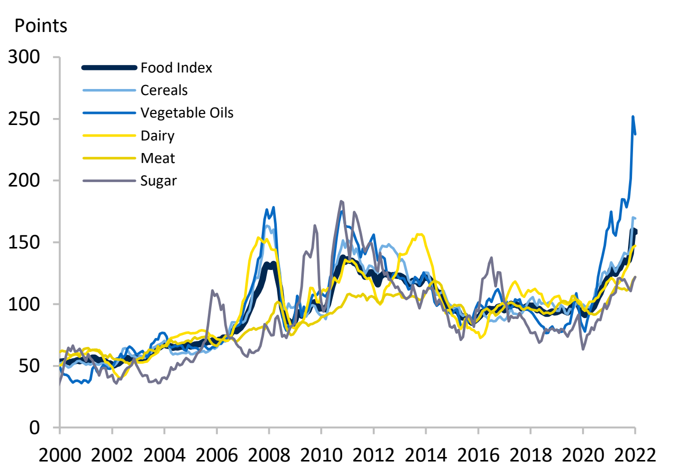
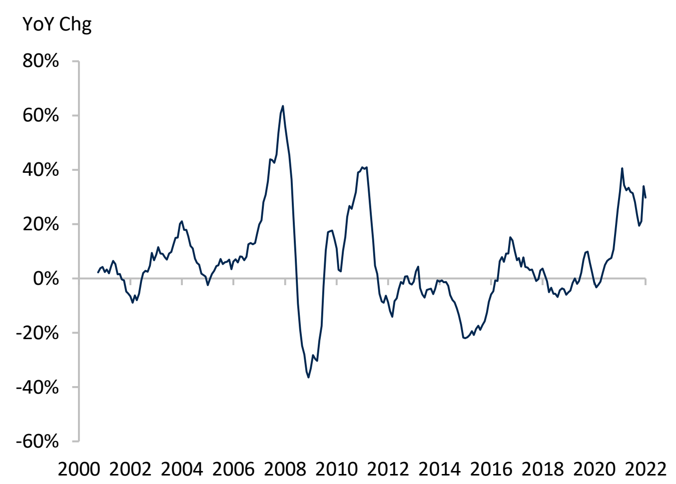


Figure 5 – UN World Food Price Index, YoY Chg



Source: RBC Capital Markets, United Nations

Dissecting the Food Supply Chain, by Product

In partnership with RBC Elements, we aim to quantify farm to retail price pass-throughs.

Partnering with our in-house data science team, **RBC Elements**, we set out to tackle this question for three food supply chains: bread, beef, and milk. We constructed our framework on top of the excellent work of Edward Roeger and Ephraim Leibtag of the US Department of Agriculture on this subject[1]. In attempt to delineate the points in the supply chain at which pass-throughs occur, we break down our analysis into two distinct relationships. First, we consider the pass-through from farm prices to wholesale prices, followed by wholesale prices to retail prices. Figures 6–8 show each supply chain component. This decomposition allows us to study each piece of the relationship independently and ascertain the portions of the supply chain that are passing through or absorbing the higher food costs. The data used in this analysis are collected from the Bureau of Labour Statistics' (BLS) monthly Producer Price Index (PPI) and Consumer Price Inflation (CPI) series for the five-decade period from January 1972 to April 2022. We empirically estimate dates of regime shift to account for structural changes in the various markets (also displayed in Figures 6–8).

Result 1: Goods that require significant processing tend to be less sensitive to farm input prices and pass-throughs take longer.

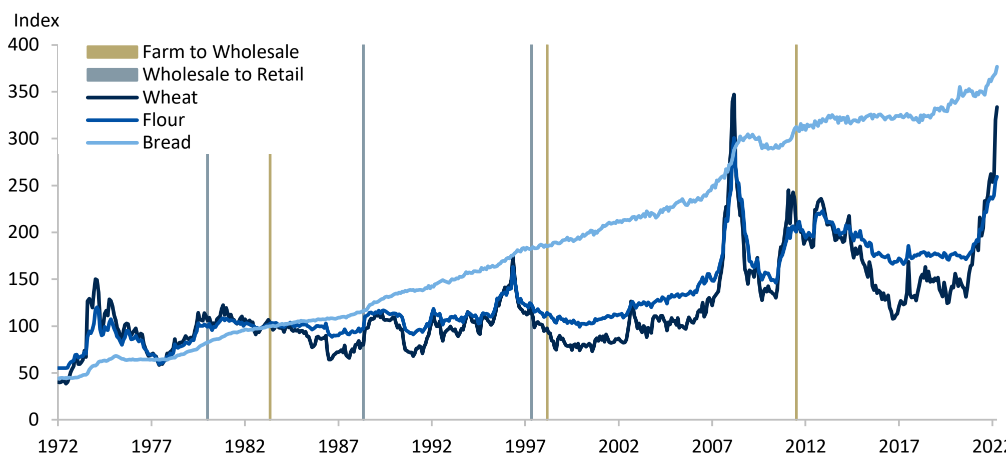
For starters, two overarching themes stick out. First, the price transmission from farm to retail differs by item and supply chain. For example, in goods requiring a higher degree of processing, such as bread, the price pass-throughs tend to be smaller and take longer. Much of this can be attributable to additional input costs such as labor and transportation. On the other hand, in items which require significantly less processing, such as beef and milk, inflation occurs more quickly, on a relative basis, from farm to retailer.

Result 2: Changes in input prices take 1–6 months to be fully reflected in retail prices.

Second, price pass-throughs are not instantaneous. Our study suggests that the bulk of food price changes will take 1–6 months to move downstream through the supply chain. In short, although we have seen grocery prices increase, our analysis suggests that major household items, such as bread, are still likely to see a considerable amount of upward price pressure in the coming months. While some may believe that record input costs may be behind us, we believe that retail grocery items have likely yet to fully work through the system.

Retail bread prices are significantly less volatile than wheat or bread prices.

Figure 6 – Bread Supply Chain Components

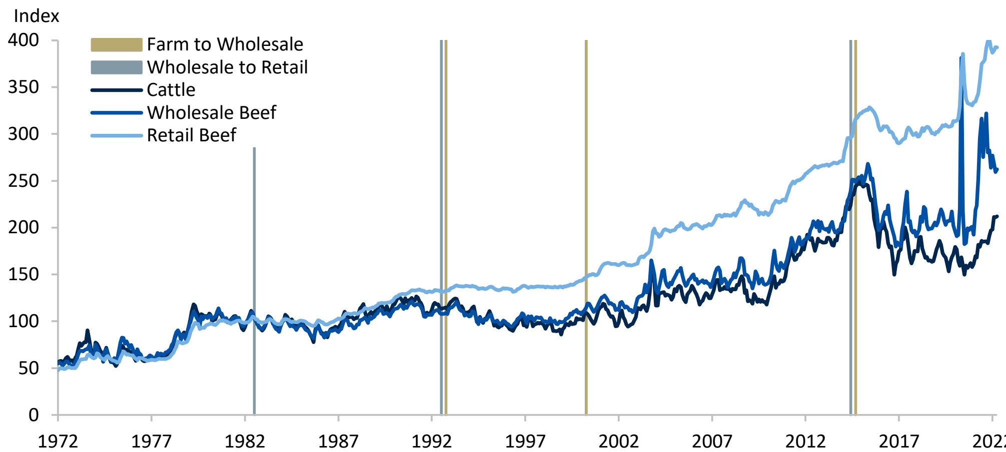


Source: RBC Capital Markets, BLS

[1] Edward Roeger and Ephraim Leibtag. How Retail Beef and Bread Prices Respond to Changes in Ingredient and Input Costs, ERR-112, U.S. Department of Agriculture, Economic Research Service, February 2011

Figure 7 – Beef Supply Chain Components

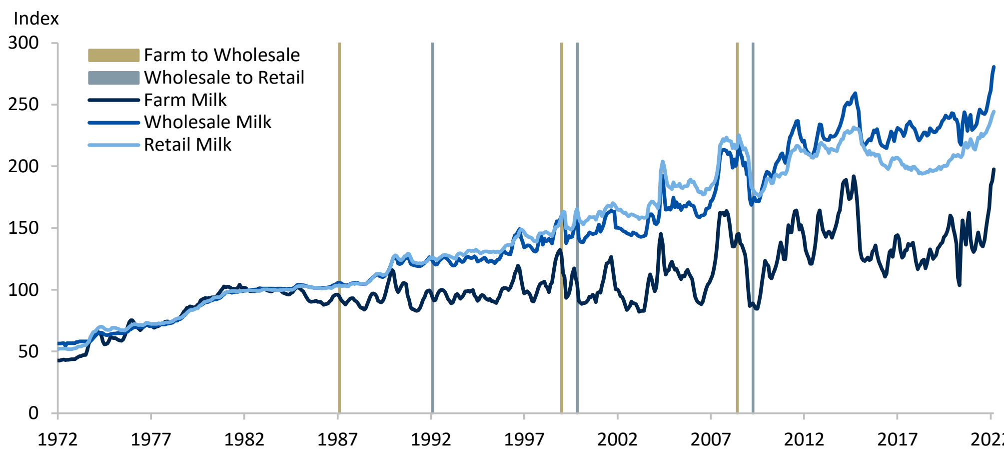
Retail beef prices have outpaced farm and wholesale prices since the early 1990s.



Source: RBC Capital Markets, BLS

Figure 8 – Milk Supply Chain Components

Retail milk prices have lagged changes in wholesale prices since mid-2008.



Source: RBC Capital Markets, BLS

Farm to Retail: Studying the Relationship Between Farm and Retail Grocery Prices

This exercise is the most mathematically intensive that we have undertaken since the formation of our Digital Intelligence Strategy team last summer. We highlight our process in the Appendix on page 10, but here, we aim to present our findings in simplistic form.

Bread: Currently, in both farm to wholesale and wholesale to retail, output prices (flour and bread) are below implied modeled levels based on current input prices. This suggests that current record futures prices have not been fully passed through to the next stage of the supply chain. Given the recent surge in wheat prices, we expect that while bread prices have increased somewhat, downstream prices have not fully priced in these record levels.

Our models suggest that the cumulative pass-through from wheat prices on the farm to retail bread prices is 8.3%. This means that if wheat prices increase or decrease by $1, this would lead to a corresponding increase of 8.3¢ in retail bread prices. We found that this transmission normally takes 1–4 months. Hence, record prices experienced in April ’22 are still moving through the system and the impact is unlikely to be realized, potentially, until four months down the road at the grocery store.

In environments such as the current one (current prices for retail bread are lower than our modeled implied pricing would suggest), the magnitude of price pass-throughs tends to be smaller, but the timing relatively the same. Bread prices tend to be the most reactive when current prices are close to their implied values, with 34% of a change in wheat passing onto flour and then 13% of flour prices being pushed onto bread.

Beef: Our math suggests that cumulatively, 35% of a change in farm cattle prices will be passed through to retail beef prices in 1–6 months. Farm to wholesale beef prices are currently close to implied levels, while wholesale to retail prices are above trend.

Retail beef prices are currently above where input prices would suggest. We estimate that 35% of a change in farm cattle prices will be passed onto the end consumer.

This means that retail prices are diverging and decoupling from the long-term trend, pricing higher than increases in input prices would imply. In the farm-to-wholesale relationship, in the current environment, an estimated 41% of a change in farm cattle prices will be transferred to wholesalers in one month. From wholesale to retail, in the current environment, 17% of wholesale prices is pushed onto retail in one month.

From farm to retail, beef prices are relatively more reactive to changes in input prices than bread and the price hikes occur much more rapidly, as pass-throughs could occur two to three months sooner. A big factor as to why a greater percentage of beef prices is transmitted is simply because the supply chain is shorter. Cattle, or beef, are raw products and require less processing, unlike the wheat to flour to oven to packaging practice for bread.

As with bread, recent increases in both farm and wholesale prices have yet to be fully reflected in retail milk prices.

Milk: Farm-to-wholesale milk prices are currently close to modeled implied levels. Retail prices, however, are lower. Similar to the development outlined in our bread model, recent increases in farm and wholesale prices have yet to be fully passed through to retail consumers. We estimate that 24% of a change in farm milk prices will be transferred to retail consumers within two months. The strongest pass-throughs take place between farm and wholesale prices, where 39–52% of price changes are passed down to wholesalers within a two-month period. The translation to retail prices occurs within one month and is estimated to be roughly 28% based on our modeling of the current price environment.

Figure 9 – Bread, Beef and Milk Results Summary

Bread Model				
		Current Price Relative to Implied Level		
	Overall	Lower	Normal	Higher
Farm to Wholesale				
Price Pass Through	14.2%	6.6%	34.0%	8.0%
Timing (months)	1-5	5	1-5	5
Wholesale to Retail				
Price Pass Through	17.1%	-	13.2%	8.6%
Timing (months)	1-4	-	1-4	4

Beef Model				
		Current Price Relative to Implied Level		
	Overall	Lower	Normal	Higher
Farm to Wholesale				
Price Pass Through	51.8%	71.3%	41.1%	-
Timing (months)	1-5	5-6	1	-
Wholesale to Retail				
Price Pass Through	21.5%	22.2%	25.3%	17.3%
Timing (months)	1-2	1	1-2	1

Milk Model				
		Current Price Relative to Implied Level		
	Overall	Lower	Normal	Higher
Farm to Wholesale				
Price Pass Through	49.3%	39.3%	50.1%	52.5%
Timing (months)	1-2	1-2	1-2	1-2
Wholesale to Retail				
Price Pass Through	24.7%	28.3%	55.8%	18.7%
Timing (months)	2	1	1	1

Farm to Retail Cumulative Pass Through					
			Current Price Relative to Implied Level		
		Overall	Lower	Normal	Higher
Bread	Price Pass Through	8.3%	7.1%	9.4%	-
	Timing (months)	1-4	1-3	1-5	-
Beef	Price Pass Through	35.3%	34.0%	22.0%	35.6%
	Timing (months)	1-6	1-5	1-2	1-7
Milk	Price Pass Through	24.3%	28.0%	18.9%	22.8%
	Timing (months)	1-2	1-2	1-2	1-2

Source: RBC Capital Markets

Who's Eating the Inflation Costs Along the Supply Chain?

Farm-to-wholesale pass-throughs are stronger than wholesale-to-retail for beef and milk. This means that consumers are being insulated by retailers.

In dissecting the supply chain, we found that the farm-to-wholesale pass-throughs are greater than the wholesale-to-retail price transmission for both beef and milk. Our math, exhibited in Figure 9, indicates that the rise in farm prices to wholesale leg passes through 51.8% and 49.3%, respectively, for beef and milk.

This is followed by 21.5% and 24.7% for wholesale to retail. Why are these numbers relevant? Simply put, the smaller the percentage pass-through, the more the next portion of the supply chain "eats" the costs that are unable to be transferred down. The opposite is true with bread. While the pass-throughs are materially lower, 14.2% for farm to wholesale and 17.1% for wholesale to retail (due to the elongated nature of the supply chain and processing required to bake bread), the portion of the supply chain absorbing the costs is the opposite of beef and milk.

Diluting of Farm Values Over Time

Farm prices mean less to the end consumer than they have historically. Only 16 cents of a dollar spent on food is attributable to the raw input.

Fluctuation in farm prices mean less to the end consumer today than they have historically. The USDA has presented the notion of the Food Dollar, which theoretically allocates the cents that comprise a dollar spent on food to each supply chain component. The findings suggest that of every dollar spent on food, only 16 cents is attributable to changes in the raw farm inputs. This compares to 41 cents of every dollar spent in 1950. Farm costs have drastically decreased in importance over time (Figure 10). In turn, items such as transportation, packaging, and processing have all dramatically increased as a percentage of the dollar spent over the last seven decades.

Also, our estimation of structural changes in the various commodities indicates that the relationship between input price (ex. wheat) and output price (ex. milled flour) has decreased in both magnitude and significance over time as well. While perhaps surprising, it makes sense when we explain that the evolution of the relationship is due to the rising costs associated with food, such as packaging, energy and transport costs, among others.

Figure 10 – Diluting of Farm Values Over Time

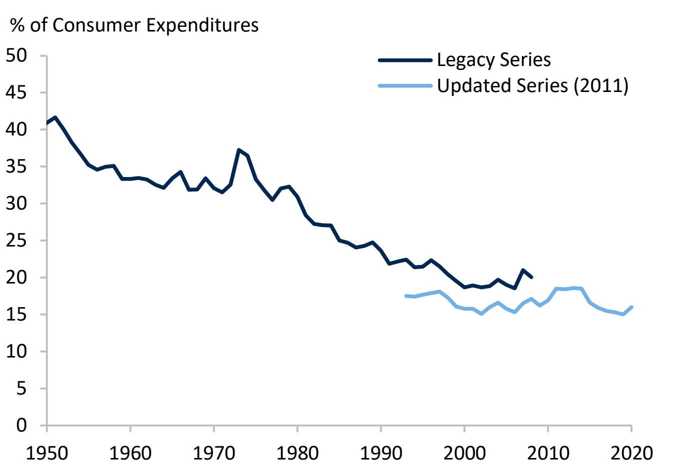
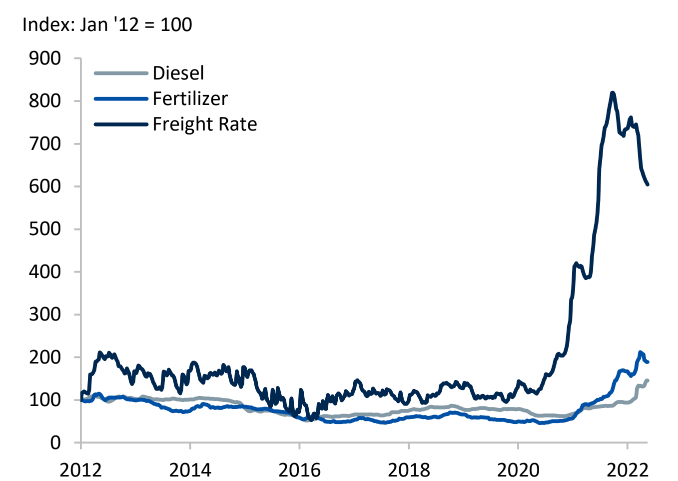


Figure 11 – Key Non-Farm Input Costs



Source: RBC Capital Markets, USDA, CRU, AAA, Drewry

Appendix

Range	Pressure Index
< 86	1
86-105	2
105-125	3
125-144	4
144-163	5
163-183	6
183-202	7
202-221	8
221-241	9
241-260	10
260-280	11
280-299	12
299-318	13
318-338	14
338-357	15
357-376	16
376-396	17
396-415	18
415-454	19
> 454	20

Source: RBC Capital Markets

Food Input Index (FIX) Construction

Index Construction

- All component data series are normalized by subtracting the mean and dividing by the standard deviation. Note that historical values may change in future updates due to a changing mean and standard deviation of the series.
- Normalized data are weighted using calculated weights based on the USDA's Food Dollar Series and qualitative factors to produce the composite index.
  - Static weights: Fertilizer (14%), Futures (14%), Diesel (21%), Plastics (8%), Freight Rates (21%), and Trucking (21%).
- Index is set equal to 100 on August 5, 2019.
- Price pressure is determined by static buckets (table at left). Buckets are evenly distributed between -1 and +3 standard deviations from the mean of the composite index and set on May 23, 2022.

Data

- Fertilizer: Average of Urea (NOLA), UAN (NOLA), Ammonia (NOLA), Phosphate (NOLA), Potash (US Midwest & East, Brazil, Southeast Asia). All in USD/short ton equivalents.
- Futures: Average of rolling front-month contracts for Wheat, Corn, and Soybeans.
- Diesel: Weekly average of US retail diesel prices.
- Trucking: Month-to-date average of US van and reefer spot rates.
- Plastics: Weekly average of general-purpose polystyrene prices.
- Freight Rates: Drewry World Container Index value.

Farm to Grocery Store: Price Pass-Through

All data are transformed to their natural logarithms before analysis. Our analysis consists of three distinct pieces: (1) long-term relationship; (2) symmetric (overall model); and (3) threshold models (based on where current prices are in relation to long-term trend).

Long-Term Relationship

First, we want to understand whether there is some kind of long-term relationship between our variables. Here, we rely on the concept of a cointegrating relationship as introduced by Engle and Granger. Cointegration is found by first testing the price series for stationarity (here we used the augmented Dickey-Fuller unit root test). If the two series (ex. Wheat and Flour) are both non-stationary, have the same order of integration, and when regressed on one another the resulting vector of residuals is stationary, we can infer that a long-term relationship between the two variables is present.

To account for structural changes that have taken place since the 1970s, we test for regime shifts in our data. To do this, we conduct an endogenous test to identify at which dates structural breaks occur. Hence, we do not impose structural assumptions onto the data. Estimated dates of structural breaks are presented in Figure A1. In the context of our analysis, we observe the presence of a cointegrating relationship between all pairs of input-output series using the Phillips-Perron test at the 10% significance level. Dates of structural breaks are coded as dummy variables and used in the following simple model:

$$Output\ Price_t = \beta_0 + \beta_1 Input\ Price_t + \beta_2\varphi_1 + \beta_3\varphi_2 + \beta_4\varphi_3 + \mu_t$$

Where φ_i terms are the dummy variables and μ_t is the error term.

Symmetric Price Response

First, we strive to understand the total degree of price pass-through across all periods and market environments. To do this, we conduct a two-stage Error Correction Model (ECM) as introduced by Engle and Granger. This method is appropriate, as all price series are non-stationary, first-difference stationary, and cointegrated. To implement the ECM, we first estimate a simple dummy variable regression as outlined above. Lagged residuals from this regression are then fed into the ECM model, which models output prices as a function of lagged input prices, lagged output prices, explanatory controls for diesel, electricity, and wages, and the error correction term (lagged residuals). We allow for dynamic lag selection across all models. Three key outputs can be extracted from this model. First, the coefficient(s) on the input price tells us the magnitude of price pass-through, which can be interpreted as a percentage. Second, the lags of the statistically significant coefficients can be interpreted as the time this price pass-through takes. Finally, the long-term relationship, which is the sign on the error correction term, demonstrates whether prices are converging or diverging from their long-term trend. The expectation is that most series will be convergent.

Asymmetric Price Response

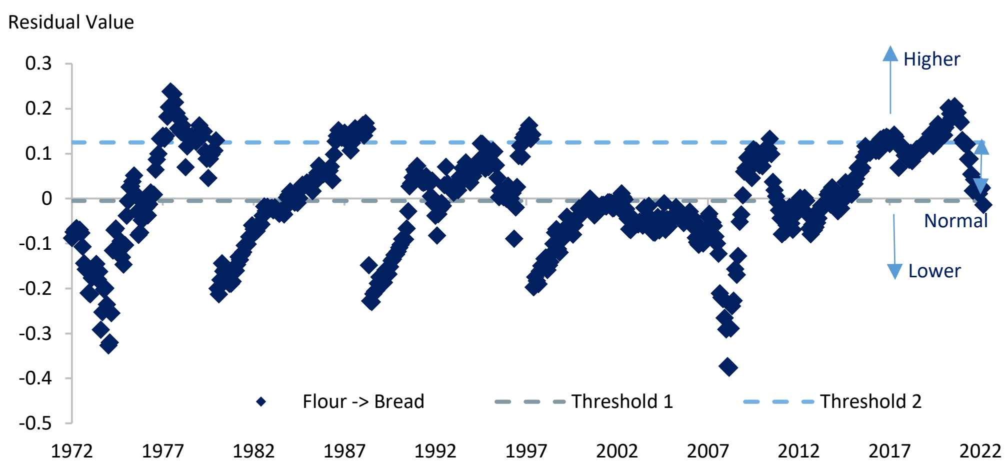
Asymmetric responses take the same form as the symmetric model; however, we partition the data based on where output prices are relative to their implied level based on long-term trend. In practice, the dataset is split based on thresholds of residuals. The thresholds are determined by utilizing a grid search method to optimize the partitions. In simple terms, we split the 1972 to 2022 time series into three pieces and run the ECM model on each subset. Partitioning the data in this manner allows for differences in the price response in different price environments. Figure A2 shows this partitioning for the wheat-to-bread supply chain.

Figure A1 – Estimated Dates of Structural Breaks

Model	Stage	Estimated Regime Shifts
Bread	Farm to Wholesale	May 1983, March 1988, November 2010
	Wholesale to Retail	January 1980, May 1988, June 1997
Beef	Farm to Wholesale	October 1992, April 2000, October 2014
	Wholesale to Retail	July 1982, July 1993, June 2014
Milk	Farm to Wholesale	February 1987, January 1999, June 2008
	Wholesale to Retail	February 1992, November 1999, April 2009

Source: RBC Capital Markets

Figure A2 – Bread: Wholesale-to-Retail Threshold Visualization



Source: RBC Capital Markets

Equity Analyst's Perspective

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Andrew Wong, Fertilizer

What has been driving fertilizer prices higher?

Fertilizer prices were already strengthening heading into 2022 due to both strong demand and tight supply, then moved higher as a result of knock-on effects from Russia's invasion of Ukraine. On demand, crop prices have strengthened due to disruption to Russian and Ukrainian production and exports, as both countries are major corn and wheat producers, supporting stronger fertilizer demand elsewhere. On the supply-side, there were three major impacts: 1) European producers that use high-cost natural gas are the global marginal cost producers for the nitrogen market and help set global prices. The Russia/Ukraine war has been a catalyst for higher European natural gas prices, pushing up the global nitrogen cost curve. 2) Belarus/Russia account for 35–40% of global potash supply. Sanctions on both countries have severely restricted potash exports, resulting in very tight global potash markets. 3) Russia is a major nitrogen and phosphate exporter (10–15% global trade), so the sanctions have resulted in lower availability.

Are we seeing demand resistance to higher fertilizer prices?

We are seeing some demand resistance as farmers try to avoid paying high fertilizer prices, but demand intentions are strong globally due to high crop prices, especially in Western countries where farmers are likely set to see high profitability—we still estimate that an average US corn acre may see near record-high profits in 2022. We think any pullback in fertilizer prices will likely result in a strong demand response given the global need to increase crop yields.

What is our outlook for fertilizer prices?

Broadly speaking, we expect prices to remain high relative to historical levels over the next several years, although in a declining trend, before settling to normalized levels by 2025 as demand steadies and supply constraints ease. We see these normalized levels as likely higher than prior historical averages: ~10–15% above the 10-year average.

In nitrogen, we expect prices to continue following cost curve dynamics, with marginal costs set by European producers using high-cost natural gas. Long-term European natural gas price expectations have increased following structural changes in global natural gas markets due to the Russia/Ukraine war, which flows through to our outlook for elevated nitrogen prices.

Potash markets may remain constrained for several years due to restricted exports from Russia and Belarus. Sanctions on Belarus, which blocks a key export route through Lithuania that accounted for ~90% of exports previously, were already in place before the Russia/Ukraine war and are unlikely to be lifted quickly. We think that any significant recovery in Belarusian exports will require new terminal capacity to be built in Russia or easing of restrictions on Lithuanian rail shipments. Russia has seen exports curtailed significantly (still down ~50% from pre-war levels through May 2022) due to sanctions pressures and logistical constraints. We expect export volumes to gradually recover as Russia works with non-sanctioning countries, especially China, India, and Brazil, although it may take time to sort through logistics. Longer-term, we see global capacity growth below prior expectations, as significant new capacity in Belarus and Russia is likely delayed due to financing and logistics challenges.

Phosphate markets have experienced less direct impact from the Russia/Ukraine war, but Russian exports may continue to see some difficulty (~10% global phosphate exports) and China may continue to restrict exports in order to ensure domestic supply. Longer-term, our S&D outlook sees limited new capacity in the queue, which may keep prices elevated.

Arun Viswanathan, Chemicals & Packaging

Has Foodservice/Food Merchandising recovered back to pre-COVID levels?

Most of our covered companies in foodservice are reporting volumes that are fully back to pre-Covid levels. For example, we are seeing strong growth in certain categories, such as plastic cups and home delivery. That said, one of our covered company's Food Merchandising segment volumes have not fully recovered to pre-Covid levels. Furthermore, supply chain and raw material inflation are still headwinds.

Are supply chain issues continuing?

Most of our packaging companies noted that they have been experiencing supply chain issues. Volumes were negatively impacted in the first quarter and a few companies lowered volume guidance modestly due to these supply chain challenges. Some companies also noted that they could have sold more volume in foodservice had it not been for logistical constraints.

What is the current demand environment?

Company managements all noted that demand remains strong, enabling price increases to help offset cost inflation. In total, we believe consumer demand will remain elevated for sustainable packaging (such as paperboard and aluminum beverage cans), although we expect the shift from at-home consumption to on-premise consumption to continue, absent a recession in the US, as the reopening trend continues.

Conversion to more sustainable products?

Most of the packaging companies have ESG initiatives in place. We have seen robust new product growth, such as plastic-to-paper conversion, driving organic growth. We also expect paper and aluminum packaging for food/bev to continue gaining market share from less sustainable packaging substrates (Polyethylene and PET) due to new product entries and some product conversions into aluminum. This trend should continue despite inflationary pressures.

What are the inflationary pressures you are seeing in the food supply chain?

The metal food and beverage packagers are experiencing higher input cost across the board. Examples include higher energy and natural gas cost to operate plants, higher logistics cost (fueling up trucks and limited trucking supply), higher aluminum and ingot conversion cost, and higher labor-related cost. In total, costs across their supply chains have risen. At the present time, we believe farmers are willing to continue harvesting large quantities of crops (corn, soybeans, etc.) despite inflationary pressures due to strong demand and elevated commodity prices. However, if the planting/harvesting economics deteriorate due to inflationary pressures and demand falters, we would expect significant headwinds for the food can manufacturers. The plastic packaging companies are experiencing higher plastic resin (polyethylene, polypropylene, PET, and PVC) costs. The glass packaging companies are experiencing significantly higher natural gas and energy costs. Lastly, the paper packaging companies are experiencing higher costs for resin, chemicals (caustic soda and titanium dioxide), recovered paper (OCC), and wood pulp. Most of this inflation is being offset by successful price increases.

James Edwardes Jones, European Consumer Staples

How significant is input price inflation for food companies?

There's a temptation to think that commodity inflation, whether that relates to agricultural raw materials, packaging, or distribution costs, will feed through to consumers in their entirety, but for the branded consumer staples companies that we cover, these inputs are only one component of the whole. While we talk about food companies, businesses like Nestlé, Danone, and Unilever see themselves first and foremost as brand marketers. Their role is to add value to commodities, by way of manufacturing, marketing, distribution, and so on. Thus, the effect of commodity price inflation is diluted by the time products reach the consumer. Typically, we estimate that agricultural inputs account for 20–25% of the ultimate sales value for the food companies we cover, packaging a further 7–8%, and distribution costs around 5%, so in total costs equating to roughly 35% of sales will be directly linked to commodity prices. It is usual for the food companies to buy forward or hedge these commodities, where possible, by around six months. This evidently won't prevent the input price inflation from having an effect on their businesses, but it will defer it while the companies get their acts together.

How are food companies reacting to higher input costs?

That will by and large involve raising prices to their customers (largely retailers) and ultimately to consumers. They will look to crank up cost-saving programmes, but given that this is a constant focus, there tends not to be much more that can be done in periods of input cost inflation and margin pressure. The forward buying/hedging gives the brand owners time to phase in their cost increases, but even then there is likely to be a delay between incurring higher input costs and implementing price increases that fully offset input price inflation. In that case, the result is margin pressure, at least in percentage terms. But with a higher absolute value of sales as a result of increased prices, that is not necessarily the same thing as lower absolute profits. That will ultimately depend on price elasticity and consumers' propensity to trade down.

How will consumers react to higher input costs?

They're called consumer staples for a reason—the stocks we follow are at the less discretionary end of the consumer spectrum, with food typically more resilient than alcoholic beverage or personal care products for example. That said, the last decade has been one of consistent premiumisation and trading up for branded consumer staples companies. Consumers' need to buy food does not necessarily mean that they need to buy relatively high-end branded products in the face of higher prices and lower disposable income. So far, the branded consumer companies have experienced little evidence of price elasticity: volumes are holding up despite higher prices. But as prices rise still further (that six-month time delay means that consumers are not yet feeling the full force of commodity price inflation so far this year) and consumers' disposable income declines in real terms, that might change, with private-label and/or lower-end branded product offering cheaper alternatives. In such a scenario, we believe the brands that display the greatest resilience will be those with the strongest brand equity.

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Driving insights through data

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