Identifying the Purpose and Success of Dairy Futures Contracts: Are Class III and Cheese Futures Contracts Serving Distinct Markets?

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Identifying the purpose and success of dairy futures contracts: are Class III and Cheese futures contracts serving distinct markets?

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Weekly cash cheese prices are highly correlated with weekly average cheese futures prices. In addition, cash cheese prices exhibit a high degree of correlation with weekly average Class III milk futures. Lastly, cheese futures and Class III milk futures are highly correlated. Based on trading volume, the Class III milk futures market is more than five times larger than the cheese futures market, and yet both are quite thin compared to derivative markets for grains and cattle. Moreover, less than two percent of U.S. cheese production between 2009 and 2018 was traded in the cheese futures market. Given the rather small number of trades in both Class III and cheese futures, and their high level of price correlation, one wonders whether the separate dairy contracts are serving unique and distinct markets. Would it be (more) beneficial if only one of the contracts existed? If the markets are effectively redundant, the elimination of one could increase liquidity in the other, and potentially reduce overall price volatility. The objective of this paper is to investigate whether its possible market performance could be improved through the trading of a single dairy futures contract, and develop a baseline for evaluating the potential economic and financial benefits that would result.

Keywords: Class III milk, Cheese futures markets, hedging, liquidity, price volatility

Introduction

U.S. raw milk produced under and outside Federal Milk Marketing Orders (FMMOs)[1] is categorized according to four different classes, i.e. Class I through Class IV, in response to the

[1] FMMOs cover over 80 percent of U.S. dairy producers' milk output. (USDA-NASS 2019; Natzke 2018)

dairy products (commodities) the raw milk is used to produce. Milk intended for cheese production is classified as Class III milk. Class III monthly prices are a function of the prices of its components: protein, butterfat, and whey. These monthly component prices are in turn, a function of weighted weekly prices of cheese (cheddar 40 lb. blocks and 500 lb. barrels), butter and whey, and provided by the National Dairy Product Sales Report (NDPSR)[2] through USDA. Monthly Class III prices are therefore not market driven but announced for the previous month by the USDA on or before the 5th day of the following month, once all weighted weekly average component prices are calculated. These backward-looking Class III prices also become the expiration settlement prices for the Class III CME futures contract[3].

The weekly dairy prices of cheese, butter and dry whey from the NDPSR are highly correlated with the average weekly futures prices from CME for cheese, butter and dry whey at 98%, 100% and 65%, respectively (Newton, 2019). The high level of price correlation among dairy products provide support for CME's claims that the cash settled futures contracts serve as a valid risk management instrument for dairy market participants. CME notes that cheese derivatives permit agents to hedge forward the exposure of cheese pricing across all parts of the milk crush (i.e., Class III milk, cheese and whey) with the use of a single contract that reflects the price of cheddar cheese at a forward date (CME Group). Here it is relevant to mention that of the approximately 33.5 billion pounds of blocks and barrels of (cheddar) cheese production from 2009 to 2018, only about 573 million pounds were traded on the CME market for the same period (Newton, 2019). That is, only about 1.7 percent of all U.S. cheesed produced from 2009 to 2018 was traded in the CME.

[2] See: https://www.ams.usda.gov/mnreports/dywdairyproductssales.pdf
[3] https://www.cmegroup.com/confluence/display/EPICSANDBOX/Dairy+Products

Recent events from 2020, specifically the worldwide pandemic, have resulted in enormous swings in prices of Class III and cheese futures contracts as can be seen in Figures 1a and 1b, respectively. Moreover, the realized and implied price volatility in dairy markets has substantially increased compared to prior years. As can be seen from the evolution of the price series in Figure 1, milk and cheese futures prices move very much in tandem. At the same time, there is a dramatically lower 'open interest' and trade volume in both contracts compared to grain or cattle futures, as seen in Figures 2a and 2b. Thus, it is reasonable to question whether the two markets serve (very) similar roles for the dairy sector, and reduce individual market liquidity by splitting trade volume across two different markets – which actually contributes to less stable prices. If so, this would have implications for volatility, hedging effectiveness and efficiency. Thus, would the dairy and related sectors be better served if only one dairy contract existed? The objective of this paper is to investigate the effects from having CME concurrently list Class III and cheddar cheese futures contracts and develop a baseline from which to evaluate potential economic and financial benefits of dropping one of the contracts.

Background

Figures 3a and 3b show the total weekly aggregate volumes of Class III and cheddar cheese futures contracts compared to futures contracts for corn, soybeans and live cattle. Note that aggregate dairy contract volume is significantly less than the volume of any of the other agricultural futures contracts considered. In addition, while both dairy contracts appear thinly traded, the weekly average volume of Class III surpasses cheddar cheese contracts by more than five-fold: 1,859 to 358, respectively.

A brief history regarding the development of Milk and Cheese futures contracts in the U.S. is provided by Fortenbery (2010), which is summarized in Table 1. From the table it can be observed that since 1993, numerous cheese and milk futures contracts have been offered by different commodity exchanges, with the majority being discontinued over time due to either lack of commercial interest or changes in government milk pricing policies. The current milk futures contract (Class III) has traded at the Chicago Mercantile Exchange (CME) since 2000, and the latest cheddar cheese futures contract, also traded at the CME began in 2010. As noted by Tejeda and Kim (2021) who recently studied the cash price dynamics among cheese varieties, the majority of milk produced in the U.S. is destined for cheese production.

An early study of cheddar cheese futures contracts traded at the at the New York Coffee, Sugar, and Cocoa Exchange (CSCE) by Fortenbery and Zapata (1997) found no evidence of a long-term (stable) relationship between cheese cash and futures prices during the first two years of futures trading. These findings conveyed limited opportunities and advantages for using cheese contracts for hedging purposes. Conversely, another early study by Fortenbery et al. (1997) focused on milk futures found evidence of long-term basis relationship developing at early stage. The study conducted simulations of milk futures for periods prior to their actual existence, with preferable hedging results when using milk contracts over cheese contracts.

More recently, Bozic and Fortenbery (2010) studied the performance of dairy futures as risk management tools using a partially overlapping time series model (POTS) by Smith (2005) to analyze price volatility and its sources, and found seasonal and time to maturity effects. The work presented here builds on that work using different procedures and updated data sets.

We also build on the work of Brorsen and Fofana (2001) and Bekkerman and Tejeda (2017). They investigated factors that affected the success of futures contracts. However, our interpretation of “success” is slightly different. The work of Bekkerman and Tejeda (2017), for example, focused on futures contracts for dried distillers grains (DDGs), interpreted contract failure as having essentially no trade volume. We focus on the problem of insufficient volume in currently traded contracts. Moreover, we are interested in basis relationships between a cash market, and a futures market (Class III) that does not trade a market driven price in the traditional sense.

Data and Methods

The data employed in this paper consists of weekly average settled prices for Class III milk and cheddar cheese futures markets traded at the CME and obtained via a Bloomberg terminal. In addition, weekly cash prices for cheese markets where obtained through the USDA National Dairy Product Sales Reports (NDPSR). The period studied is from February 14, 2012 to December 19, 2019.

Additional data also includes the ‘Disaggregated Commitment of Traders’ Reports (COT) from the Commodity Futures Trading Commission (CFTC) for Class III milk and cheddar cheese futures markets for the same period. The CFTC reports delineate s trade volumes, open interest, and the disaggregated number of commercial and non-commercial traders in each market, as well as non-reportable traders. The disaggregated report splits traders into four categories: (i) producer/merchant/processor/user, (ii) swap dealers, (iii) managed money, and (iv) other reportable. Comparing with previous legacy COT reports which separated reportable traders into ‘commercial’ and non-commercial’ categories, the disaggregated report considers producer/merchant/processor/user and swap dealers as ‘commercial’ traders and previous ‘non-commercial’ traders include the money-managers and ‘other reportable’. It is important to note that the disaggregated report also includes a category named ‘non-reportables’, which is obtained by directly subtracting the total sum of long and short ‘reportable’ positions from the total open interest; i.e. a derived figure.

The lack of existing market driven Class III cash prices leads to an initial approach of investigating the cheese cash market in relation to Class III and cheddar cheese futures markets. Unit root and cointegration tests (in case of non-stationarity properties) are conducted to probe possible long-term relationships among the three series. Three unit root tests are applied to each series; the Dickey-Fuller (Dickey and Fuller, 1979) test, the Phillips-Perron (Phillips and Perron, 1988) test, and the KPSS (Kwiatkowski et al., 1992) test. Pending confirmation of non-stationarity properties among the series, the Johansen co-integration (Johansen 1991) test is subsequently applied to the series. In order to assess hedging effectiveness, simple OLS regressions are estimated between the cheese cash prices and each of the futures markets to determine their correlation (Leuthold et al. 1989).

The Working’s T speculative index (Working, 1960) is applied to both contracts to compare whether the level of speculative positions being traded is deemed sufficient to “balance” the hedging positions. This provides a measure of “adequate” liquidity.

Expressing hedgers or commercial long (short) positions with $H_L(H_S)$, and the speculators or non-commercial long (short) positions with $S_L(S_S)$, Working’s T speculative index is defined by:

$T = 1 + \frac{S_S}{(H_L + H_S)}$ when $H_S > H_L$ (i.e. when short hedgers surpass long hedgers)

Conversely,

$T = 1 + \frac{S_L}{(H_L + H_S)}$ when $H_L > H_S$ (i.e. when long hedgers surpass short hedgers)

As noted previously, there were a number of unreported traders in both contracts. To properly calculate Working's T index, these non-reportable traders where split proportionally among commercials and non-commercials according to the percentage of total traders each of these represented in the reportable trader data. This is in line with previous studies by Irwin and Sanders (2010) and Sanders et al. (2010).

Other calculations include statistical analysis of the 'percent of total interest' from each category of commercial and non-commercial traders, which provides a relative measure of market position size. This metric offers insight into the relative percentage from different types of traders and their position movement, computed for both Class III and cheddar cheese futures contracts. The metric is calculated as the sum of both long and short positions held by the particular trader divided by twice the market's total open interest (TOI), as noted by Sanders et al (2004). This leads to the percent of the total market share held by Producers/Merchants/Processors/Users in time *t*:

Reported Producers/Merchants/Processors/Users' percent of $TOI_t = \frac{PL_t+PS_t}{2*(TOI_t)}$

Likewise, the percent of net long for each of these categories is characterized and analyzed, as well as the percent of long and short positions by trader category (Sanders et al, 2004; Sanders et al., 2010). For each trader type, the percent of the net long (PNL) position is calculated as the long position minus the short position divided by the sum of the two. e.g. the percent net long for Producers/Merchants/Processors/Users at time *t* is computed by:

Producers/Merchants/Processors/Users' $PNL_t = \frac{PL_t-PS_t}{PL_t+PS_t}$

where PNL represents the net position held by the trader type that is normalized by its total size. This metric, calculated for both Class III and cheddar cheese contracts, is used as a measure of the position size for each trader type.

Two additional metrics considered are the Percent of Long and Short Positions for each type of trader. This metric is calculated as the long (short) position divided by the sum of all long (short) positions. The percent net long for Producers/Merchants/Processors/Users at time *t* is computed by:

Producers/Merchants/Processors/Users' $PL_t = \frac{PL_t}{Sum\ All\ Long_t}$

This metric provides insight into the relative size of each trader type at the long and short positions in the market (Sanders et al., 2010).

Results

The three series reveal non-stationary properties based on the unit root tests, as shown in Table 2. The Johansen cointegration test applied finds significant evidence of the three price series being cointegrated, under one cointegration vector as shown in Table 3. That is, these three prices maintain a steady long run relationship, and if there is any price series in particular with a short run divergence, it will converge to the other series in the long run. This provides evidence that both futures contracts are adequately able to serve as a hedging instrument for the cheese cash prices since they share joint long term dynamics.

The estimated OLS regression between cheese cash and futures prices enables one to infer their level of correlation and evaluate hedging effectiveness. Weekly cheese prices (NDPSR) are reported by Tuesday of the week following their data collection process, and this is accounted for by regressing these cash prices on average weekly futures prices of the previous week. Figures 4a and 4b show the OLS estimation and correlation of cheese (40 lb. block) on Class III futures and cheese (40 lb blocks) on cheddar cheese futures, with values of 0.94 and 0.95, respectively. Thus, the difference in hedging effectiveness for cheese cash prices is quite minor when utilizing Class III futures over cheese futures contracts.

Results from Working T's calculations for the sample period are in Figure 5, showing the series of Working's T-1 indexes for both Class III and cheddar cheese contracts. This index measures the speculation positions in excess of the positions necessary to absorb the needs from hedgers. The index series shows that from 2015 onwards, the Class III index broadly surpasses that of the cheese contracts. That is, in general there is ample more net (long or short) excess speculation positions with respect to hedging positions of commercial traders in Class III futures contracts compared to cheese futures contracts. This increased level of speculation may be a direct consequence of the increased trading that occurs in Class III versus cheese contracts, as noted previously in Figures 2a and 3a.

Just as important, the cheddar cheese index seems to frequently be below 0.15 (T index of 1.15), which is regularly considered as insufficient liquidity (Irwin and Sanders, 2010). While agricultural commodity markets are generally considered to have low liquidity (Sanders et al., 2010), this may be problematic none-the-less.

Examining the percent of total interest per trader for each contract in Table 4, note there is a substantial difference between producer commercial hedgers with about 40% the positions in Class III, and a bit over 50% in the cheese contracts. There are much smaller comparable percentages between Class III and cheese contracts for commercial swap dealers (between 7 to 8% of the total). Likewise, the other reportable speculators are about 1/3 of all trades for both contracts. It is noteworthy to point out that non-reportables are a bit over 15% of all trades for Class III futures, and yet only 4% of the cheese contracts. Thus, there seems to be a lot of small trading in the Class III market, perhaps responding to smaller, granular producers involved in the market for milk.

Figures 6a and 6b provide the evolution of market share per trader through the years for Class III and cheese futures, respectively. As can be seen for Class III, commercial producers commanded the bulk of trades at 60% until mid-2014 where their position decreased to about 40% of the market, and after 2018 to roughly 35%. Interesting to note is that commercial swap dealers and money manager speculators have always hovered at less than 10% of the market. In the case of non-reportables, these bounce between the mid-20% and mid-30% range. In regards to the evolution of traders for cheese contracts, more than half has been dominated by hedgers specifically producers. Here reportable speculators have hovered between the 30 and 40% range, and all other trader types are less than 10%.

Analyzing the Percent of Net Long shown in Table 5, there is a dramatic difference for hedgers, both under producers and swap dealers type of traders - between the two contracts. While both hedgers for Class III are net short, at roughly 20% and 2% of the market, respectively, both hedgers in cheddar cheese futures are net long at roughly 31% and 18% of the market, respectively. Just as important, net positions of hedgers are about 20% of all trades in Class III but almost three-fold that (about 60%) for cheese. That is cheese contract traders are a majority of hedgers going long. Figures 7a and 7b show the evolution through the years of the types of traders and their net positions for Class III and cheddar cheese contracts, respectively. For Class III in Figure 7a, producer hedgers were mainly net long until mid-2014, and after that they have become net short. Conversely, other reportable speculators have mainly held net long positions.

Swap dealer hedgers from early 2016 have mainly held net long positions. Non-reportables have always been net short. In the case of cheese contracts in 7b, producer hedgers have always held net long positions, which has been somewhat ‘mirrored’ by speculators of other reportable positions holding an inverse net short position. The other trader types have evolved to being balanced between net long and short.

In regards to the percent of long and short positions per trader type for each contract shown in Table 6, it is observed that producer hedgers are more than 70% long for Cheese contracts and about half of that (at 35%) for Class III. Other reportable speculators in the case of Class III contracts is a notably large group that holds a long position at about 40% market share. Other trader types have 10% or less of all long positions in both contracts. In the case of short positions, Class III producer hedgers have a higher percentage than in cheese at 47% to 37%, respectively. For Class III the next noteworthy traders are speculators, with other reportables holding about 18% of all shorts; also, non-reportables hold almost a quarter of all short positions at 23%. In the case of cheese contracts, other reportable speculators hold just a bit more than 50% of all short positions, and are the main traders in this (short) position.

Conclusions

The study into the benefits and drawbacks of having both Class III and cheddar cheese futures contracts is still under investigation. While there are a number of daily trades occurring in both contracts, there is substantial thinness in both of these when compared to heavier traded crop and cattle markets. There certainly is much less speculative trading with cheddar cheese contracts, which also has about one-fourth the trading volume compared to Class III contracts. Likewise, it seems per Working T's index, that cheese contracts may have insufficient liquidity to cover all hedging pressure.

The percentage and variation through the years of traders making use of these futures instruments and switching from long to short or staying long or short, in each contract, indicates possible changes in strategies according to market shifts through the period studied. It seems apparent, especially with the low level of cheese contracts traded and the high level of correlation between cheese cash prices and Class III contracts, that it is beneficial to investigate further the possible benefits and costs from uniting these two contracts in one.

Future work will investigate the price discovery process, as well as the level of hedging efficiency. Just as importantly, we will investigate the costs of cross-hedging cheese cash prices through Class III contracts versus direct hedging with present cheddar cheese contracts. In addition, we will study the difference between bid/ask spreads of both contracts in order to further identify liquidity effects among the two contracts.

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Table 1: Timeline of Milk (Class III) and Cheese Futures Contracts offered by Commodity Exchanges

- Cheddar Cheese contract (NYCSCE[4]) first traded in June 1993; discontinued.
  Settled via delivery.
- Milk contracts (NYCSCE and CME) first traded in Dec 1995 & Jan 1996; discontinued at NYCSCE.
  Cash settled (BFP[5]).
- Cheddar Cheese contract (CME) first traded in 1997; discontinued.
  Settled via delivery.
- Class III contract (CME) began trading in February 2000; previously known as Milk contract.
  Cash settled (USDA announced Class III price after contract expiration[6]).
- Cheese contract (CME) began trading in February 2010.
  Initially settled via delivery, now mainly Cash settled.

[4] NYCSCE: New York Coffee, Sugar and Cocoa Exchange; then part of NYBOT: New York Board of Trade; recently known as ICE: Intercontinental Exchange.
[5] BFP or Basic Formula Price: non-market reference price announced once a month (Jesse and Cropp, 1997)
[6] https://www.cmegroup.com/confluence/display/EPICSANDBOX/Dairy+Products

Table 2: Unit Root Tests

Data (n = 411)	Phillips-Perron (non-zero mean)[b]		
	Cheese Cash	Class III	Cheese Futures
Z(t) statistics	-2.753	-2.844	-2.458
Lags[a]	4	4	4
5% critical value	-2.882	-2.882	-2.890
Decision[c]	NS	NS	NS
	KPSS test (level stationarity)[b]		
	Cheese Cash	Class III	Cheese Futures
Test statistics	0.154	0.145	0.162
Lags[a]	4	4	4
5% critical value	0.463	0.463	0.463
Decision	NS	NS	NS

[a] Lags for test is given byNewey-West lags, int $\left\{4(T/100)^{\frac{2}{9}}\right\}$, where T is the number of observations

[b] Phillips-Perron test - testing the null hypothesis of nonstationarity, thus the series is non-stationary by failing to reject null hypothesis; KPSS test - testing the null hypothesis of stationarity, thus the series is stationary by rejecting null hypothesis

[c] Decision: NS = nonstationary, S = stationary

Table 3: Trace Test on Order of Co-integration

Rank	Trace[*b]	5% Critical value
r = 0	35.3324	24.08
r ≤ 1	1.5933	12.21
r ≤ 2	0.098	4.14

Decision: The first "fail to reject" of null hypothesis occurs for r ≤ 1 (at 1%). Thus, there is 1 cointegrating vector.

Table 4: Percent of Total Interest per Trader Type for each Contract

	Percent of Total Interest	Commercial	Non-commercial			
	Mean Total Open Interest	Producer/ Merchant/ Processor/User	Swap Dealers	Managed Money	Other Reportables	NON Reportables
Class III	27,330	39.3%	7.4%	6.1%	31.1%	16.2%
Cheese	20,594	53.1%	7.8%	2.6%	32.4%	4.0%

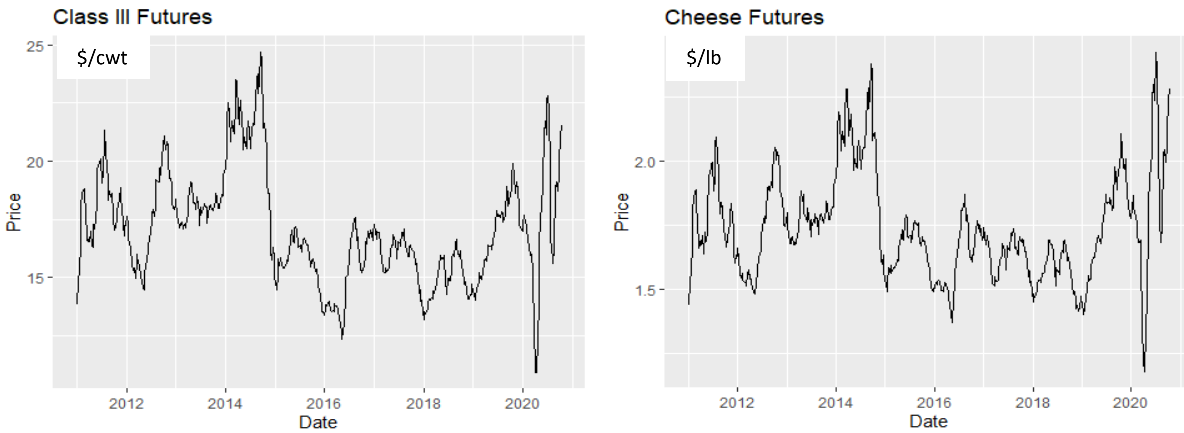
Table 5: Percent of Net Long per Trader Type for each Contract

	Percent of Net Long	Commercial		Non-commercial		
	Mean Total Open Interest	Producer/ Merchant/ Processor/ User	Swap Dealers	Managed Money	Other Reportables	NON Reportables
Class III	27,330	-19.6%	-1.8%	-12.7%	31.6%	-34.4%
Cheese	20,594	30.8%	18.1%	-2.5%	-60.3%	-12.9%

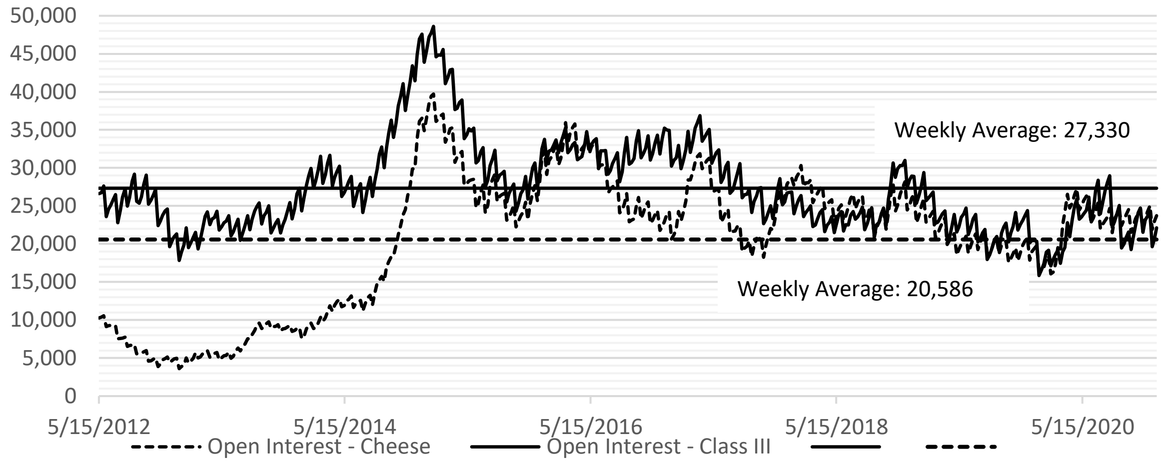
Table 6: Percent of Long and Short Positions per Trader Type for each Contract

	Percent of Long Positions	Commercial		Non-commercial		
	Mean Total Open Interest	Producer / Merchant/ Processor/User	Swap Dealers	Managed Money	Other Reportables	NON Reportables
Class III	27,330	35.3%	9.1%	4.1%	40.7%	10.8%
Cheese	20,594	73.3%	10.6%	2.1%	11.1%	2.9%

	Percent of Short Positions	Commercial		Non-commercial		
	Mean Total Open Interest	Producer / Merchant/ Processor/User	Swap Dealers	Managed Money	Other Reportables	NON Reportables
Class III	27,330	47.1%	5.1%	7.0%	17.6%	23.2%
Cheese	20,594	37.1%	3.2%	1.8%	52.4%	5.5%



Figures 1a & 1b: Average weekly cash prices for Class III and Cheese futures contracts (source: CME)



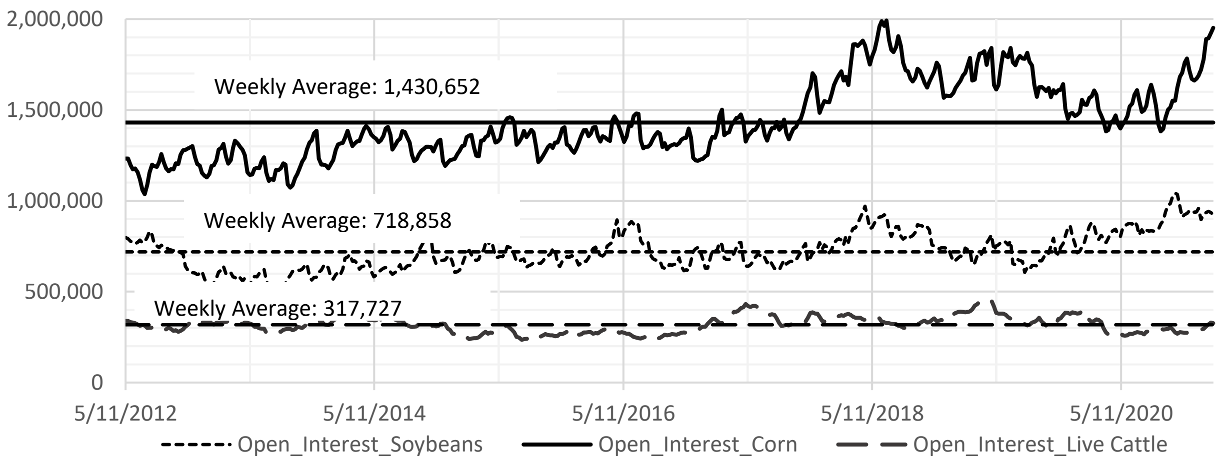
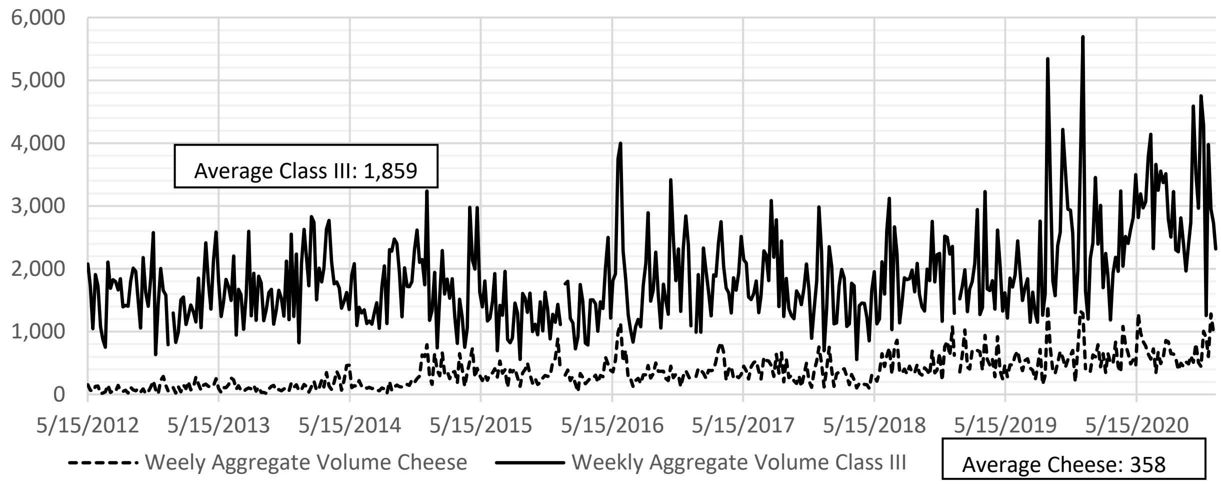


Figure 2a: Average weekly Open Interest for Class III and Cheese futures contracts (CME)
Figure 2b: Average weekly Open Interest Corn, Soybeans, Live Cattle futures contracts (CME)



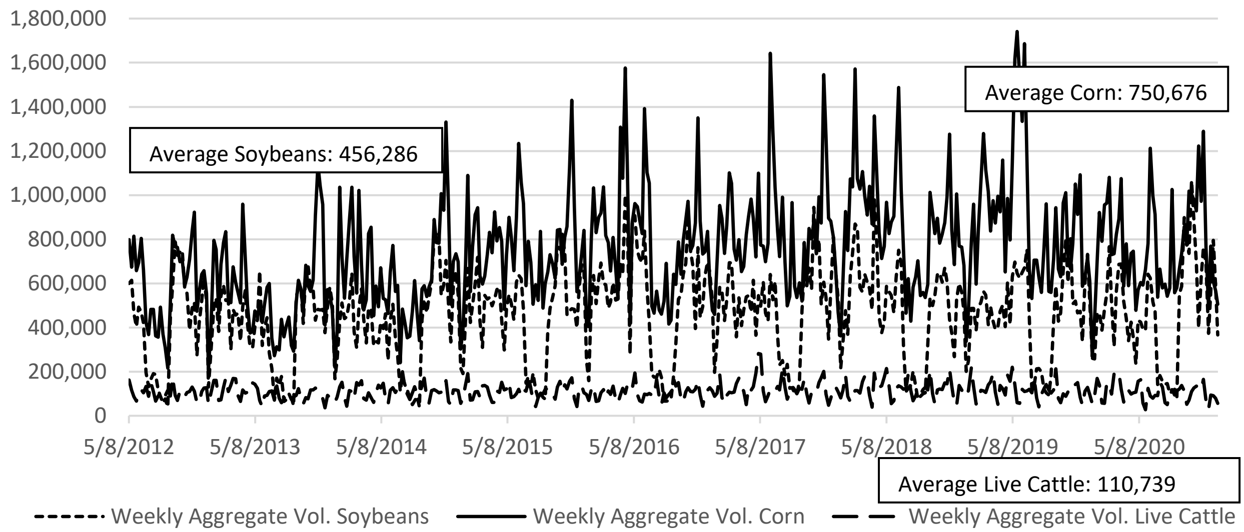
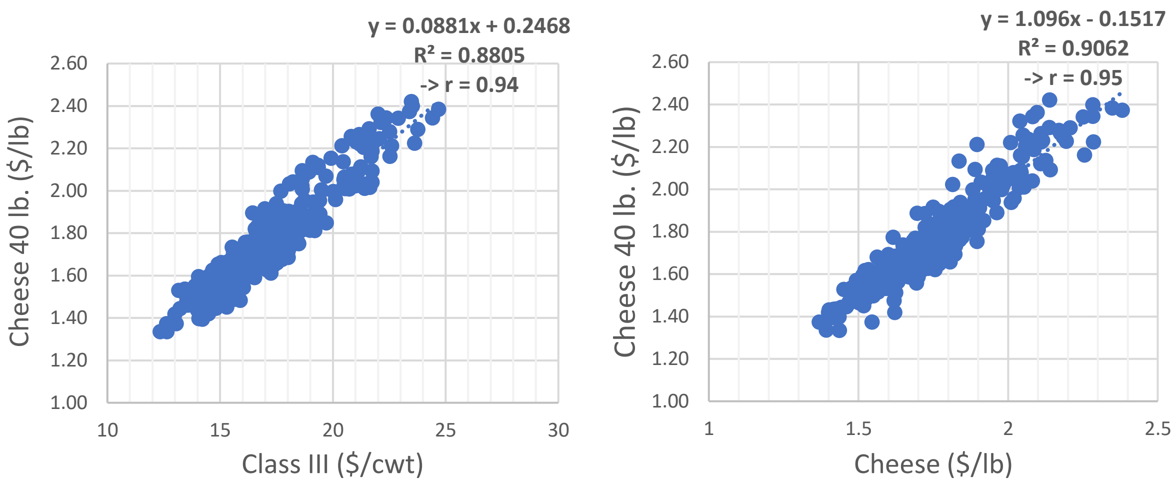


Figure 3a: Total Weekly Aggregate Volume: Class III & Cheese futures contracts (DCOT - CFTC)
Figure 3b: Total Weekly Aggregate Volume for Soybeans, Corn, Live Cattle futures contracts (DCOT -CFTC)



Figures 4a & 4b: Correlation values between Cheese (40 lb. block) cash prices and Class III futures prices; and between Cheese (40 lb. block) cash prices and Cheese futures prices.

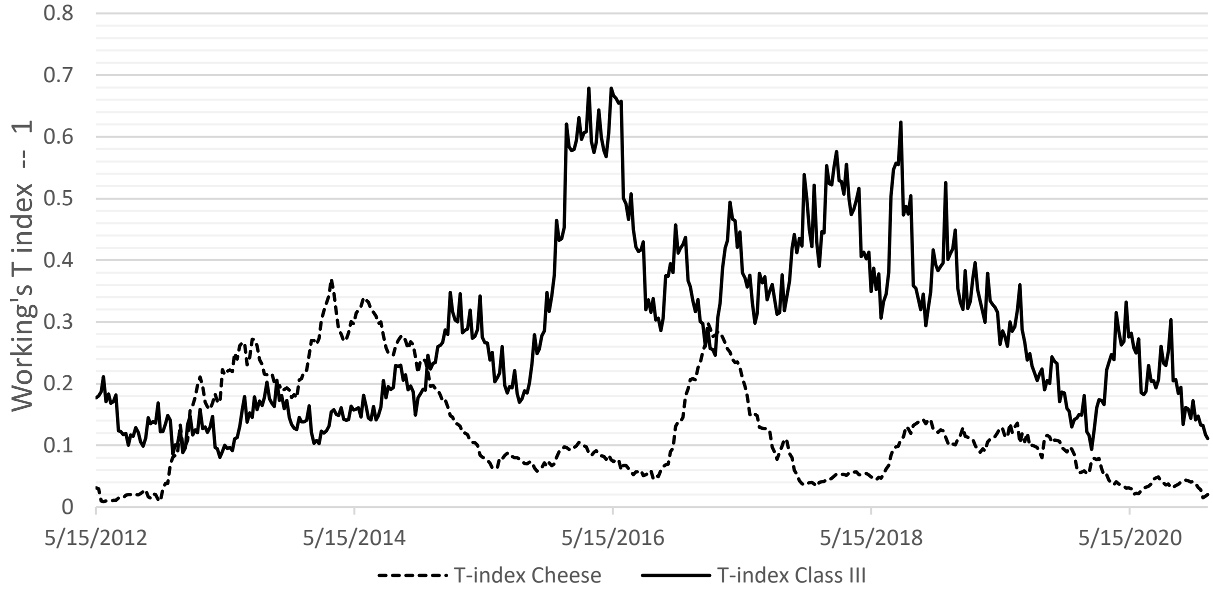
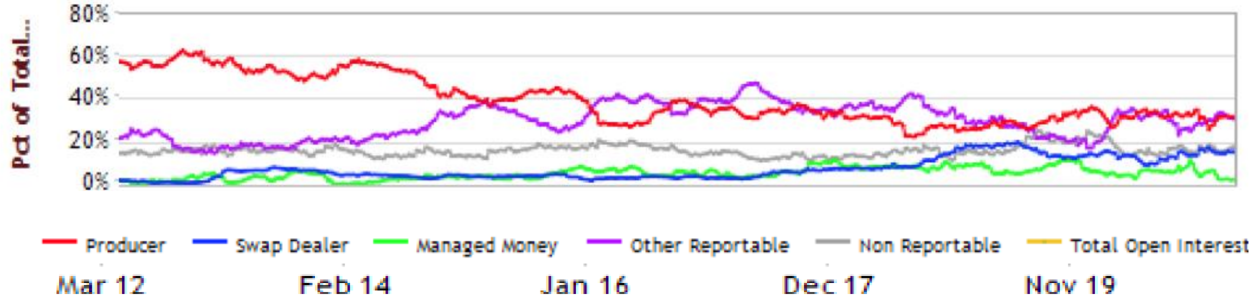


Figure 5: Working's T – 1 index for Cheese and Class III futures contracts.



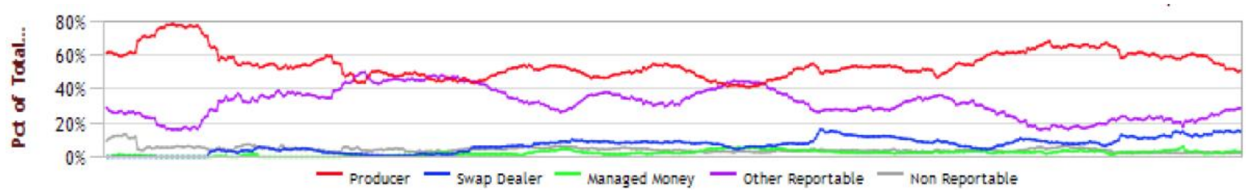
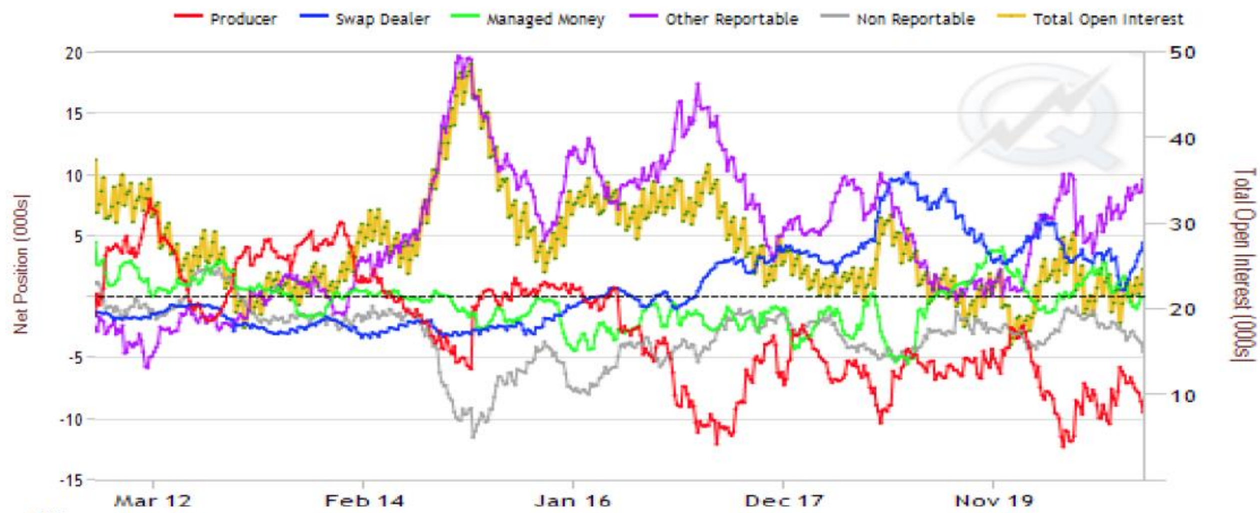


Figure 6a: Percent of Total Interest per Trader Type for Class III (CME)
Figure 6b: Percent of Total Interest per Trader Type for Cheese (CME)



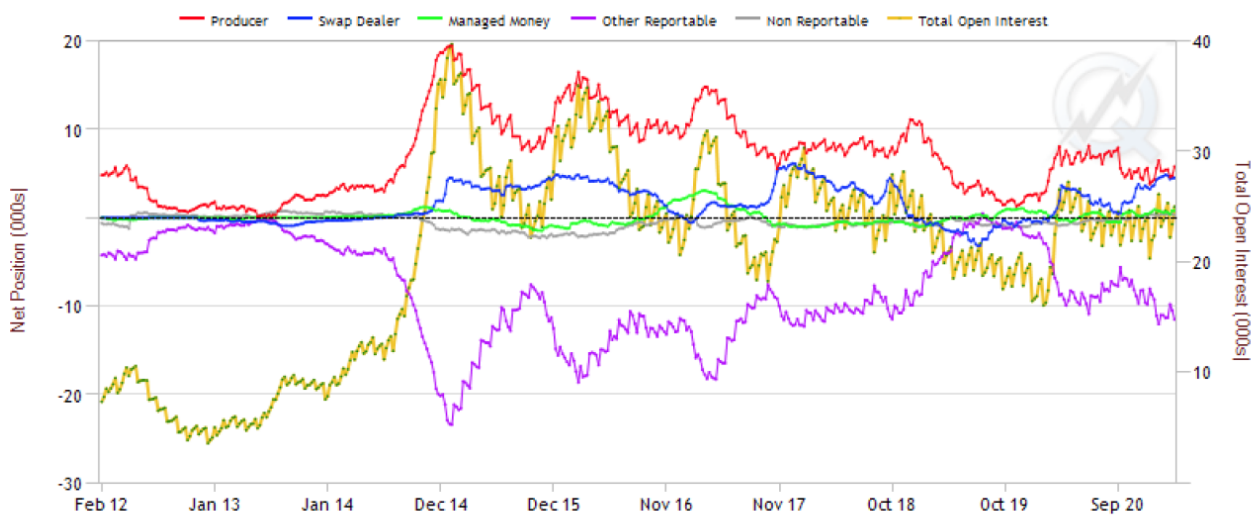


Figure 7a: Net Position per Trader Type for Class III (CME)
Figure 7b: Net Position per Trader Type for Cheese (CME)