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## **Exploring Commodity Trading Activity: An Integrated Analysis of Swaps and Futures**

by

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Suggested citation format:

Mixon, S., E. Onur, and L. Riggs. "Exploring Commodity Trading Activity: An Integrated Analysis of Swaps and Futures." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [<http://www.farmdoc.illinois.edu/nccc134>].

# Exploring Commodity Trading Activity: An Integrated Analysis of Swaps and Futures

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*Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis,  
Forecasting, and Market Risk Management  
St. Louis, Missouri, April 18-19, 2016*

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The research presented in this paper was authored by Scott Mixon, Esen Onur, and Lynn Riggs, CFTC employees who wrote this paper in their official capacities with the CFTC. The Office of the Chief Economist and CFTC economists produce original research on a broad range of topics relevant to the CFTC's mandate to regulate commodity future markets, commodity options markets, and the expanded mandate to regulate the swaps markets pursuant to the Dodd-Frank Wall Street Reform and Consumer Protection Act. These papers are often presented at conferences and many of these papers are later published by peer-review and other scholarly outlets. The analyses and conclusions expressed in this paper are those of the author and do not reflect the views of other members of the Office of Chief Economist, other Commission staff, or the Commission itself.

# Exploring Commodity Trading Activity: An Integrated Analysis of Swaps and Futures

*This paper provides the first public analysis of a cross-section of physical commodity swap markets using proprietary position data collected by the Commodity Futures Trading Commission. We find that futures markets are generally larger than swaps markets, as measured by open interest, with WTI crude oil being an exception. By merging data on futures, swaps, and index swaps, we gauge exposures for various types of market participants, products, and tenors across the entire US WTI derivatives market for the first time. We find that, in aggregate, market participants appear to use futures and swaps in tandem – Financial End-Users and Commercial End-Users both have net positions in swaps in the same direction as their net positions in futures. Swap dealers appear to have offsetting swaps and futures net positions. To illustrate the joint nature of these markets, we contrast Working’s T index computed from both futures and swaps data with the index computed solely from futures or swaps. We find that the combined index differs substantially from the index computed using either the futures or swaps data alone, highlighting the potentially incomplete nature of any analysis done using only futures or swaps market data.*

Key words: swaps market, futures market, WTI crude derivatives, Working’s T

## 1. INTRODUCTION

Aside from anecdotal evidence, little is known about the size or structure of OTC commodity swap markets, and quantitative evidence detailing the connections between trading activity in commodity swap and futures markets is scant. A key problem is that the OTC market was opaque until the beginning of 2013, when public reporting began for swaps transactions under the jurisdiction of the Commodity Futures Trading Commission (CFTC). While recent research has utilized the publicly available transactions-level data (e.g., Peterson (2014)), broader questions about the structure of commodity swaps and futures trading remain unanswered. Some examples are as follows:

- i. How large are the OTC commodity swaps markets?
- ii. How do the listed futures and OTC markets for commodity products compare in terms of exposures across the term structure?
- iii. Do swap dealers generally have balanced or one-sided trading books in commodity swaps?
- iv. How do swap dealers use listed futures products to hedge OTC swaps?
- v. How do different types of market participants use the OTC and listed futures markets?

In this paper, we present initial results that make use of the CFTC’s new regulatory data on OTC commodity swaps in conjunction with CFTC’s traditional futures and options data<sup>2</sup> in

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<sup>2</sup> We combine data on futures with data on the delta-adjusted options on those futures. Hereafter, we will refer to this more generically as the futures market.

order to address a number of these fundamental questions. The paper presents the first public analysis of commodity swap data collected by the Commodity Futures Trading Commission.<sup>3</sup> The findings derive from position-level swaps data reported by dealers to the Commission for 2014-2015 and the data provide unprecedented visibility into swap market activities.

After presenting a bird's eye view of the various OTC commodity swap markets, we focus on WTI crude oil exposure, examining both the direct exposure through WTI swaps as well as the indirect exposure via commodity index swaps. We merge the swap data with NYMEX futures market data in order to characterize the entire US WTI derivatives market for the first time. In our sample, we find that 1) the swap market is comparable in magnitude (open interest) to the futures market, 2) Commercial End-Users have larger positions (both net and gross), on average, in swaps than in futures but are short in both, and 3) Financial End-Users have larger positions (both net and gross) in futures than in swaps but are net long in both.

We also find that the majority of swap market exposure is direct exposure via swaps on WTI, with a minority of the exposure via commodity index swaps. Specifically, our data shows that exposure via WTI swaps accounts for 67% of the open interest, with 19% of the open interest being due to implicit exposures via index swaps or basket swaps. The remainder (~15%) is attributable to swaps that contain two floating legs, one of which is WTI.

Although a minority of WTI exposure is via commodity index baskets, Financial End-Users account for almost all of this index exposure. That is, we find that 80% of the approximately 340,000 contract net long exposure by Financial End-Users is implicit exposure via basket swaps. For Commercial End-Users, their approximately 365,000 contracts net short is acquired predominately by direct WTI swaps exposure. Not surprisingly, we find that Swap Dealers provide liquidity to end-users; dealers simultaneously have, on net, long significant WTI exposure (mostly due to Commercial End-Users) and short significant WTI exposure due to index basket exposures (mostly due to Financial End-Users).

To show the joint nature of these markets, we contrast Working's T index computed using the combined futures and swaps markets data with the index computed separately from futures market data alone and from swaps market data alone. We find that the index using the futures and swaps data is substantially lower and more stable<sup>4</sup> than the values computed solely using the futures data, which is the methodology typically used in the literature, and is substantially higher than the values computed solely using the swaps data. This finding suggests two things. First, these markets appear to work in tandem and should be studied in tandem. Second, some conclusions regarding activity in crude oil, based solely on the listed futures

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<sup>3</sup> The CFTC has large trader reporting rules for physical commodity swaps that are codified in Part 20 of the Commission's regulations. These reporting rules require daily reports from clearing members and swap dealers related to their activity in certain swaps (see Section 3 for details). Under these rules, clearing members began full daily reporting on July 2, 2012, and swap dealers began their daily reporting on March 1, 2013. Clearing members and swap dealers report the paired swap positions of their own principal accounts as well as those of their direct legal counterparties when such positions become reportable, even for inter-affiliate transactions if the affiliates are separate legal entities from the reporting entity. These paired swap positions must be reported to the Commission as futures-equivalent positions (i.e., in terms of the futures contract to which the swap is considered paired).

<sup>4</sup> Specifically, the combined index has less of an upward trend than the index calculated using futures data alone. The combined index also seems to have a smaller variance, but this may be due to averaging values over the week.

market data during times with significant swap activity, should be treated with caution because swaps market activity currently represents nearly half of the overall net positioning in WTI derivatives.

The remainder of the paper is organized as follows. Section 2 describes the existing literature and how our paper relates to existing studies. Section 3 gives a detailed description of the data used in this study. Section 4 outlines the methodology used to classify counterparties into various participant categories. Section 5 presents the basic findings regarding the cross-section of commodity markets. Section 6 provides a detailed analysis of exposures and positions in the WTI crude market across futures and swaps. The final section concludes.

## 2. LITERATURE REVIEW

There are relatively few empirical studies examining trading activity in OTC markets in general, with most studies focused on credit default swaps (CDS) in the United States. A number of these studies use DTCC's Trade Information Warehouse (TIW) data including papers by Chen, Fleming, Jackson, Li, and Sarkar (2011), Duffie, Scheicher, and Vuillemeys (2014), Schachar (2012), and Siriwardane (2015). The data utilized in Siriwardane (2015) is similar to ours because he observes the full identities of counterparties, which allows him to determine the net buyers and sellers for each reference entity. He exploits the data and finds that that CDS markets are dominated by a group of protection net sellers, which he concludes has implications for the stability of markets. Getmansky, Girardi and Lewis (2014) also analyze the CDS market and conclude that the network of CDS dealers is more concentrated than the network for cash bonds.

A handful of studies compare swaps and futures markets side by side. Mixon and Onur (2015) analyze the volatility derivatives markets by making use of CFTC regulatory data. Comparing the market structure of index variance swaps with VIX volatility futures, they find that VIX futures dominate in maturities of less than a year; whereas variance swaps dominate for longer maturities. Mixon and Onur (2016) analyze index dividend swaps and index dividend futures markets and focus on derivatives referencing the EURO STOXX 50. Yadav and Naik (2003) similarly explore dealer activity across interest rate futures and cash government bond markets. They find that the dealers actively use the futures markets to hedge changes in their spot positions but also that dealers sometimes use futures markets to take directional bets.

The study closest to ours is Lau and Robe (2016), where the authors make use of open swaps oil derivatives data that are reported to Swap Data Repositories (SDRs) following the implementation of the Dodd-Frank Act. While the authors also compare the futures open interest with open swaps positions (albeit from a different source of data), their goal is different than ours. They provide a market-wide characterization of the instruments and products traded across a variety of crude oil types (e.g., the relative activity in Brent, Louisiana Light Sweet, WTI, and other benchmarks), while we focus on the activities and exposures of different categories of market participants (e.g., Commercial End-Users, Financial End-Users, and Swap Dealers) in WTI specifically.

We note three other studies that use publicly disseminated OTC swaps data. Loon and Zhang (2014) and Loon and Zhang (2016) study the effects of the Dodd-Frank Act, especially that of central clearing and post-trade reporting in the credit default swap (CDS) market. Similarly, Benos, Payne, and Vasios (2016) combine the publicly reported interest rate swap (IRS) data with a special data set from the London Clearing House (LCH) to show that introduction of swap execution facilities (SEFs), as well as the introduction of new regulations on swap trading, have both improved liquidity in the IRS market.

The research presented in this paper is differentiated from the studies noted above, because a key goal is to simultaneously characterize the positioning of various market participants in both the commodity swaps and commodity futures markets. With respect to the focus on commodity swap markets, part of our analysis is similar to that of Peterson (2014), which explores the size of the agricultural swaps market using publicly reported transactions by the Swap Data Repositories (SDRs). In contrast to Peterson (2014), however, we use confidential regulatory position data made available to the CFTC, on a daily basis, for swaps and futures markets. Because the swaps data CFTC collects is reported as futures-equivalent positions, we are able to integrate the data from these two sources in a reliable and understandable manner.

### 3. DATA

We primarily rely on the Commodity Futures Trading Commission's (CFTC's) new regulatory data on OTC commodity swaps. Specifically, we use the CFTC's large trader reporting for physical commodity swaps, the reporting of which is codified in Part 20 of the Commission's regulations.<sup>5</sup> Reporting entities (primarily comprised of swap dealers) submit daily position reports related to their activity in swaps that are paired to 46 physical commodity futures contracts (e.g., Chicago Board of Trade "CBOT" Corn, New York Mercantile Exchange "NYMEX" Crude Oil, Light Sweet). Swaps are considered to be "paired" if the swap settles using either the price of one of 46 futures contracts or the price of the same commodity for delivery at the same location(s) as one of the 46 futures contracts. The 46 covered futures contracts are listed in Appendix A.

Under Part 20, reporting entities report the swap positions of their own principal accounts as well as those of their direct legal counterparties when such positions become reportable.<sup>6</sup> Positions resulting from inter-affiliate transactions are also separately reported if the affiliates are separate legal entities from the reporting entity. These paired swap positions must be reported to the Commission as futures-equivalent positions (i.e., in terms of the futures contract to which the swap is considered paired) which facilitates comparisons of the swaps and futures markets. In particular, delta-adjusted positions associated with swaptions are reported.

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<sup>5</sup> More information about the CFTC's Large Trader Swaps Reporting is available on the CFTC website: <http://www.cftc.gov/LawRegulation/DoddFrankAct/Rulemakings/XXXII.LargeSwapsTraderReporting/index.htm>.

<sup>6</sup> Large Trader Reporting for Physical Commodity Swaps is similar to Large Trader Reporting for Futures such that positions above a threshold are deemed to be reportable; however, for swaps, reporting entities have the option to report only those positions that exceed the threshold or to report all positions.

The swap positions reported are also classified based on the type of swap contract as follows:

- Direct exposure to a swap contract with payments linked to the specified commodity future (e.g., a swap on NYMEX WTI crude oil);
- “Two-component inter-commodity” swaps are composed of exactly 2 different commodity components with 1 long commodity component and 1 short commodity component (e.g., a swap with one floating leg that is long NYMEX WTI and one floating leg that is short Henry Hub Natural Gas);
- “Two-component locational basis” swaps are composed of exactly two positions in the same or substantially the same commodity with delivery at two different locations or with pricing based on the difference in the locational prices (e.g., a swap with one floating leg that is long NYMEX WTI and one floating leg that is short Louisiana Light Sweet crude oil); or
- “Index or basket” swaps are composed of 2 long positions in different commodities; composed of 2 short positions in different commodities; or composed of positions in more than 2 different commodities (e.g., WTI exposure implicit in a swap referencing the S&P GSCI Commodity Index or the Bloomberg Commodity Index).

We further classify swap positions based on the tenor of the exposures. As part of the futures equivalence calculations, reporting entities provide the related contract month to which the position pertains.<sup>7</sup> We use these futures-equivalent months to determine the term structure of exposures and aggregate positions into the following categories: 1 year or less (0 – 1 year), between 1 and 2 years, between 2 and 3 years, and more than 3 years.

In this data set, market participants do not report data on particular transactions; they report the futures-equivalent economic exposures that make up their positions with various counterparties. Hence, the exposures reported to the Commission are for the futures equivalents underlying the extant swaps. For example, if a swap contract expires in three years but has cash flows each month for the next three years, the dealer would be obliged to report the futures-equivalent position for each of the contract months over the next three years (i.e., 36 monthly values corresponding to the 36 payout dates).

The conversion into futures-equivalent contracts is quite important for comparing futures and swap activity, given the complexity and bespoke nature of the derivatives utilized by many Commercial End-Users. Publicly available data provides support for the contention that some commercial hedgers utilize the significant amount of flexibility offered by swaps. A representative description of a firm’s hedging activity is the following: “The Company generally uses financial hedge instruments including fixed price swaps, purchased call options, and commonly used combinations using put and call options including collars (a sold put option combined with a purchased call option), three-ways (a collar with a higher strike sold call option) and four-way collars (a collar with a higher strike sold call option and a lower strike purchased

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<sup>7</sup> See Appendix C for more details about reporting of futures-equivalent months.



put option). These hedge instruments are generally based on aircraft fuel or closely related commodities including diesel fuel and crude oil.”<sup>8</sup>

More granular detail, again from the public domain, underscores this point. One large Commercial End-User reported in its 2014 10-K Annual Report that the firm hedged fuel prices by entering into calendar strips of zero cost collars on Brent crude oil. The firm broke out the amount of crude hedged (in barrels) for future fiscal years and noted that “Fuel derivatives mature evenly over each month within the ... fiscal periods”, indicating that the component puts and calls are Asian.<sup>9</sup> The hedge also appears to be constructed with forward starting options, because the hedges were put into place several years before the fiscal year corresponding to contract maturities.

In this example, the hedged exposure is spread out over the tenor of the contract, and the notional amount of the transaction is roughly twice the magnitude of the economic exposure being hedged (because a combination of long calls and short puts were utilized to construct the hedge). Hence, an analysis solely based on the tenor of the underlying contracts would miss the fact that the contracts might generate economic gains or losses each month over the final twelve months of the contract, not just at expiration. Similarly, an analysis solely based on the notional amount of the contract would overstate the size of the trade by a factor of two, given that multiple options were required to construct the hedge for a given maturity. Our analysis properly accounts for such features, given that the data is reported directly to the Commission in futures-equivalent contracts per contract month.

The data reported under the CFTC’s large trader reporting for physical commodity swaps cover the vast majority of the global market for those physical commodity swaps that are linked to the 46 covered physical commodity futures contracts, and we believe that these data provide quite a comprehensive and representative view of these markets.<sup>10</sup> The largest participants in swaps markets are required by CFTC regulations to register with the Commission as either Swap Dealers or as Major Swap Participants. Swap Dealers are required to report large counterparty positions in commodity swaps, although Major Swap Participants are not required to do so.<sup>11</sup> These reporting Dealers represent a significant global presence, and we expect them to represent a very large fraction of total swaps activity. Because the registration regulations are applied at the legal entity level, many of the largest firms often have multiple entities that meet the swap dealer definition, and many of these are domiciled in different countries. By the end of December 2013, 96 Swap Dealers had been provisionally registered with the Commission, and as of December 2015, that number had increased to 103 Swap Dealers. Of the 103 Swap Dealers registered in December 2015, 50 were domiciled in the U.S., 20 were in the U.K., and the remaining 33 were in 13 other countries. Moreover, even though Dealer registration requirements are based on transacting a certain amount of swaps with “U.S. persons”, Large

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<sup>8</sup> United Continental Holdings 10-K Annual Report, p. 52.

<sup>9</sup> Carnival Cruise Lines, 2014 10-K Annual Report, p. 33. Asian options exhibit payouts based on the average price over time of the underlying instrument, as opposed to the price observed at a given point in time.

<sup>10</sup> See Appendix A for the list of covered futures contract.

<sup>11</sup> Clearing Members that are authorized by a clearing organization to clear paired swaps are also required to report under Large Swaps Trader Reporting. However, reporting entities are primarily limited to Swap Dealers after the conversion of many cleared physical commodity swaps to futures contracts in October 2012 since many entities that had been clearing paired swaps are no longer doing so.

Swaps Trader Reporting applies to all of the Dealers' counterparties regardless of whether or not they are U.S. persons. Not all Swap Dealers transact in or have reportable positions in the physical commodity swaps covered by the Large Trader Swaps Reporting. During the time period examined in the paper, the number of Swap Dealers reporting positions in any commodity ranged from 60-70, and those reporting positions for WTI swaps ranged from 50-60. Moreover, Swap Dealers are only required to report positions that exceed the reportable threshold for both themselves and their counterparties.<sup>12</sup> However, some Dealers chose to report all positions and not just those that exceeded the threshold. Hence, there is a small gap in coverage for counterparty reporting, but to the extent that these positions are reported as part of the Dealers' positions, we know the size of this segment.

One gap in coverage relates to transactions where one of the counterparties is not provisionally registered with the Commission as a "Swap Dealer". In untabulated computations using transaction data reported to SDRs, we estimate that less than 10% of transactions do not have a Dealer on one side of the transaction. Many of these transactions without a Dealer appear to be inter-affiliate transactions, whereby a firm's various legal entities transact among themselves in order to shift exposures within the large parent firm. Hence, many of the transactions "missing" from the data analyzed here are not market-facing transactions. Moreover, Lau and Robe (2016) show that crude oil swaps between non-dealers accounted for less than five percent of the total notional reported to the largest Swap Data Repository (SDR) for the time period we study. While the data reported to the SDRs also does not represent the universe of transactions in the global market, we expect that these transactions are representative.

To measure the size of futures and options markets, we use month-end open interest numbers for futures and delta-adjusted open interest for options on the futures.<sup>13</sup> When looking at open interest by participant type for WTI, we use data from the Historical Disaggregated Commitments of Traders Report for NYMEX Crude Oil, Light Sweet for futures and options combined.<sup>14</sup> The Disaggregated Commitments of Traders Report is published weekly and is based on one day of activity – Tuesday.

For counterparties with swap positions reported resulting from swaps paired with the NYMEX Crude Oil, Light Sweet futures contract, we classify them using the participant types used in the publicly-available Disaggregated Commitments of Traders Report:

- Producer/Merchant/Processor/User,
- Swap Dealers,
- Managed Money, and

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<sup>12</sup> A reportable position is comprised of 50 or more futures-equivalent paired swaps or swaptions, in any one futures-equivalent month, based on the same commodity, grouped separately by swaps and swaptions, then grouped by gross long contracts on a futures-equivalent basis or gross short contracts on a futures-equivalent basis. Once one position in a commodity is reportable, all of the positions in that commodity for the counterparty are reportable.

<sup>13</sup> Hereafter, we will refer to this more generically as the futures market or as the futures data.

<sup>14</sup> For additional information about the Historical Disaggregated Commitments of Traders Report, see <http://www.cftc.gov/idx/groups/public/@commitmentsoftaders/documents/file/disaggregatedcotexplanatorynot.pdf>.

- Other.<sup>15</sup>

For the analyses presented in this paper, we combine ‘Managed Money’ with ‘Other’ to create a new class which we call ‘Financial End-Users’. For the publicly available COT report, the “Money Manager” category includes registered Commodity Trading Advisors (CTAs), registered Commodity Pool Operators (CPOs), and hedge funds; whereas, the “Other” category includes entities that have reportable positions but are not classified as Commercial users or Money Managers. This “Other” category would therefore include institutional money managers such as pension funds, insurance companies, and sovereign wealth funds. Hence, we believe that these two categories generally cover. We also conducted the analysis with these two categories separated, but the trends between these two categories were fairly similar.

While the focus of this paper is on quantities, we also incorporate the crude oil price into the analysis in order to provide a more complete picture of market activity. In these instances, we use the settlement price for the NYMEX Crude Oil, Light Sweet nearby futures contract.

In an effort to compare our results to other data sources, we benchmark our data to the publicly-available Index Investment Data previously made available by the CFTC on a monthly basis.<sup>16</sup> These Index Investment data, although no longer collected, capture index activity in commodity markets by a variety of investors such as swap dealers, index funds, pension funds, hedge funds and mutual funds. These data include index activity in futures markets as well as in over-the-counter swap agreements. For month-end dates, these data provide the gross long and gross short positions in terms of the equivalent number of futures contracts.

#### 4. METHODOLOGY

The analysis in this paper has two components. One provides an overview of the size of commodity swaps markets relative to their corresponding futures and options markets, where size is measured by the delta-adjusted open interest. The second is a more in-depth analysis of the futures, options and swaps markets for NYMEX Light Sweet Crude Oil.

For the first component, we provide a comparison of the June 2015 average daily open swaps reported to the June 2015 month-end open interest reported for F/O markets. To calculate the average daily open swaps, we use data covering June 1, 2015 to June 30, 2015 from the large trader reporting for physical commodity swaps for reporting entities for various commodities.<sup>17</sup> We first calculate the average daily open swaps for a reporting month for each reporting entities’ proprietary gross positions (long plus short) and then sum the average daily open swaps for all principals in order to obtain the average daily open swaps for each reporting month. We calculate the average in this way in order to account for missing reports. This method should be robust to

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<sup>15</sup> We manually classify accounts based on the name of the counterparty reported for the account. This is described in further detail in section 4 of the paper.

<sup>16</sup> For additional information about the Index Investment Data, see <http://www.cftc.gov/MarketReports/IndexInvestmentData/ExplanatoryNotes/index.htm>.

<sup>17</sup> Given the manual effort required to integrate exposures due to index basket swaps, this cross-sectional analysis focuses solely on exposures due to single commodity swaps.

missing reports because the gross positions for reporting entities are fairly stable throughout the month.<sup>18</sup>

We then adjust the average daily open interest to remove positions resulting from inter-affiliate transactions and to remove duplicative reporting of positions due to transactions between reporting entities. Without this adjustment, the data would dramatically overstate the activity in market-facing swaps: some positions would be reported two or three times in the raw data. For example, consider a commodity swap transaction between an end-user and a dealer that aggregates such exposures into a single legal entity for risk management purposes (assume both Dealer entities are reporting parties). Suppose Dealer A's New York entity transacts with the end-user and then initiates an offsetting transaction with Dealer A's London entity. Dealer A's New York entity would then report the position with the end-user, the New York entity would also report the inter-affiliate position with the London entity, and the London entity would report the position with the New York entity. For the purposes of this paper, we exclude such inter-affiliate swaps and count only the Dealer position with the end-user. Similarly, but less dramatically, two reporting dealers that transact with each other would both report the same trade.

For this reason, we use the counterparty accounts of each reporting entity to flag counterparty accounts of other reporting entities and of each reporting entity's affiliates. We then use the daily average of the gross positions for these accounts to adjust the average daily open swaps. For affiliates, we remove the total amount reported for these positions from any calculation. For reporting firms, we remove one-half of the total positions reported for these accounts from any calculation. Similarly, we flag the counterparty accounts for entities that are affiliates of each reporting entity in order to adjust the average daily open swaps.

For the second, more in-depth analysis using NYMEX Light Sweet Crude Oil, we use data from the Disaggregated Commitments of Traders covering January 1, 2014 to December 31, 2015 in conjunction with large trader swaps data covering April 1, 2014 to December 31, 2015. This time period excludes some of the earliest reported data, which requires more manual cleaning, but it includes the precipitous decline in oil prices that began in late June 2014.

In order to compare positions by the different participant types that are available in the futures and options data, we manually classified each account found in the large trader swaps using the name of the counterparty for the account. To facilitate comparison with publicly available data for futures, we follow the same general breakout of market participants as is used in the Commitments of Traders (COT) report. The first enumerated category is "Swap Dealers". This designation encompasses entities who act as a dealer; the group is not limited to legal entities provisionally registered as a Swap Dealer with the CFTC. The second category is "Commercial End-Users", which corresponds to the "Producers/ Merchants/Processors/Users" category in the COT. These entities predominately engage in the production, processing,

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<sup>18</sup> As a robustness check, we also calculated the average daily open swaps for the reporting month without accounting for the missing reports. We found that the average daily open swaps calculated without adjusting for the missing data was always less than the daily average that does account for missing data and that the two averages are generally close. Because we believe that the average that accounts for the missing data is more representative, we present our results using the methodology accounts for missing data.

packing, or handling of a physical commodity. The third category is “Financial End-Users”, which corresponds to a combination of the “Money Managers” and “Other” categories in the COT. For the publicly available COT report, the “Money Manager” category includes registered Commodity Trading Advisors (CTAs), registered Commodity Pool Operators (CPOs), and hedge funds and the “Other” category includes entities that have reportable positions but are not classified as Commercial users or Money Managers. This category would therefore include institutional money managers such as pension funds, insurance companies, and sovereign wealth funds. The final category is “Unclassified”. For futures, this category includes small accounts with no reportable position in the COT (the value is computed as the difference between aggregate open interest and the sum of reported trades); for swaps, it includes entities for which classification data was not readily available for this project.

Also for the sake of comparability, we calculate the average daily swap positions for the different participant types on a weekly basis (long, short, and net) in order to match the weekly frequency of the Commitments of Traders report. We adjust these daily averages of swap positions to remove positions resulting from inter-affiliate transactions and the duplicative reporting for Dealer to Dealer transactions. We do not impute missing reports. An alternative methodology would have been to use the large trader swaps data observed each Tuesday; however, the weekly average smooths some of the noise in the swaps data caused by reporting errors.<sup>19</sup> Given the descriptive and largely graphical objective of this first analysis of the data, we rely on averaging to minimize the noise in the data.

It also worth noting that swaps do not offset the way that futures offset, especially for the purpose of calculating open interest. Given the wide variety of instruments reported as swaps, it is difficult to know how much compression could really be done in a way that is comparable to the offsetting that is done for calculating open interest. Even in the fairly standardized world of swaps, positions in different instruments would generally not be offset even for instruments resulting in the same exposure.

## 5. OVERVIEW OF COMMODITY SWAPS MARKETS

Figure 1 provides a bird’s eye view of the cross section of commodity futures and swap market exposures for a representative reporting month, June 2015. The chart displays the average daily number of futures-equivalent contracts outstanding for 29 different commodities. The blue bar represents the futures market and the red bar represents the swaps market. The vertical axis is the one-sided open interest (i.e., long or short, but not long plus short). There are a few striking observations to be made from the chart. First, there are substantial differences in open interest across these markets. The largest market by far is the commodity swaps market for natural gas, with over 5 million futures-equivalent contracts, and the market for WTI light, sweet crude oil

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<sup>19</sup> While there are some cases in which averaging positions could amplify reporting errors given the persistence of positions, we typically do not find this to be the case in these data. We typically find spikes up and down which generally persist for one day and then revert back to the previously reported position. While there are a number of explanations for this, the vast majority appear to be due to reporting errors and not due to actual changes in the position.

swaps is a distant second with about half as many open contracts.<sup>20</sup> Corn swaps are third with about 1 million open futures-equivalent contracts. The magnitude of open swaps is well below 1 million contract equivalents for other markets. The second striking observation is that the swaps market exposure for a commodity is significantly smaller than the futures exposure for most of the 29 commodities, with rare exceptions. The disparity in swap activity is actually understated by Figure 1, in that the chart excludes many commodities for which data is required to be reported but activity is at even lower levels than the ones presented (e.g., Ethanol, Butter, Cheese, Whey, and others).

Figure 2 reproduces the same chart information, but only for a subset of agricultural products. Accordingly, the scale is adjusted such that the open interest for each contract is more visible. Despite this change in scale, the evidence indicates that the swaps markets for these commodities appear to be of quite modest size compared to the listed futures market. While there is exposure for a variety of swaps such as Soybean Meal, Soybean Oil, Soybeans, and others, open interest is half or less than that of the futures market. Plus, the relative size rankings of these futures market do not follow the size rankings for their corresponding swaps market. Based on the evidence presented in these charts, which we believe is representative of our 2014-2015 sample data, we focus the remainder of the paper on a deep dive into one commodity: NYMEX WTI Crude Oil.

## 6. ANALYSIS OF WTI DERIVATIVES

### 6.1. WTI Swaps and Futures Data

In this section, we focus on comparisons between the WTI Swaps and Futures Markets. We begin with a general comparison of the size of these markets using open interest/swaps and then progress to further comparisons using the different participant types in these markets.<sup>21</sup> Given the dramatic decline in the price of WTI during this time period, we also look for signs of the impact of this decline on these markets.

As a comparison of the size of these markets, Figure 3 displays the aggregate open interest over time for NYMEX WTI futures and delta-adjusted options, as well as the open interest (futures-equivalent contracts) for WTI-linked swaps<sup>22</sup> reported to the CFTC. The aggregate open interest for swaps includes both direct exposures to WTI and indirect exposures due to commodity index investments where the underlying index contains NYMEX WTI as a constituent. The blue line displays the futures data and the red line displays the swaps data. Both series represent the one-sided open interest (i.e., long or short, but not long plus short). The swaps data are adjusted for double and triple counting of swaps due to inter-affiliate transactions

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<sup>20</sup> In natural gas, we see far more variety in the reported reference prices for the swaps than for any other commodity. This reflects the wide variety of delivery locations for natural gas. In futures, these different locations are generally covered by different futures contracts.

<sup>21</sup> For these analyses, we do not account for missing swaps data as we did in Section 5 due to the complexity of determining missing data for the different participant types. However, we do not expect the missing data to bias our general results. We do expect the numbers presented in this paper to be lower bounds for open swaps and for gross positions.

<sup>22</sup> This also includes delta-adjusted options that meet the swap definition.

or to transactions between dealers. The chart suggests that the two series are moving broadly in tandem, drifting downward over the course of 2014, trending upward in late 2014 and the beginning of 2015, and then plateauing for the last half of 2015. Figure 3 also presents the settlement price of the nearby NYMEX WTI futures price. Visual inspection of the chart reminds the reader that, in aggregate, the increase in open interest at the end of 2014 coincided with the decline in crude prices from roughly USD 100 per barrel to USD 50 per barrel. It is difficult to see meaningful patterns in this chart, so we move to a more disaggregated analysis of the data.

In order to better understand the duration of these exposures, we turn to the tenor of these swap exposures and compare them to equivalent exposures in swaps. Table 1 breaks out the overall WTI swap exposures by tenor, with a side-by-side comparison for futures open interest. The table makes clear that the vast majority (71%) of WTI swaps have a tenor less than one year, mirroring the nature of futures markets to exhibit the majority of exposure in these shorter-dated instruments (78%). Swap contracts with exposure covering the one- to two-year tenor account for another 21% of the open interest. The remaining 8% is for contracts with exposures from two years or more. Based on this sample, swaps markets appear to exhibit the same general term structure of exposure as futures markets exhibit.

It is worth reiterating at this point that the exposures reported to the Commission are for the futures-equivalents underlying the extant swaps. The tenors reported are not the tenors of the actual swaps but are for the futures contracts making up the swap exposures. If a swap contract expires in three years but has cash flows each month for the next three years, the dealer would be obliged to report the futures-equivalent position for each of the contract months over the next three years (i.e., 36 monthly values corresponding to the 36 payout dates).<sup>23</sup> Hence, the values in Table 1 should not be interpreted as swap tenors but as exposures across the term structure.

To show the composition of participants using these markets, Figure 5 presents a side-by-side comparison of the open interest in futures (the left hand chart) and swaps (the right hand chart). The chart displays the two-sided open interest figure, i.e., the long plus short open interest, which is twice the one-sided value. The futures chart on the left displays data from the publicly available Commitments of Traders report, with the different colors marking open interest attributable to three main market participant types plus the unclassified, small accounts. The chart displays the swap dealer open interest in blue, the Commercial End-Users (a.k.a., producer/merchant/processor/user) open interest in red, and the Financial End-User open interest in green.

Comparison of the two charts in Figure 5 reveals several interesting observations. First, the swap dealer category is larger in swaps than in futures, with their two-sided open interest in swaps averaging around 150% of their two-sided open interest in futures (around 2 million contracts versus 1.4 million contracts, respectively). Second, the Commercial End-User component is much larger for swaps than for futures; these participants appear to represent about 14% of futures open interest and 29% of open swaps.<sup>24</sup> Third, the Financial End-User category is much larger in futures than in swaps; it represents about 53% of futures open interest but just 16% of open swaps. Finally, the relative magnitudes of these attributions appear generally stable

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<sup>23</sup> See Appendix C for additional information.

<sup>24</sup> This is true despite the fact that the swaps data does not include swaps between two end users.

over the sample. Based on the data presented in this chart, it is clear that “real economy” Commercial End-Users are significant users of WTI futures and, to an even larger extent, swaps; but that Financial End-Users are a bigger user of futures than swaps.

While the gross positions for these participants provide some insight into the overall composition of these markets, the net positions of these participants are of particular interest. Figure 6 displays the average daily net exposures, for both futures and swaps, of these participant types over the entire period of April 1, 2014 to December 31, 2015. The figure makes clear the consistency in exposures across futures and swaps for end-user categories (i.e., their net exposure in swaps is in the same direction as their net exposure in futures). Financial End-Users, as a group, have net long WTI exposure in futures and in swaps, although their futures positions are larger than their swaps positions (340,000 contracts versus 190,000 contracts). Similarly, Commercial End-Users, as a group, are net short WTI exposures in both futures and swaps. However, unlike Financial End-Users, Commercial End-Users are far larger in swaps markets than in futures, with an average net position equal to short 100,000 contracts in futures and short 340,000 contracts in swaps.

The other striking observation to take from Figure 6 is that swap dealers have net long exposure to WTI in swaps but are net short in futures. Swap dealers, as expected, have offsetting exposures across these two types of instruments. Hence, Swap Dealers appear to have only a moderately balanced WTI book when the COT futures data are examined (net-to-gross ratio of 0.18), but the imbalance is substantially smaller when swaps and futures positions are both included (net-to-gross ratio of -0.04).<sup>25</sup>

Computing this same ratio of the average net exposure to the average gross exposure for each of the other participant types suggests that end-users of swaps are more homogeneous in their directionality than end-users for futures. In swaps, this ratio is +0.30 for Financial End-Users and is -0.33 for Commercial End-Users, but it is only 0.05 for Swap Dealers. When these same net-to-gross ratios are constructed using the publicly available COT data for futures over the corresponding sample, the ratio is +0.13 for Financial End-Users, -0.17 for Commercial End-Users, and -0.16 for Swap Dealers.

Finally, note that the average net exposure of “Not Classified” accounts is virtually zero in futures (due to unreportable positions) but is positive for swaps. In general, of course, swaps exposures would exactly offset. The imbalance reflects unreported counterparty positions.<sup>26</sup> However, the magnitude of this group’s position is less than a quarter of the average Commercial End-User position and less than half of the average Financial End-User position. We believe that this segment of the market is small enough that our conclusions are not qualitatively affected by excluding it from consideration in the more detailed analysis.

While Figure 6 shows the average net position of our participant types across the entire time period, Figures 7 through 9 show how these participants’ net positions change from week to

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<sup>25</sup> This net-to-gross ratio is effectively the longs minus shorts divided by the longs plus the shorts, for a particular group.

<sup>26</sup> Reporting entities are only required to report positions that exceed a specific threshold, though some report all positions regardless of the size.



week for both futures and for swaps. These charts also display the settlement price of the nearby WTI futures contract. For Swap Dealers, Figure 7 highlights swap dealers' tendencies to generally have offsetting futures and swap positions. The chart also highlights the swap dealers' relatively large net positioning for both futures and swaps when crude oil was near USD 100 per barrel as well as the shift in the magnitude of these net positions, which are substantially smaller after the price decline starting in mid-2014. Figures 8 and 9 show the changes over time in net positions of Commercial End-Users and Financial End-Users, respectively. The most notable characteristic of Figures 8 and 9 appear to be the consistency of net positioning in futures and swaps over time for both Financial End-Users and for Commercial End-Users. That is, Financial End-Users were consistently net long both futures and swap exposure over this sample, and Commercial End-Users were consistently net short both futures and swap exposure over this sample. However, Commercial End-Users appear to increase their net position in futures while reducing their net position swaps. Conversely, Financial End-Users appear to increase their net position in swaps while reducing their net position in futures.

## 6.2. Further Analysis of WTI Swaps Data

The figures presented thus far have generally been focused on comparing the futures and swaps markets for WTI. Because futures data are publicly available, the remainder of the analysis presents more detail for WTI swaps with minimal reference to the corresponding futures.

While we have been representing the economic exposure of the participant types by the net exposures in the previous analysis, Figures 10 through 12 disaggregate these net swap exposures into the component long and short positions held by these participant types. These gross exposures are a first step for providing better insight into the counterparty risks faced by these participant types as a group. Figure 10 illustrates the fact that Swap Dealers take significant long and short positions, which is consistent with the business of swap dealers as intermediaries who facilitate the net long positioning desired by the money managers and the net short position desired by the Commercial End-Users. Figures 11 and 12 correspondingly break out the long and short positions held by Financial End-Users and Commercial End-Users, respectively. While neither of these two groups appears perfectly homogeneous with respect to the directionality of the constituents, they do appear to be much more homogeneous than Swap Dealers.<sup>27</sup>

We further break these exposures down by tenor. Figures 13 through 15 display the time series for the net positioning of Swap Dealers, Financial End-Users, and Commercial End-Users, respectively, broken out by the tenor of the underlying futures market exposure of the open swaps. These figures show that the majority of the net positioning for each of these participant types is concentrated in the zero to two year bucket, which is not surprising given the aggregate market characterization shown in Table 1. Swaps Dealers, as shown in Figure 13, were net long in the shorter dated (less than 3 years) with a very small net short exposure in the longer dated exposures (greater than 3 years) through most of 2014. Near the end of 2014 dealers started to hold net short positions in very shortest dated exposures (less than one year) while maintaining net long positions in the longer dated exposures (primarily 1-2 years). This pattern appears to

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<sup>27</sup> As noted earlier, the net-to-gross ratio in swaps is +0.30 for Financial End-Users and is -0.33 for Commercial End-Users, but it is only 0.05 for Swap Dealers.

hold until the end of 2015. Conversely, Financial End-Users maintain their net long exposures across all the tenors, while Commercial End-Users maintain their net short position across all tenors.

We next examine the composition of the WTI swaps market with respect to product type. Table 2 provides an overview of this composition by breaking out the average swap exposures according to different product types (i.e., swaps with direct WTI exposure, index basket swaps, locational basis swaps, and 2-component inter-commodity spreads). The largest average exposure is to direct exposure via WTI swaps, accounting for some 67% of the open interest. A further 19% of the open interest is due to implicit exposures via index or basket swaps. The remaining 15% is attributable to swaps that contain two floating legs, one of which is WTI. These inter-commodity spreads (e.g., WTI vs. natural gas) or locational basis swaps (e.g., WTI vs. Louisiana Light Sweet crude) can be long or short WTI, although that distinction does not impact the computation of open interest as shown in the table.

Figures 16 through 18 provide time series charts which expand on the average, aggregated net values presented in Figure 6 by presenting the net exposure for these participants by product type (e.g., direct exposure via WTI swaps or indirect exposure via index basket swaps) on a weekly basis over the entire time period. For example, the average net exposure for swap dealers, as shown in Figure 6, is a long exposure of roughly 100,000 contracts. Figure 16 provides more detail, hidden by aggregated values, on the underlying composition of this net long exposure – for these same swap dealers, their overall net exposure is comprised of net long exposure via WTI swaps (long roughly 400,000 contracts on average), net short exposure via index basket swaps (short roughly 225,000 contracts on average), and modest short positions due to basis and spread contracts. The net long WTI exposure and implicit net short exposure due to basket swaps leaves an average of roughly +175,000 contracts. This net exposure is further offset by the net short two commodity spread contracts, which averages roughly 80,000 contracts, leaving the net long position just below 100,000 contracts.

Figure 17 provides the same breakout for the Financial End-User category, providing more detail on the nearly 200,000 average net long position held by money managers. In aggregate, these participants are net long across all of the product types, with roughly 80% of the net exposure via basket swaps. About half of the remaining exposure (i.e., about 10%) is via direct WTI swaps, with the residual positions due to spread contracts. Further, the scaling of this figure is the same as in Figure 16, highlighting the relatively small net footprint of Financial End-Users in the swap space when compared to Swap Dealers.

Figure 18 provides more context for Commercial End-User swap activity. Figure 6 indicated that the group was net short, on average approximately 350,000 contracts, and Figure 18 reveals that this exposure is virtually all direct WTI net short exposure. There is a small net positive exposure to WTI due to spread trades (long WTI, short another location or commodity), but the existence of this exposure does not materially impact the overwhelming nature of the net short position in WTI by Commercial End-Users. Moreover, the net exposure from index/basket swaps is barely perceptible in the chart.

Taken together, Figures 16 through 18 demonstrate that the net positioning for these participant types has been fairly stable around the averages shown in Figure 6 during the sample period. Moreover, these figures demonstrate that Swap Dealers are therefore, on net, long significant WTI exposure (mostly due to Commercial End Users) and short significant WTI exposure due to index/basket exposures (mostly due to Financial End-Users). The overall WTI exposure, therefore, is much smaller in magnitude than either of these components. Exposures to unclassified or unreportable counterparties make up the residual.

Given the significance of index/basket swaps for Financial End-Users (and hence, the Dealers on the other side of these swaps) and the complicated nature of reporting these in the large swaps trader reporting, we benchmark the index basket component of this new swaps data to existing, publicly available data that has been used by researchers (e.g., Sanders and Irwin, 2013). Hence, we make the comparison to the CFTC's Index Investment Data series, which provides long, short, and net notional values and futures contract equivalents for index investment activity in select commodities from December 2007 to October 2015. This legacy report data reflects index activity whether carried out in the futures market or swap market. The report summarized the monthly results of a "special call" requiring certain swap dealers and index funds to report index activity. Therefore, the values from these reports are expected to be at least as large as the values from the new data, which covers only swap market activity.

The Index Investment Data was discontinued as of the October 2015 publication; however, we still have a direct comparison for more than 20 monthly data points (March 2014 to October 2015).<sup>28</sup> Figure 19 displays the net index activity linked to WTI futures (the top, dashed line in the chart) and the net non-dealer swap exposure linked to indirect WTI exposure due to index swaps (the bottom, solid line in the chart). The Index Investment Data series begins around 300,000 futures contract equivalents in March 2014, remains in that range until the end of 2014 and then trends upward, rising to nearly 500,000 contract equivalents. The swap exposure data displays a similar rising trend, moving from approximately 100,000 contract equivalents to just over 300,000 contract equivalents by the end of 2015. The average ratio of the two series is 0.57.

Although the two series use different methodologies to measure WTI-linked commodity index exposure, the general trend of increased exposure over the sample is reassuring. Based on visual inspection of these two series, we conclude that the new swap data appears to capture the same market-wide activity trends that the legacy Index Investment Data captured.

### 6.3. Application: Working's T Index

Our analysis shows that the swaps and futures markets, at least for WTI, work in tandem and that analyzing only one market may not provide a comprehensive view. To further illustrate the joint nature of these markets, we apply our data to an application typically used strictly for futures markets – Working's T Index – in order to see if the conclusions change when using swaps and futures data combined compared to only using swaps or futures data alone.

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<sup>28</sup> We align the swaps market observation for the first week of April 2014 with the end-of-March 2014 Index Investment Data.

The so-called T index introduced by Working (1960) quantifies the relative activity of liquidity demanders and liquidity providers. This index summarizes the long and short derivatives positions of commercial entities and non-commercial entities in a given commodity into a single scalar statistic. Various authors (e.g., Büyüksahin and Harris (2011) and Robe and Wallen (2016)) have used this index to quantify the relative amount of liquidity demanded compared to the amount of liquidity supplied in futures markets.

Working's T index is computed using the traditional "Commercial" and "Noncommercial" categorizations summarized in the Commitments of Traders report. The index is computed as

$$T = 1 + \frac{NC_{Short}}{C_{Long} + C_{Short}} \text{ if } C_{Short} \geq C_{Long}$$

or

$$T = 1 + \frac{NC_{Long}}{C_{Long} + C_{Short}} \text{ if } C_{Short} < C_{Long}$$

where open interest held by non-commercials and commercials, respectively, are denoted by the variables NC and C. Subscripts denote whether the long or short open interests for a particular group is used.<sup>29</sup>

Figure 20 displays Working's "T" index over the March 2014 to December 2015 sample. The topmost line in the chart is computed using the same data used in our earlier analysis for analyzing futures – the public Commitments of Traders data incorporating futures and delta-adjusted options. The value of this series trends strongly upward during the first part of the sample, moving from 1.45 to 1.65 during 2014; the series oscillates around 1.60 during 2015. The bottommost line in the chart is computed using just the open swaps data. This series shows little variation in absolute terms and averages around 1.05. Of course, each of these series represents a subset of the overall WTI derivatives market. The substantial difference between these lines indicates that these two markets work very differently and that using either series alone may provide an incomplete and potentially biased representation of the aggregate market. Given the findings of our paper that Commercial End-Users hold larger positions (net and gross) in swaps relative to futures and that the reverse is true for Financial End-Users, this finding is not surprising.

To compare these results to those for the combined derivatives market, we also calculate Working's T index by combining the futures and the swaps market data using the open interest aggregated by participant type. Figure 20 shows this Working's T index as the thick middle line of the chart. This combined version of the T index appears to be relatively stable over the period and averages approximately 1.25 over most of the sample. Hence, the comprehensive index

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<sup>29</sup> Note that, consistent with the CFTC publicly reported data, Commercial positions aggregate the Producer/Merchant/Processor/User and Swap Dealer positions and Non-Commercial positions aggregate other reportable categories (i.e., Money Managers and Other Reportables). For computation of Working's T in this paper, we allocate the small, nonreportable positions to the Non-Commercial category.

suggests a much lower level of non-commercial activity, in relative terms, than the listed futures and options index suggests. While the index computed from publicly available data suggests there is 60% more non-commercial activity than is mathematically required to offset commercial activity, the comprehensive index suggests there is just 30% more non-commercial activity than is required. Moreover, the 2014 upward trend in the index is far more muted and is not particularly notable in the combined index.

The 1.30 value of the index computed using listed and OTC contracts can be compared to the typical values observed in commodity markets. Sanders, Irwin, and Merrin (2010) report published historical estimates of Working's T spanning the 1940s to the late 1970s – an era preceding swaps – for traditional grain futures contracts ranging from 1.009 to 2.173, with average values nearer to 1.20 to 1.40. Hence, the combined T index shown here for WTI crude derivatives is quite consistent with historical values for commodity markets, although the futures portion of the WTI space suggests a much larger value than the comprehensive view of the market suggests. We therefore argue that analyzing either swaps or futures data alone may provide an incomplete and potentially biased view of commodity markets, especially when there is a fair amount of crossover between the swaps and futures as appears to be the case currently for WTI crude derivatives.

## 7. CONCLUSION

We have presented initial results that summarize the CFTC's new regulatory data on OTC commodity swaps, and we have focused the majority of our attention on WTI swaps. Our analysis has been largely descriptive due to the novel character of our data. We have presented many of the results for swaps alongside the corresponding results for futures in order to emphasize the potential connections between the two markets. When looking at various physical commodities, we find that futures markets are generally larger than the corresponding swaps markets, as measured by open interest, with WTI crude oil being an exception. We also compare the term structures of exposures in swaps to that in futures and find them to be very similar with 71% of WTI open swaps and 78% of open interest in futures have a tenor of exposure less than one year. Moreover, approximately 2% of futures and 2% of swaps open contracts have a tenor of exposure of 3 years or more.

To make swaps and futures results more comparable, we organize swaps counterparties using the participant type classifications utilized in the publicly-available Disaggregated Commitments of Traders Report. We find differences in how the various participant types make use of both the swaps and futures markets to gain WTI exposure. For example, "real economy" Commercial End-Users are significant users of WTI futures and, to an even larger extent, swaps; but Financial End-Users appear to be more active in futures rather than in swaps.

In terms of long and short exposure, Swap Dealers generally appear to have offsetting futures and swap positions, which is suggestive of active management to neutralize exposures to WTI price changes. The size of dealer exposure was relatively large when crude oil was near USD 100 per barrel, but the magnitude of positions gets considerably smaller after the substantial price decline starting in mid-2014. In contrast to Swap Dealers' relatively neutral exposure to WTI price moves, Financial End-Users consistently exhibit a net long exposure in

both futures and swaps over the sample, and Commercial End-Users consistently exhibit a net short exposure in both futures and swaps over this sample.

Using this newly available swap position data, we also analyze swap exposures for different product types. Direct WTI swaps constitute the largest portion of swap exposure, accounting for some 67% of the open interest. A further 19% of the open interest is due to implicit exposures via index or basket swaps. The remaining 14% is attributable to swaps that contain two floating legs, one of which is WTI.

Further breaking out product types utilized by different participants in the swaps market, we find that in aggregate, the Financial End-User category is 200,00 contracts net long across all of the product types in swaps, with roughly 80% of their net exposure via basket swaps. On the other hand, Commercial End-Users' net short exposure – 350,000 contracts on average – is predominantly acquired via direct WTI swaps. Not surprisingly, we find that Swap Dealers act as intermediaries between end-users across listed and unlisted trading venues. In swaps, this behavior is most clearly exhibited by their substantial net long position from direct WTI swaps (mostly due to Commercial End Users' desire to be net short using this type of product) and their substantial net short position due to index/basket swaps (mostly due to Financial End-Users' desire to be net long using this type of product).

Finally, to illustrate the joint nature of these markets and the importance of studying them jointly, we contrast Working's T index computed for the combined futures and swap markets with the index computed solely from public futures market data and solely from swaps market data. We find that the index computed using the futures and swaps data combined is substantially lower and more stable than the values computed solely using the futures data and is substantially higher than the values computed solely using the swaps data. These findings suggests that some conclusions regarding activity in crude oil, based solely on the listed futures market data for example, may be unreliable because swaps market activity represents nearly half of the overall net positioning in WTI derivatives.

**APPENDIX A: Large Trader Reporting for Physical Commodity Swaps Covered Futures Contracts**

<b>Exchange</b>	<b>Contract</b>
Chicago Board of Trade	Corn
	Ethanol
	Oats
	Rough Rice
	Soybean Meal
	Soybean Oil
	Soybeans
	Wheat
Chicago Mercantile Exchange	Butter
	Cheese
	Dry Whey
	Feeder Cattle
	Hardwood Pulp
	Lean Hogs
	Live Cattle
	Milk Class III
	Non Fat Dry Milk
	Random Length Lumber
	Softwood Pulp
COMEX	Copper Grade 1
	Gold
	Silver
ICE Futures U.S.	Cocoa
	Coffee C
	Cotton No. 2
	Frozen Concentrated Orange Juice
	Sugar No. 11
	Sugar No. 16
Kansas City Board of Trade	Wheat
Minneapolis Grain Exchange	Wheat
NYSELiffe	Gold, 100 Troy Oz.
	Silver, 5000 Troy Oz.

(continued on next page)

<b>Exchange</b>	<b>Contract</b>
New York Mercantile Exchange	Brent Financial
	Central Appalachian Coal
	Cocoa
	Coffee
	Cotton
	Crude Oil, Light Sweet
	Gasoline Blendstock (RBOB)
	Hot Rolled Coil Steel
	Natural Gas
	No. 2 Heating Oil, New York Harbor
	Palladium
	Platinum
	Sugar No. 11
	Uranium

Note that Diversified Commodity Index positions can be reported in their own category (and not as futures-equivalent positions) for diversified indices that are commonly known with publicly available weightings.



## APPENDIX B: CLEANING THE DATA

The raw data was filtered and cleaned to remove erroneous information. While the vast majority of records appear appropriate, some require correction. These issues were typically more problematic in the early months of reporting and have become somewhat less of an issue as reporters have been notified of systematic errors and have worked to correct their systems. This appendix describes some of the common, systematic errors found in the data.

For example, a systematic review revealed that some positions were extraordinarily large, either in absolute terms or relative to the expected size of a particular counterparty's position. To diagnose this and correct the problem in existing data, we note that the reports to the Commission include two separate fields quantifying the position size. For each record, we compare the "*reported position*" field (to be reported in futures contract equivalents) to the "*reported notional*" field (to be reported in notional value). This notional field is expected to equal the number of contracts multiplied by the dollar value of one contract; therefore, the ratio of the two fields ("*reported notional*" divided by "*reported position*") should approximate the dollar value for one futures contract.

We have identified two main systematic errors using this ratio. First, positions are sometimes reported in units rather than futures contract equivalents (e.g., e.g., as 1 million barrels of oil as opposed to 1,000 contracts of NYMEX Light Sweet Crude Oil). For errors of this type, we have contacted reporting entities, who have typically confirmed that these positions were in fact mistakenly reported as the number of units of the underlying commodity as opposed to the number of futures-equivalent contracts. In this circumstance, the reported positions were adjusted to the number of futures-equivalent contracts.

Second, some records contain a misplaced decimal (e.g., a position of 2 instead of 200). This appears to occur when the price of a contract is used in internal computations by a dealer to obtain the position to report, but the computation does not properly account for units. For example, a contract quoted in cents per pound might be used in a computation as if it were in dollars per pound. When identified, we also adjusted these records to reflect the correct size.

In some cases, we have identified no systematic adjustment to correct obviously erroneous data. In these instances, the positions were excluded from the analysis. In total, less than 1% of position records are corrected or excluded.

Additional editing of the swaps data was required to correctly distinguish the reporting entities positions from those of their counterparties. Moreover, there are a handful of reporting entities that only report positions for their counterparties. In these cases, the positions of the reporting entities are derived from the positions reported for their counterparties.

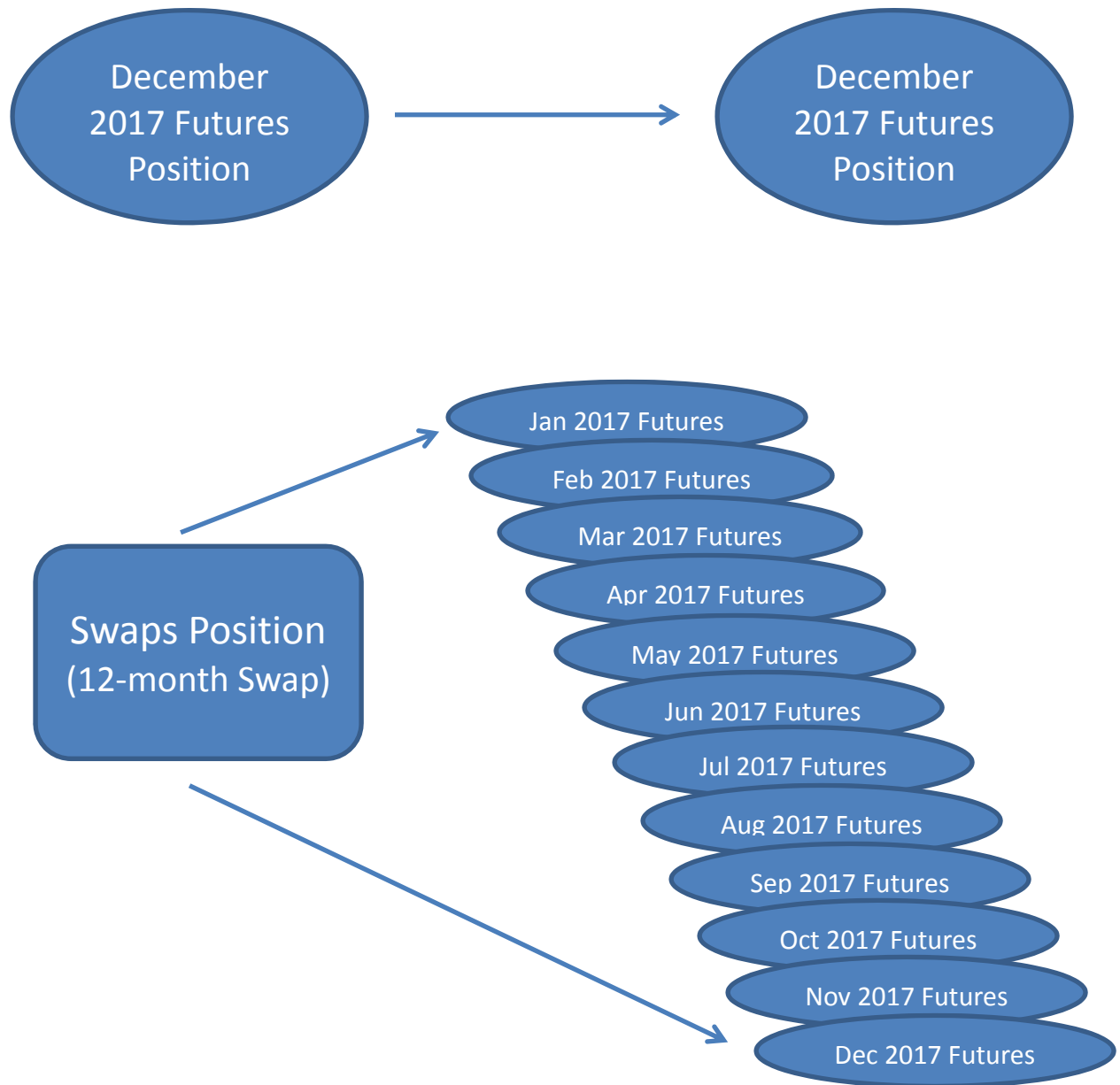
We also identified transcription errors by reporters where the name entered in the *commodity reference price* field (i.e., the price upon which the swap settles) for the swap contract did not exactly correspond to the correct futures market name as reported in the underlying commodity field. For example, in some cases, the relevant commodity reference price is reported as "PALLADIUM-NYMEX" but the underlying commodity is reported as "NYMEX

Platinum” rather than as the corresponding futures market name “NYMEX Palladium”. In these cases, we adjusted the underlying commodity accordingly. In other cases, the commodity reference price indicated that the position did not result from a paired swap (e.g., Japan Yen), so the record was excluded. In speaking with reporting entities and by assessing other information reported for the position, we determined that the commodity reference price is the best indicator of the underlying commodity when the commodity reference price and the underlying commodity do not agree. These adjustments also impacted a small number of records.

## **APPENDIX C: REPORTING FUTURES-EQUIVALENT CONTRACTS**

Generally, the futures-equivalent month of a swap, or for some portion of a swap's duration, should correspond to the price exposure resulting from the swap. Stated another way, the futures-equivalent positions generated from a swap would be the portfolio of futures contracts that would most closely provide the price exposure of that swap. The futures-equivalent contracts resulting from this treatment of swaps may differ in some ways from the risk management practices that firms may use in that the futures equivalents may not be the same as the futures contracts and contract expiration months that a firm could actually use to offset the risk of a particular swap. For example, if a swap generated price exposure to the monthly settlement of a futures contract for twelve consecutive futures contract expirations, this price exposure could be offset by "stacking and rolling" a futures market position forward from month to month as liquidity migrates to the nearby futures expiration months. While this may be an acceptable risk management practice, representing the futures-equivalent position resulting from the swap as if, for the first month, all twelve months of price exposure was obtained from the nearby futures contract, would be incorrect and not consistent with the intent to best represent the price exposure generated by a swap in terms of futures-equivalent months.

The following is a graphical representation of the difference between futures and swaps. One swap contract with 12 monthly settlement periods can be thought of as a series of monthly futures contracts; whereas, one futures contract generally represents one contract month.



## References

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**Table 1. WTI-Linked Open Swaps Compared to WTI Futures Open Interest by Tenor of Exposure**

Table 1 displays average daily open swaps linked to WTI (in terms of futures-equivalent contracts) by tenor in comparison to the average daily open interest from futures and delta-adjusted options in the NYMEX WTI Light, Sweet Crude Oil contracts. The sample period covers April 2014 to December 2015.

Exposure	Open Swaps		Futures Open Interest	
	Number of Contracts	Percent of Total	Number of Contracts	Percent of Total
0 - 1 year	1,331,164	71	1,856,840	78
1 - 2 year	402,490	21	380,408	16
2 - 3 year	105,143	6	90,186	4
3+ year	44,136	2	45,876	2
Total	1,882,932	100	2,373,310	100

**Table 2. WTI-linked Open Swaps by Product Type**

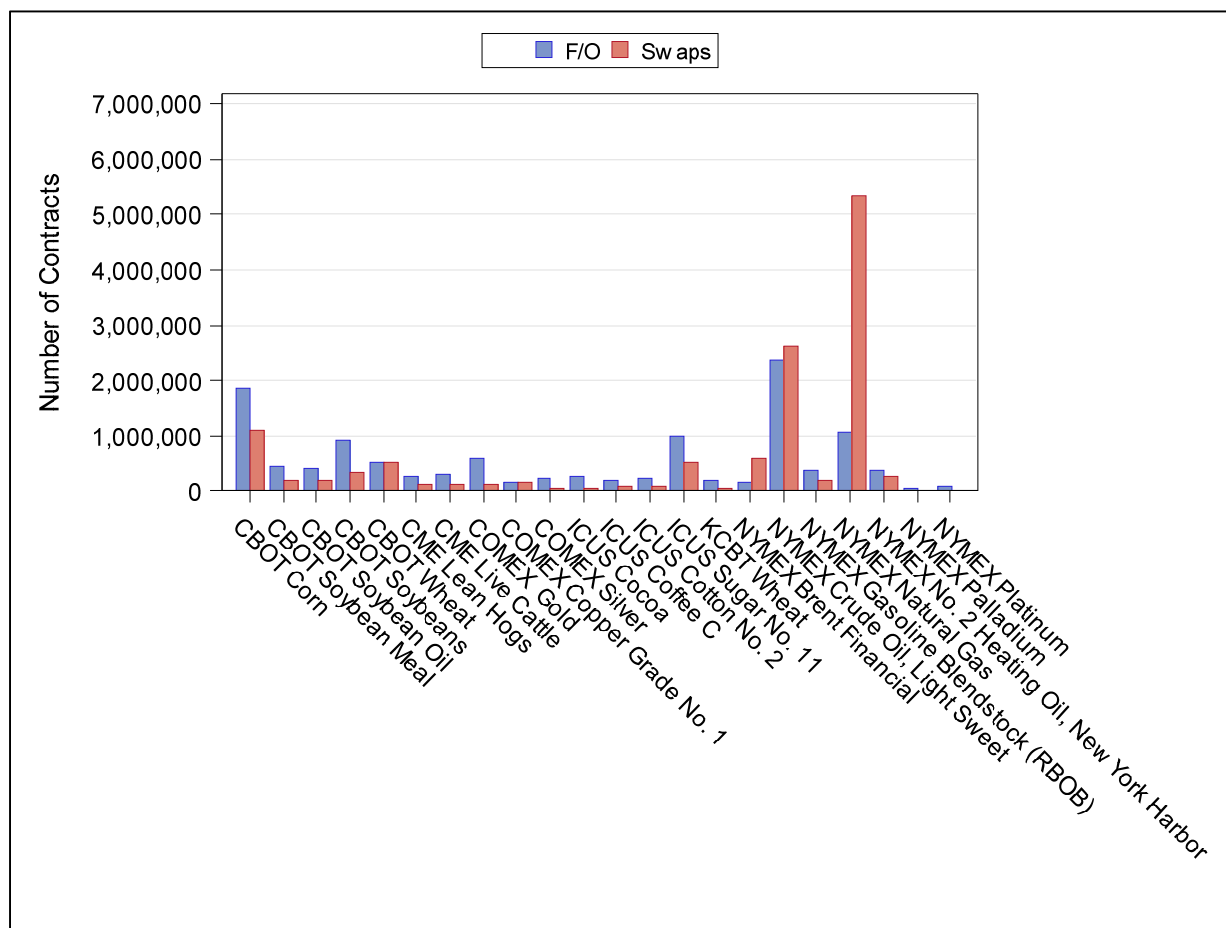
Table 2 displays average daily open swaps linked to WTI (in terms of futures-equivalent contracts) by product type. For the index or basket, location basis, and inter-commodity spread product types, the open swaps are specific to the WTI component of the swap. The sample period covers April 2014 to December 2015.

Open Swaps		
Product Type	Number of Contracts	Percent of Total
WTI	1,253,075	67%
Index or Basket	350,366	19%
Locational Basis	203,700	11%
Inter-commodity Spread	75,791	4%
Total	1,882,932	100%



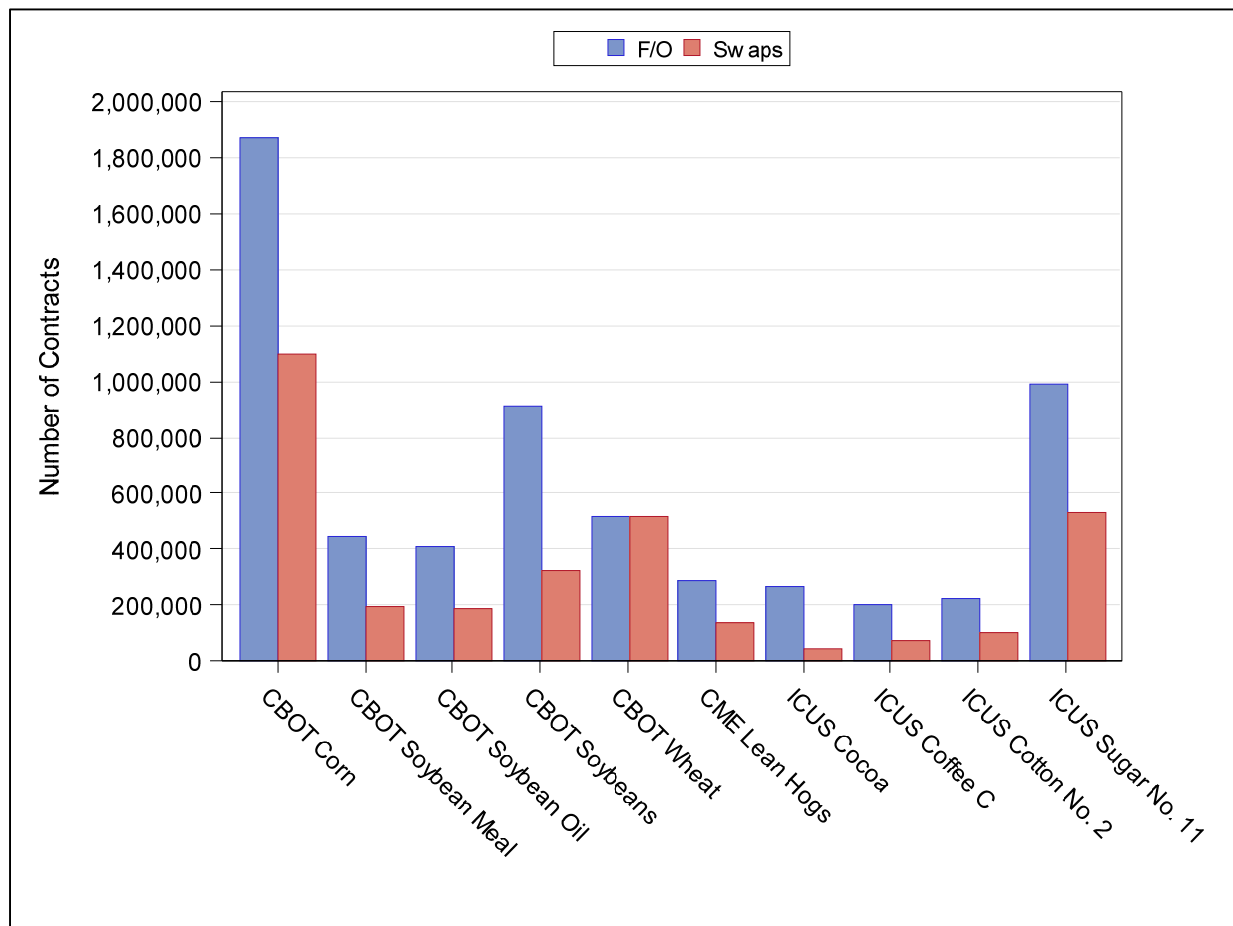
**Figure 1. Average Daily Open Swaps vs. Month-End Open Interest for Futures and Options Reported for June 2015**

Figure 1 shows the average daily open swaps and month-end open interest for futures and options reported for June 2015 for a select number of markets. Daily open swaps and open interest values are averaged across the month. Futures (F/O) and Swaps values are represented on the graph with different colors.



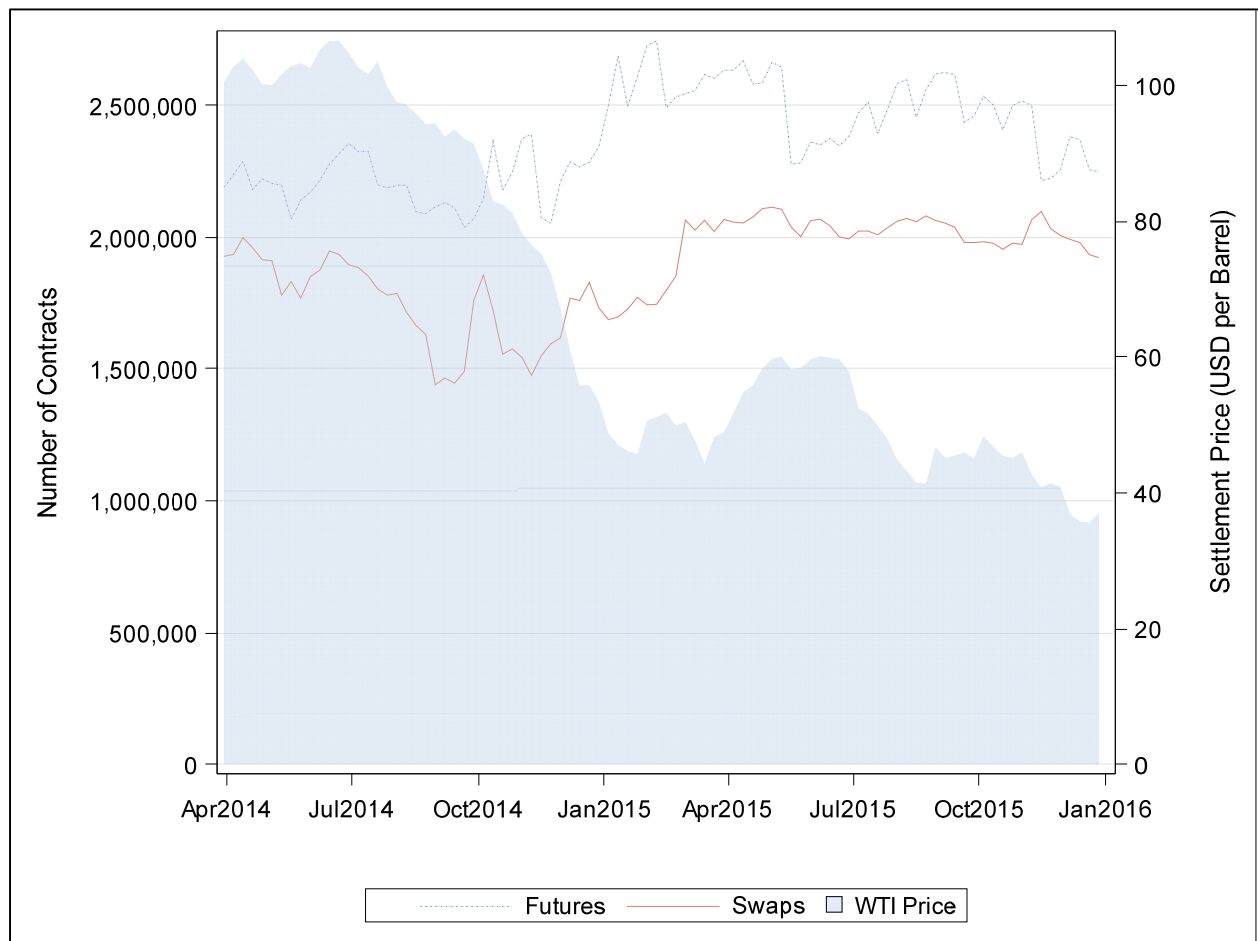
**Figure 2. Average Daily Open Swaps vs. Month-End Open Interest for Futures and Options for Agricultural Products Reported for June 2015**

Figure 2 shows the average daily open swaps and month-end open interest for futures and options reported for June 2015 for a select number of agricultural products. Daily open swaps and open interest values are averaged across the month. Futures (F/O) and Swaps values are represented on the graph with different colors.



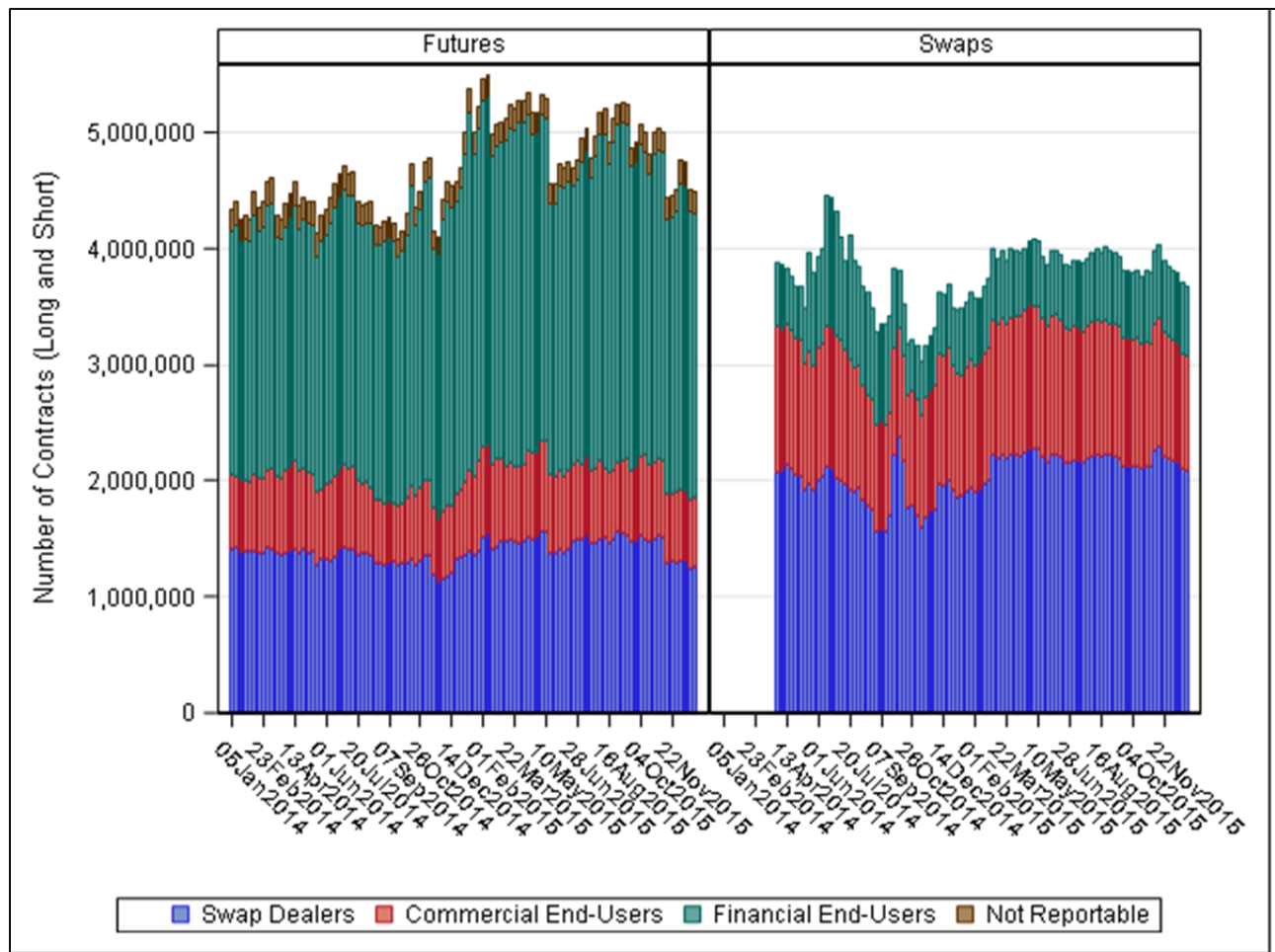
**Figure 3. Total Open Swaps, Futures Open Interest, and WTI Futures Price**

Figure 3 displays average daily open swaps (solid red line) and futures open interest (broken blue line), averaged by week, in terms of futures-equivalent contracts. The solid blue band represents the weekly average WTI futures settlement price. Total futures-equivalent contract values for open swaps and open interest are represented on the left axis, and the WTI Futures price is on the right axis.



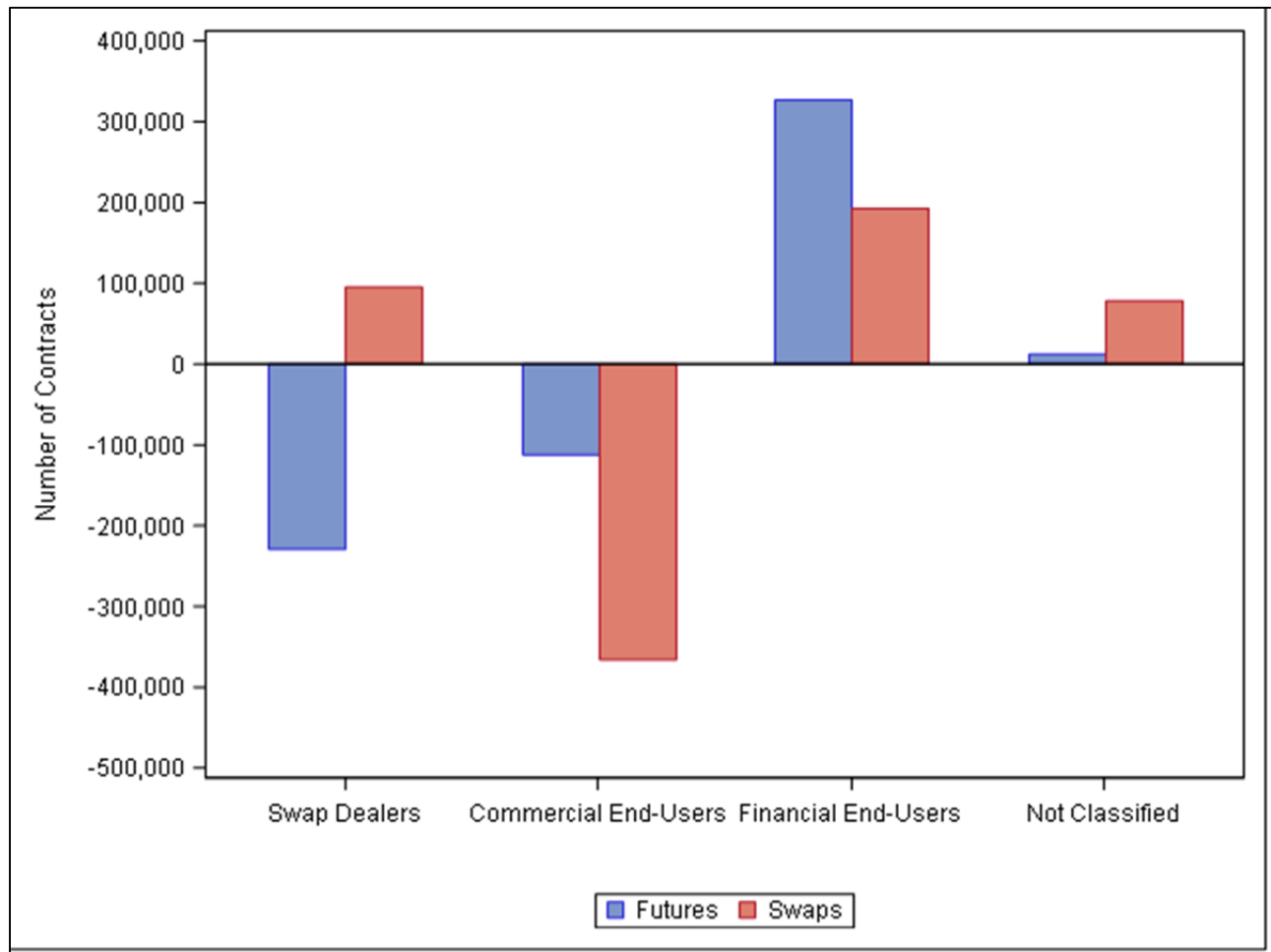
**Figure 5. Total Open Swaps and Futures Open Interest by Participant Type**

Figure 5 displays average daily open swaps and open interest on a weekly basis in terms of futures-equivalent contracts by participant type.



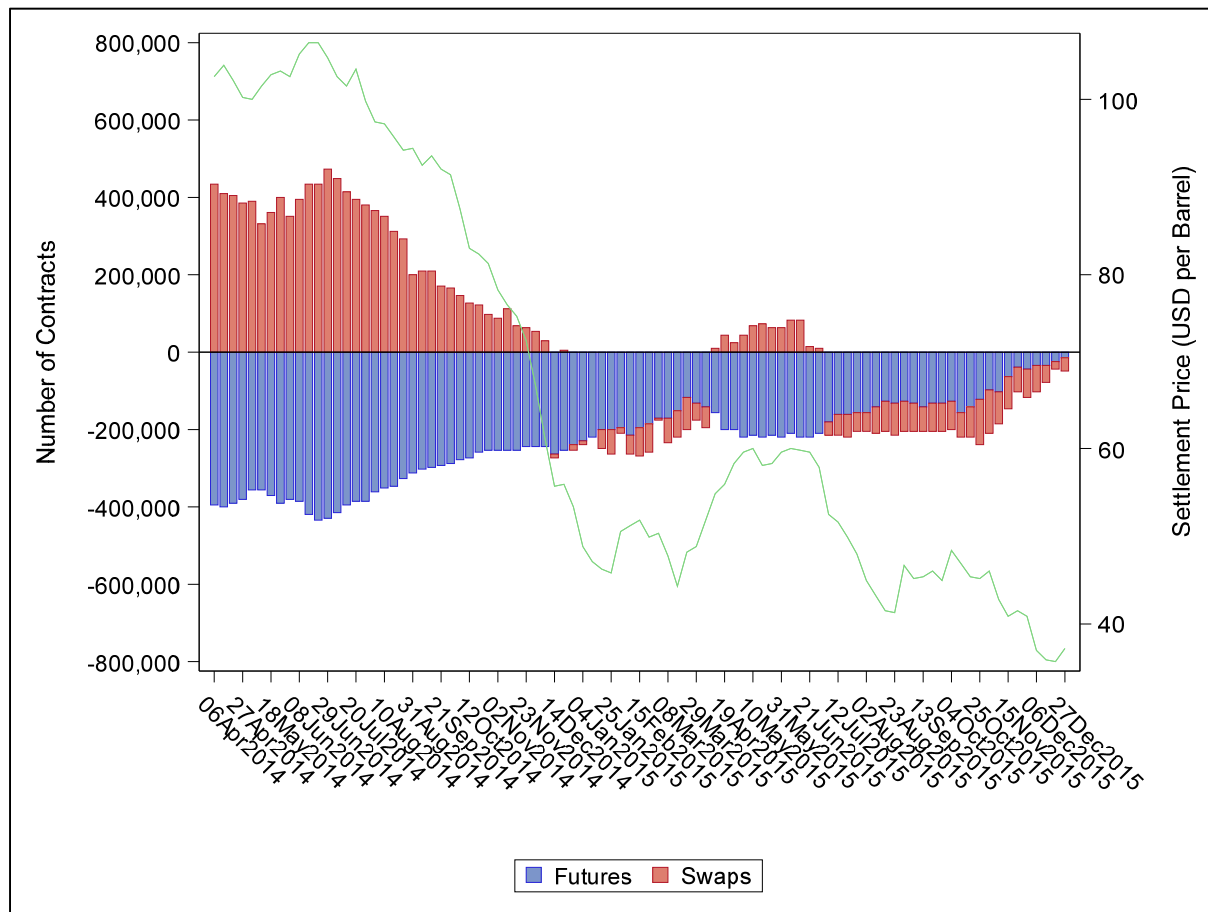
**Figure 6. Swaps and Futures Net Exposure by Participant Type**

Figure 6 displays the average daily net exposure both from futures and also from swaps in aggregate for each participant type averaged over the period of April 1, 2014 to December 31, 2015.



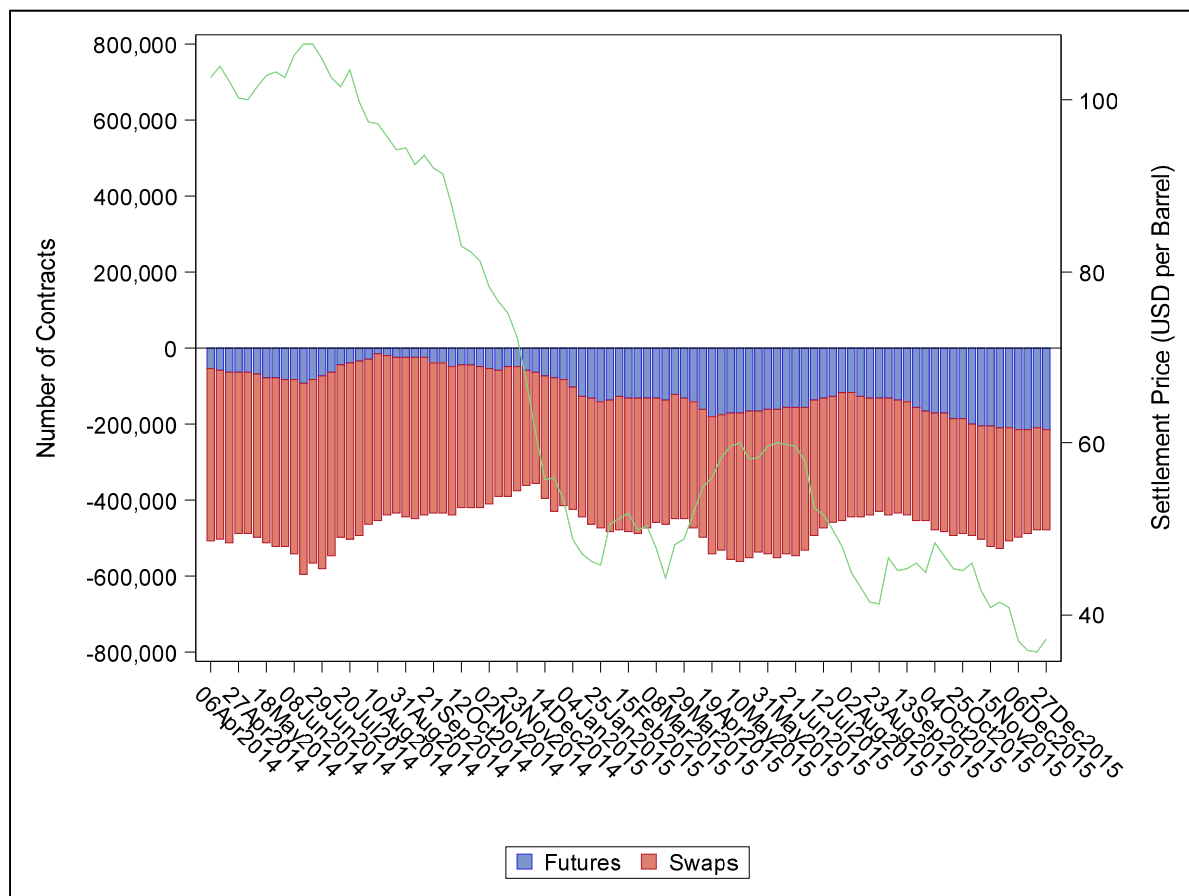
**Figure 7. Net Futures and Net Swaps Position of Swap Dealers**

Figure 7 displays the Swap Dealers' average daily net swaps position (represented by red bars) and their average daily net futures position (represented by blue bars) on a weekly basis (left axis). Positions are scaled to the left axis. In addition, the average WTI Futures price for each week is shown with the green line (right axis).



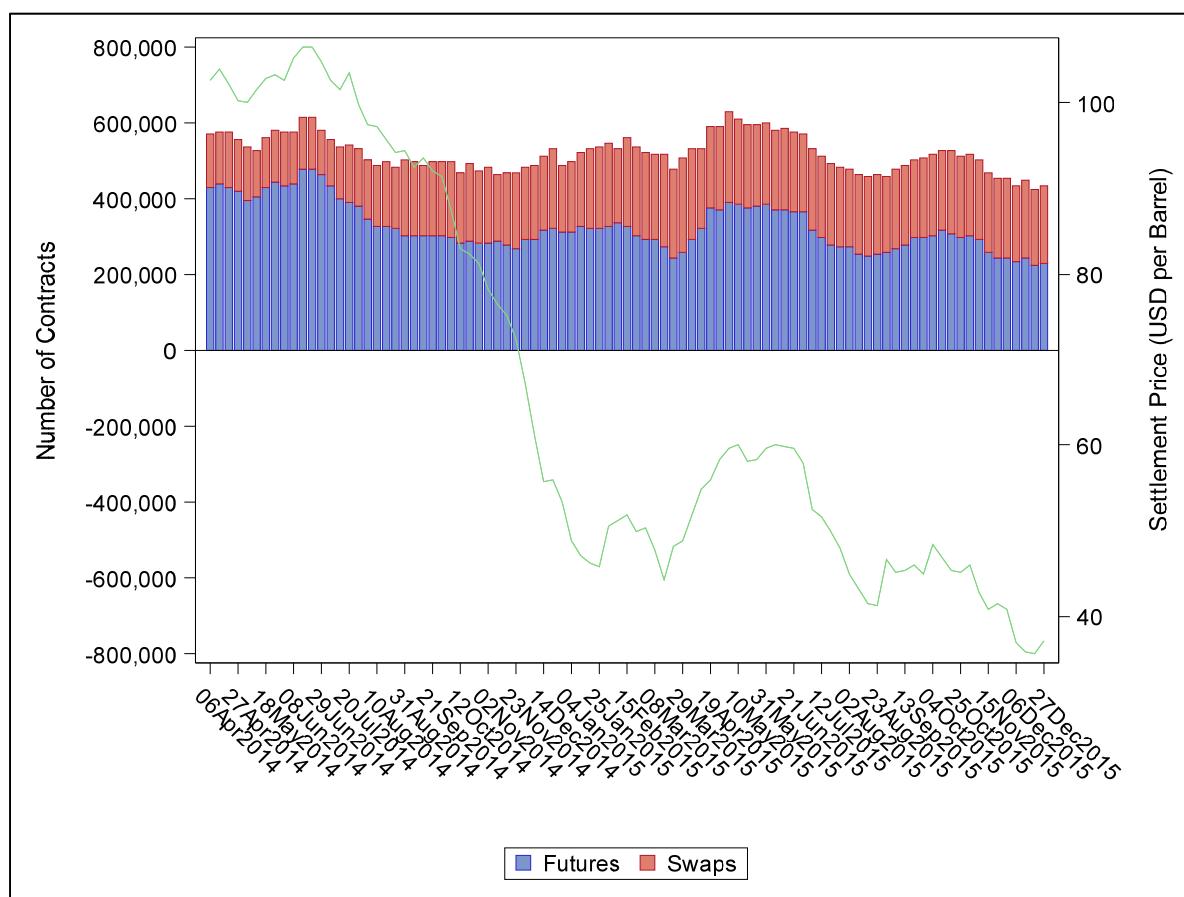
**Figure 8. Net Futures and Net Swaps Position of Commercial End-Users**

Figure 8 displays Commercial End Users' average daily net swaps position (the red component of the bar) and their net futures position (the blue component of the bar). Their total net position is represented by the entire bar. Positions are scaled to the left axis. In addition, the average WTI Futures price for each week is shown with the green line (right axis).



**Figure 9. Net Futures and Net Swaps Position of Financial End-Users**

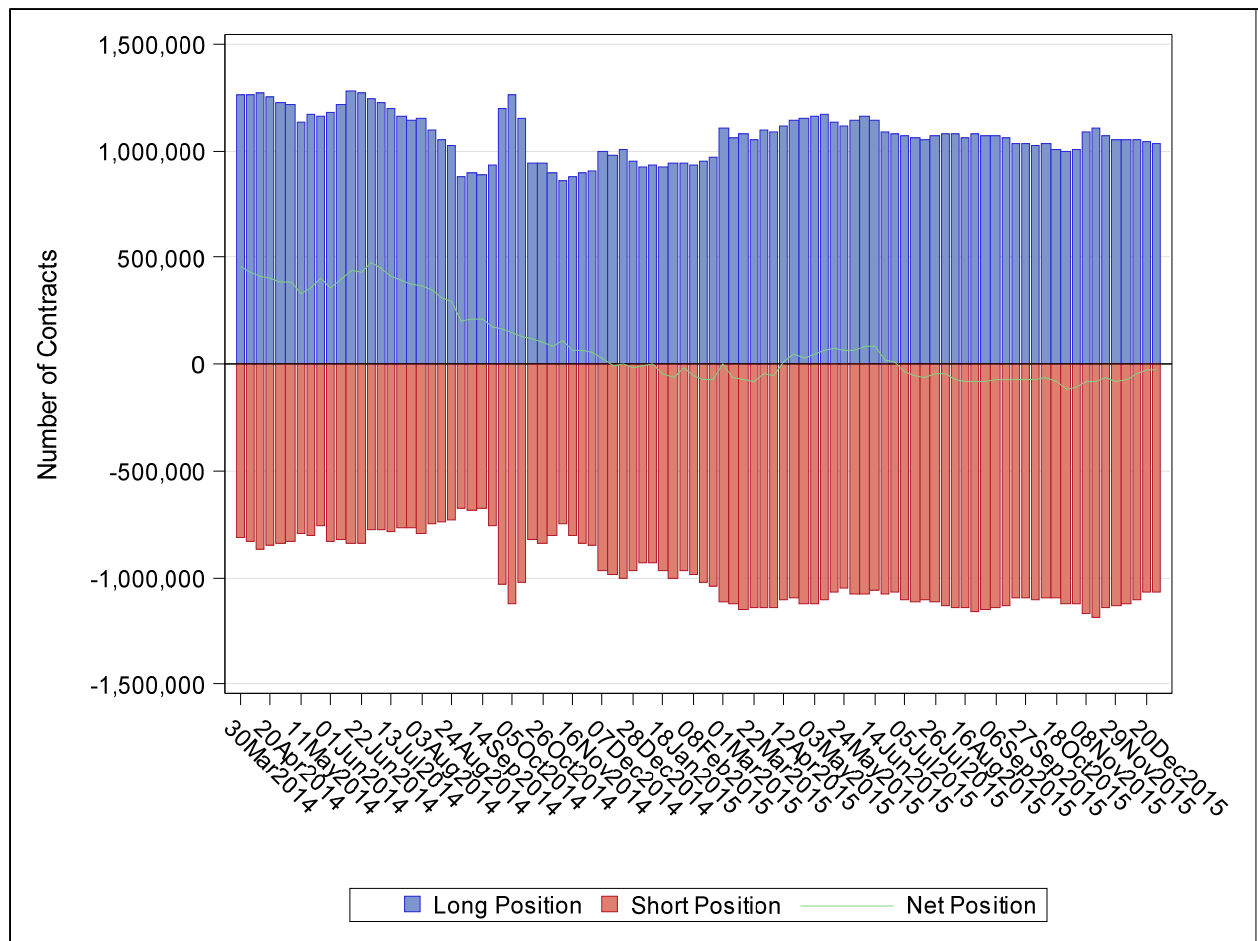
Figure 9 displays Financial End-Users' average daily net swaps position (the red component of the bar) and their net futures position (the blue component of the bar). Their total net position is represented by the entire bar. Positions are scaled to the left axis. In addition, the average WTI Futures price for each week is shown with the green line (right axis).





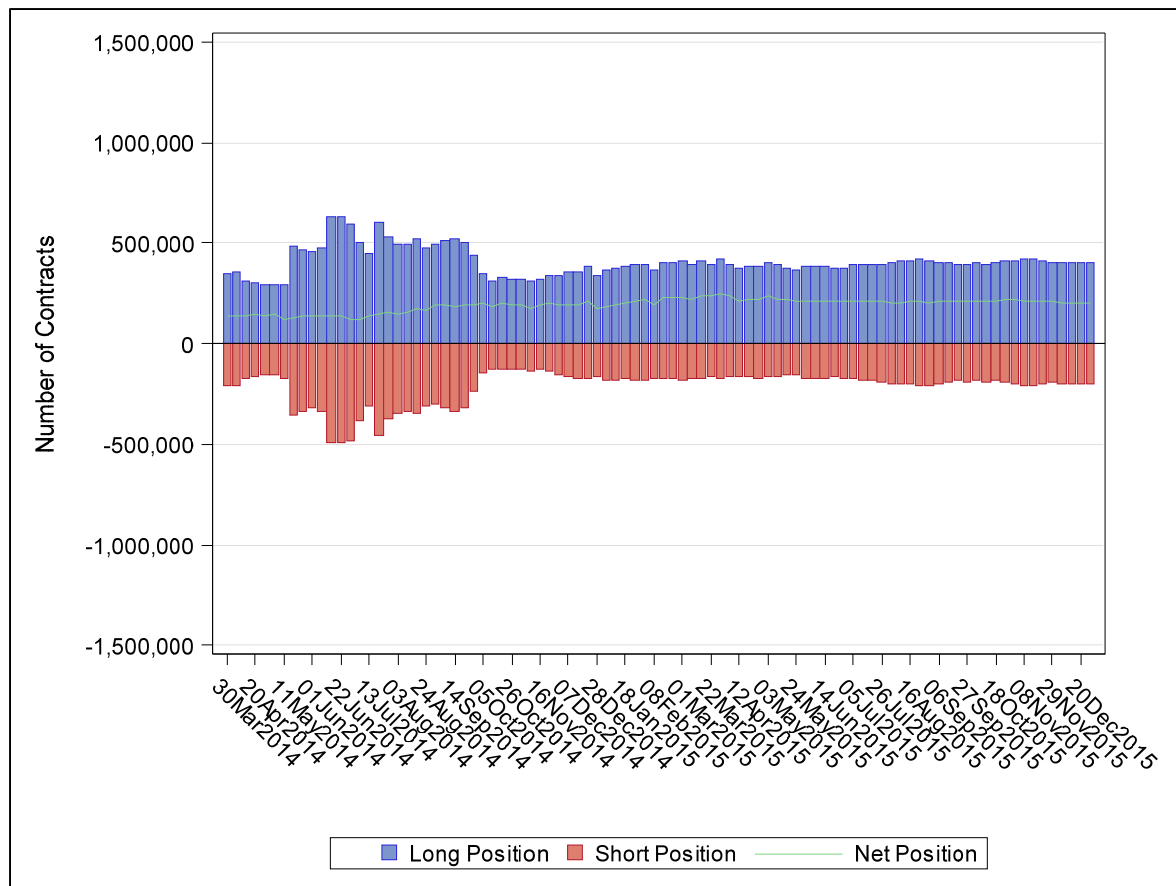
**Figure 10. Long, Short and Net Swap Positions of Swap Dealers**

Figure 10 displays Swap Dealers' average daily long (blue bar), short (red bar) and net swap positions (green line) on a weekly basis.



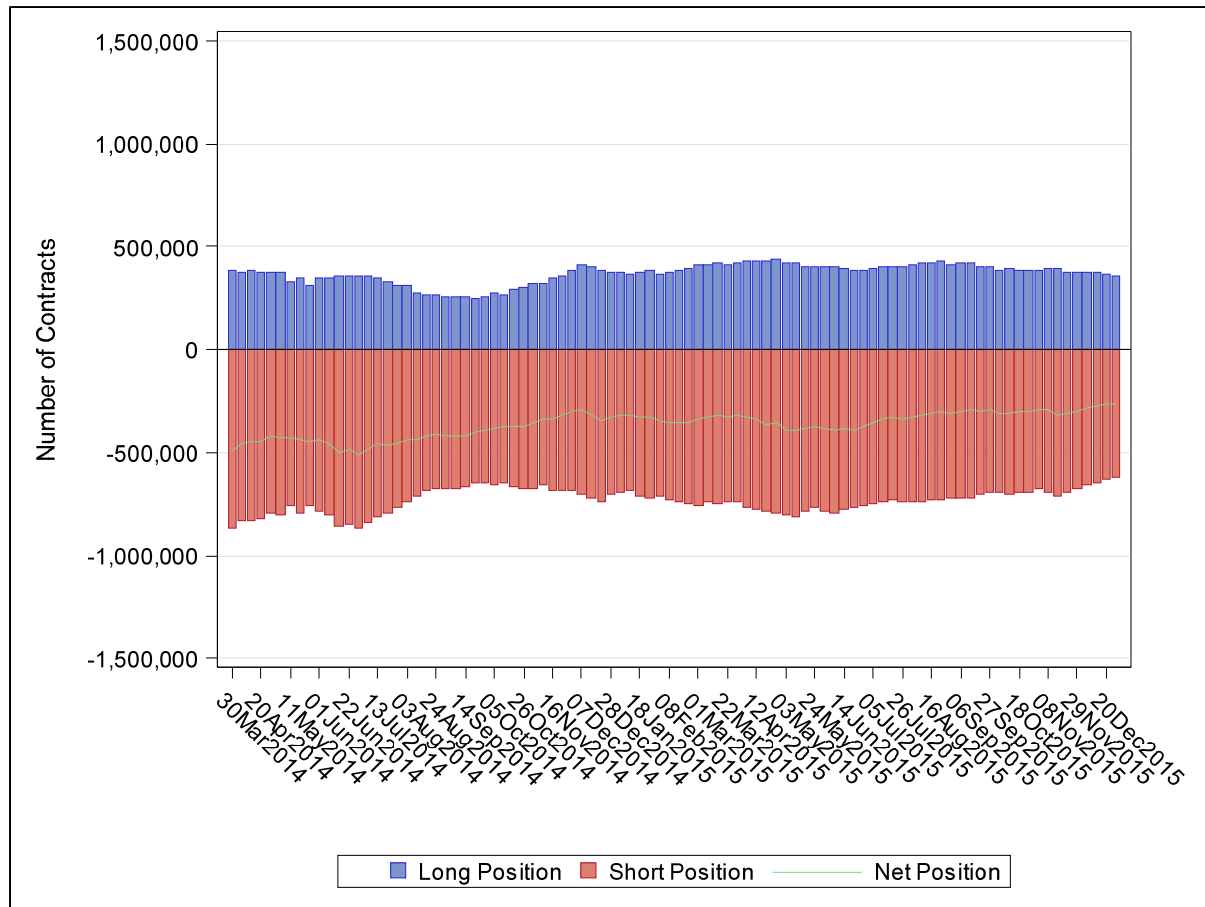
**Figure 11. Long, Short and Net Swap Position of Financial End-Users**

Figure 11 displays Financial End Users' average daily long (blue bar), short (red bar), and net swap positions (green line) on a weekly basis.



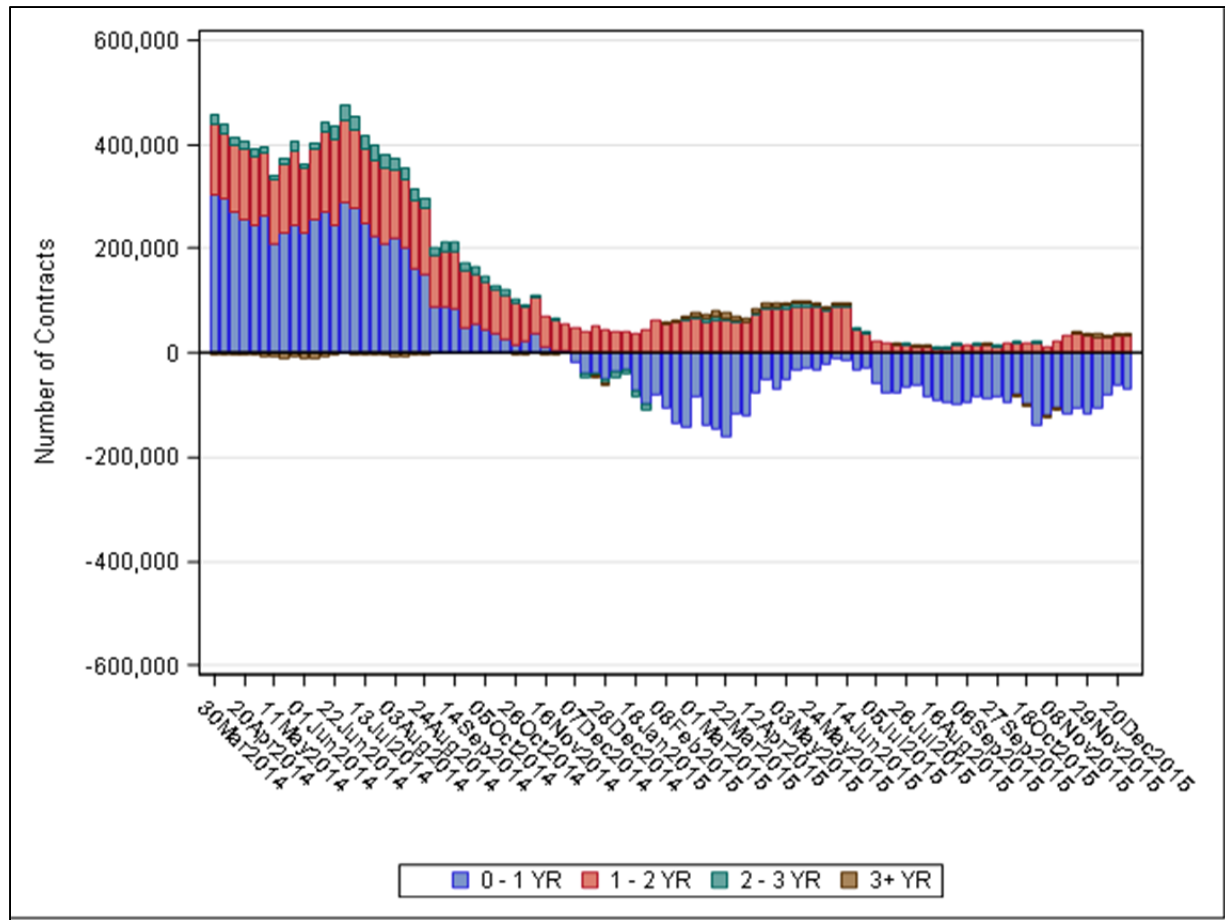
**Figure 12. Long, Short and Net Swap Position of Commercial End-Users**

Figure 12 displays Commercial End Users' long (blue bar), short (red bar), and average daily net swap positions (green line) on a weekly basis.



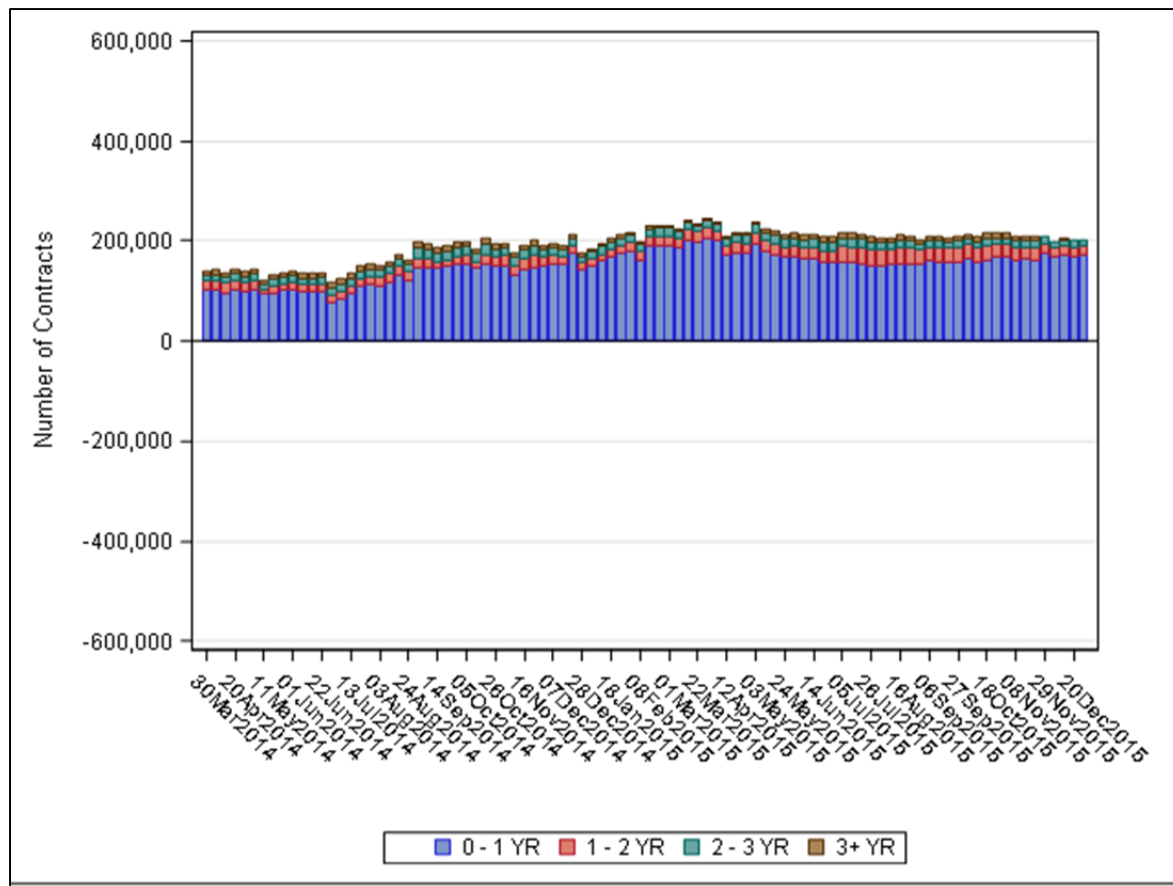
**Figure 13. Net Open Swaps Positions of Swap Dealers by Tenor of Exposure**

Figure 13 displays the average daily net open swaps positions of swap dealers by tenor of exposure on a weekly basis.



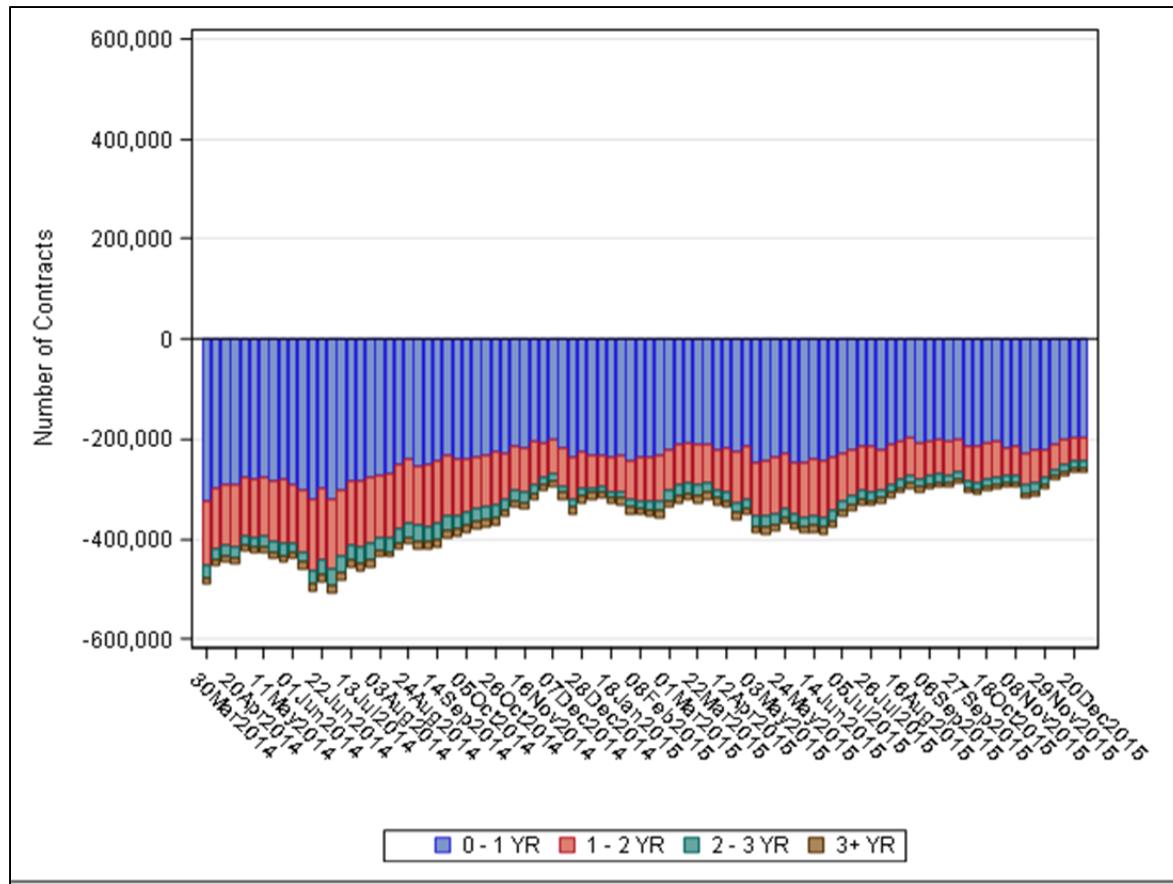
**Figure 14. Net Open Swaps Exposure of Financial End-Users by Tenor of Exposure**

Figure 14 displays the average daily net open swaps of Financial End-Users by tenor on a weekly basis.



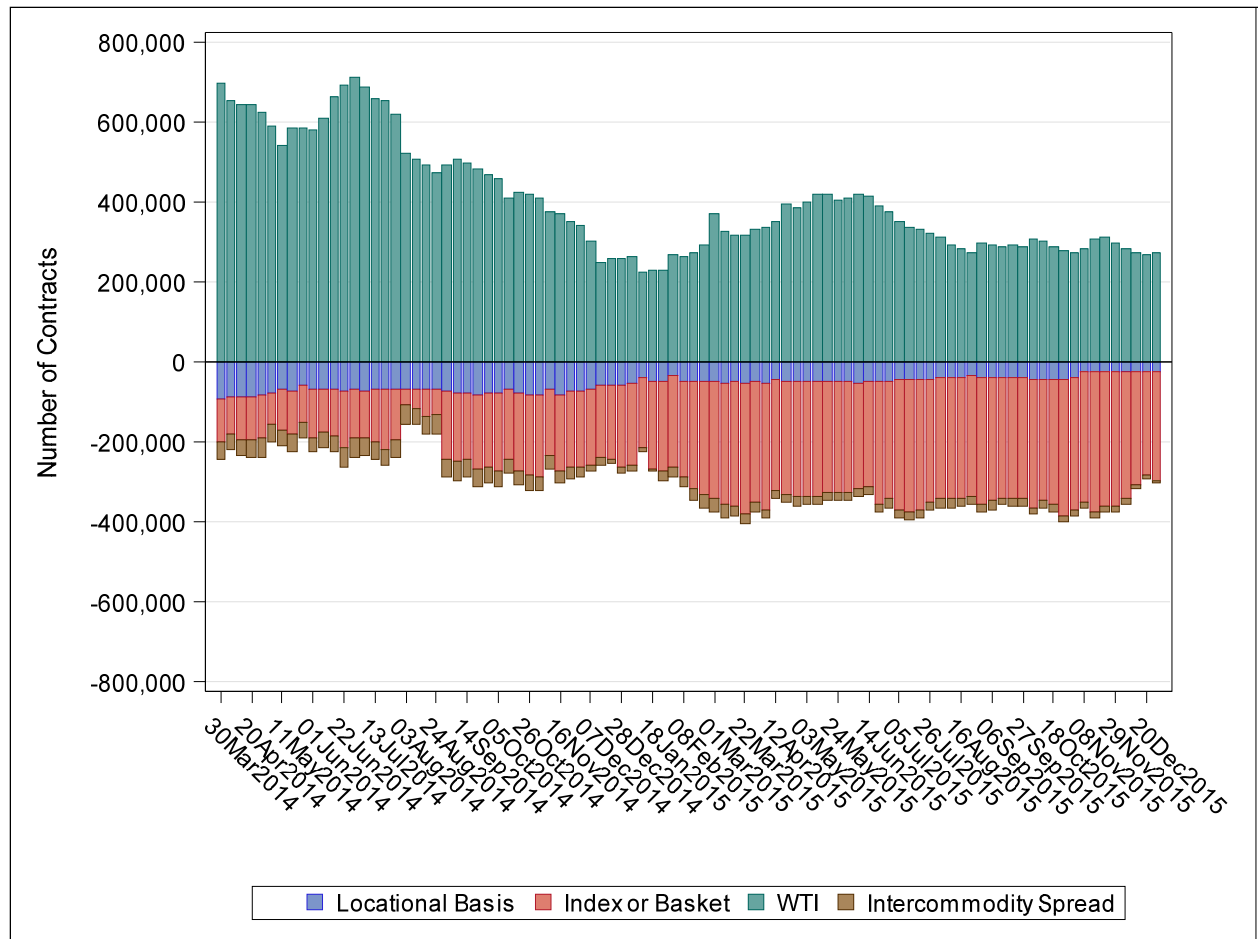
**Figure 15. Net Open Swaps Position of Commercial End-Users by Tenor of Exposure**

Figure 15 displays the average daily net open swaps position of Commercial End Users, by tenor on a weekly basis.



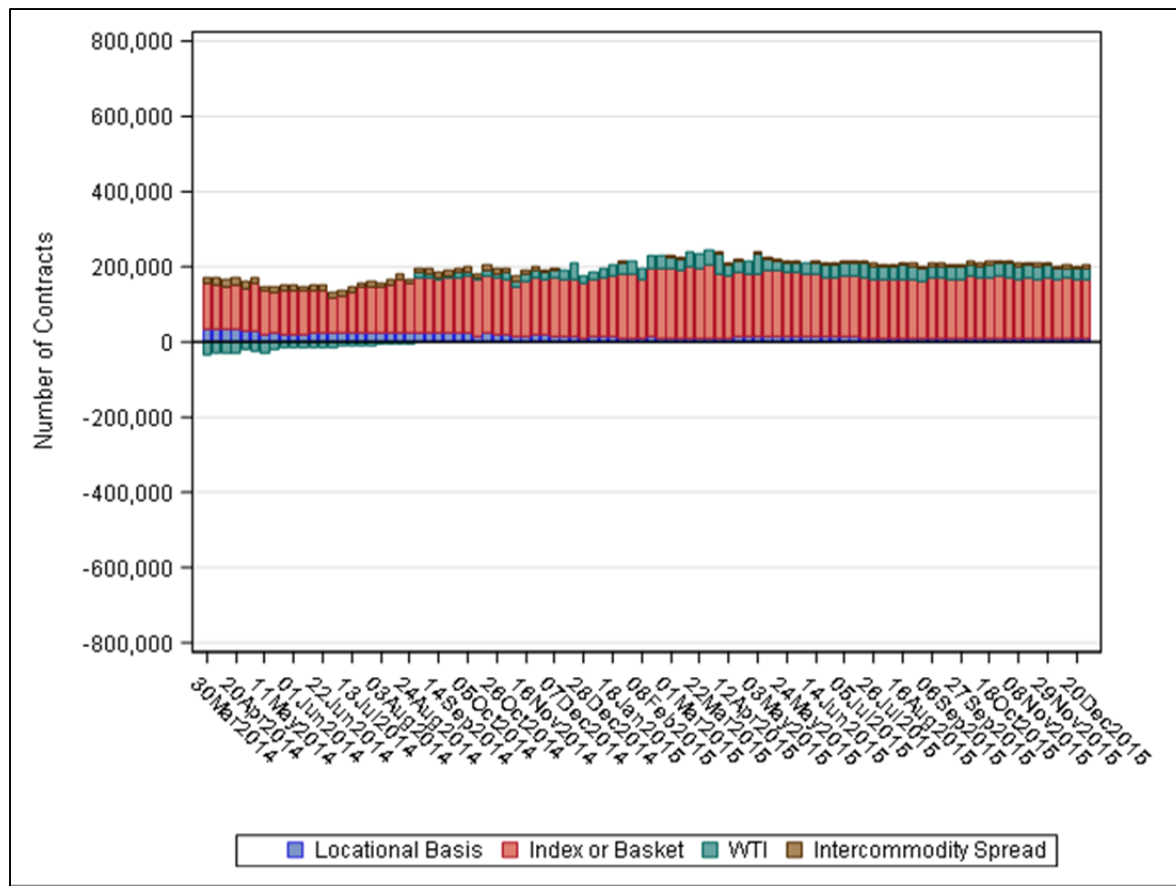
**Figure 16. Net Open Swaps Position of Swaps Dealers by Product Type**

Figure 16 displays Swap Dealers' average daily net open swaps position by product type on a weekly basis.



**Figure 17. Net Open Swaps Position of Financial End-Users by Product Type**

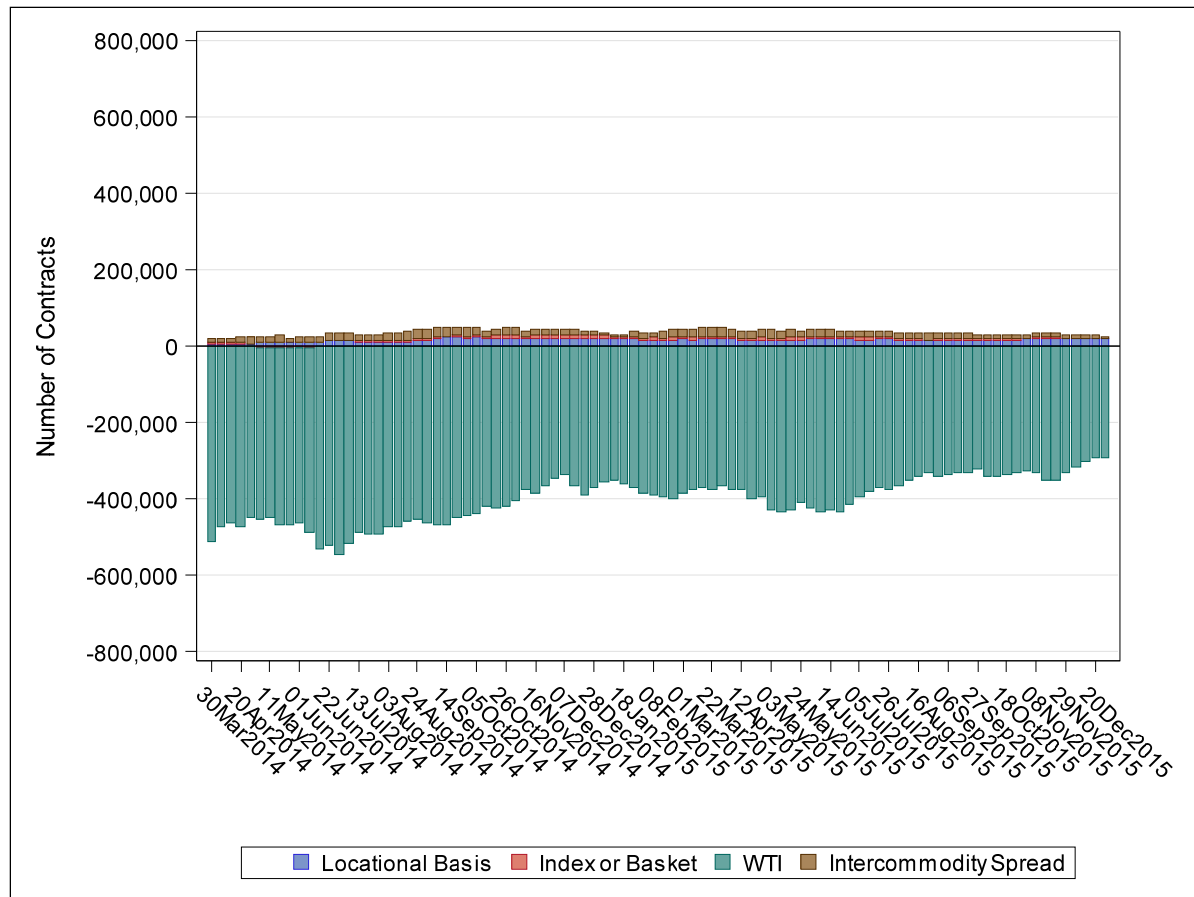
Figure 17 displays Financial End-Users' average daily net open swaps position by product type on a weekly basis.





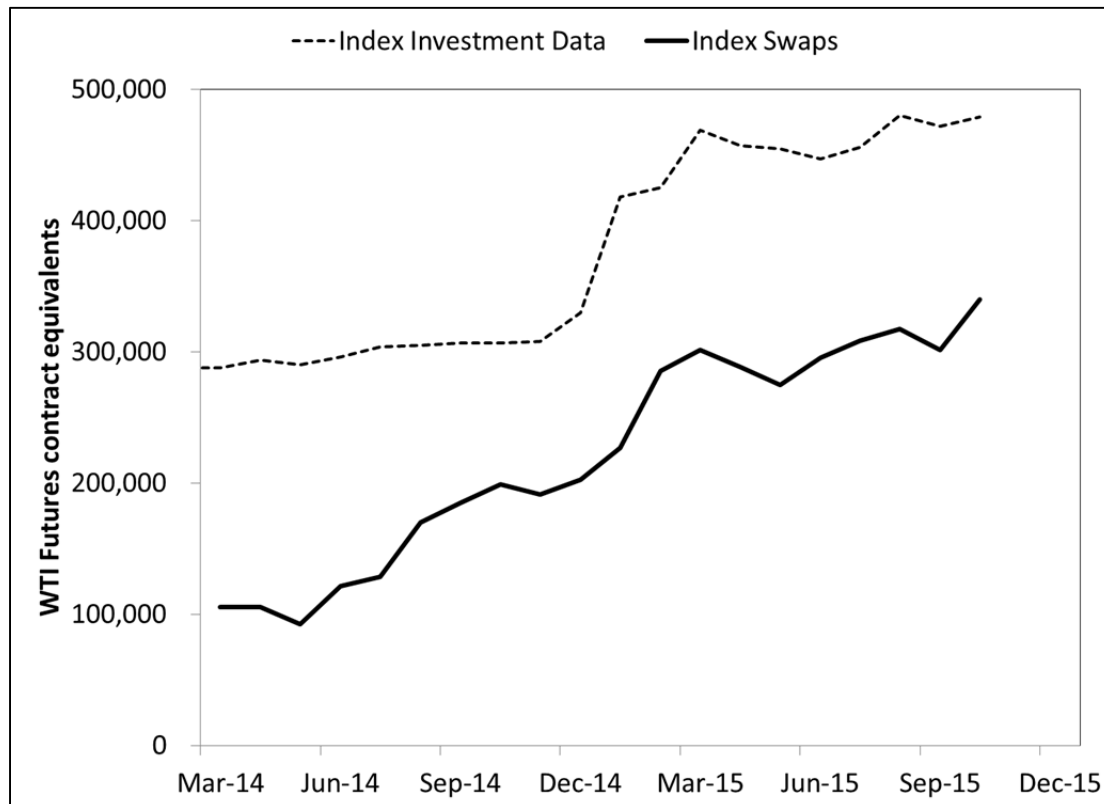
**Figure 18. Net Open Swaps Position of Commercial End-Users by Product Type**

Figure 18 displays Commercial End-Users' average daily net open swaps position by product type on a weekly basis.



**Figure 19. Net Swaps Index Position and Index Investment Data for WTI**

Figure 19 displays the net non-dealer index swaps position for WTI (thick line) and the net position for WTI index-related positions from the CFTC's Index Investment Data report (dashed line). The sample consists of month-end observations from March 2014 to October 2015.



**Figure 20. Working's T for Futures, Swaps, and Both Combined**

Figure 20 displays Working's T index for futures and delta-adjusted options (dashed line), swaps (gray line with circular markers) and both combined (thick black line). The sample period is April 2014 to December 2015.

