Energy Economics 72 (2018) 486–504

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Mapping algorithms, agricultural futures, and the relationship between commodity investment flows and crude oil futures prices☆

Lei Yan[a], Scott H. Irwin[b,*], Dwight R. Sanders[c]

[a] University of Illinois at Urbana-Champaign, 452d Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801, United States
[b] University of Illinois at Urbana-Champaign, 344 Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801, United States
[c] Southern Illinois University-Carbondale, 226E Agriculture Building, 1205 Lincoln Drive, Carbondale, IL 62901, United States

ARTICLE INFO

Article history:
Received 27 October 2016
Received in revised form 27 March 2018
Accepted 1 April 2018
Available online 16 April 2018

JEL classification:
D84
G13
Q13
Q41

Keywords:
Commodity futures
Crude oil
Index investment
Mapping algorithm

ABSTRACT

Several studies employ mapping algorithms to infer index positions in WTI crude oil futures from positions in agricultural futures and report an economically large and statistically significant impact of index positions on crude oil futures prices. In this article, we provide direct evidence that the apparent impact of index investment based on mapping algorithms is spurious. Specifically, an idiosyncratic spike in agricultural index positions during 2007–08, coupled with the spike in oil prices, causes the spurious impact of index investment on crude oil futures prices found in these earlier studies.

1. Introduction

Commodity futures prices increased substantially over 2003–08, with crude oil futures price hitting a record high of $147 per barrel in mid-2008. As prices soared, concerns emerged that the record price rise was driven by the increasing participation of financial investors.[1] Hedge fund manager Michael W. Masters is a leading proponent of the view that commodity index investment was the main driver of the spike in commodity futures prices. In a series of testimonies and reports, Masters argues that index inflows from institutional investors imposed strong buying pressure and created a massive bubble in commodity futures prices, most notably in the crude oil market (e.g., Masters and White, 2008). This argument has become widely known as the "Masters Hypothesis" (Irwin and Sanders, 2012). Masters-like arguments were quickly adopted by some policymakers and other advocates to push for regulations to limit commodity index activity. As called for in the 2010 *Dodd-Frank Wall Street Reform and Consumer Protection Act*, the U.S. Commodity Futures Trading Commission (CFTC) proposed regulations implementing limits on speculative futures and swaps positions in December 2013 and proposed a revised set of rules in December 2016. The European Securities and Markets Authority also published new regulatory rules on commodity derivatives with a focus on ancillary activity and position limits, which took effect in January 2018.[2]

☆ The authors thank James Hamilton, Aaron Smith, seminar participants at the 2016 Agricultural & Applied Economics Association Annual Meeting, 2017 Commodity Markets Winter Workshop in Norway, 2017 International Conference on Energy Finance in China, and anonymous referees for helpful suggestions and comments. James Hamilton and Cynthia Wu generously shared their estimates of WIT crude oil positions from the Masters algorithm for comparison to our own estimates.

* Corresponding author.
E-mail addresses: leiyan2@illinois.edu (L. Yan), sirwin@illinois.edu (S.H. Irwin), dwights@siu.edu (D.R. Sanders).

[1] Financial investors seek exposure to commodity futures markets through either Exchange-Traded Products or over-the-counter swap contracts, whose returns are tied to an index of commodity prices (e.g., the Standard & Poor's Goldman Sachs Commodity Index). In the remainder of this paper, the term "index investment" is used to generally refer to commodity index-based investment.

[2] See ESMA's reports at https://www.esma.europa.eu/policy-rules/mifid-ii-and-mifir.

https://doi.org/10.1016/j.eneco.2018.04.005
0140-9883/

Empirical research has examined the impact of index investment on crude oil prices based on different index position measures. Some researchers use positions from the CFTC *Disaggregated Commitments of Traders* (DCOT) and *Index Investment Data* (IID) reports or private index funds and find no significant impact on futures prices for WTI crude oil (e.g., Büyükşahin and Harris, 2011; Sanders and Irwin, 2011; Irwin and Sanders, 2012; Sanders and Irwin, 2014; Brunetti et al., 2016). While informative, these index position measures are subject to a netting problem or limitations on data frequency, sample length, and representativeness. Other researchers infer index positions in WTI crude oil using mapping algorithms and report an economically large and statistically significant impact on oil prices (e.g., Mayer, 2012; Singleton, 2014; Cheng et al., 2015). Fig. 1 demonstrates the large correlation between index positions inferred from a mapping algorithm and WTI crude oil futures prices during 2007–08. A mapping algorithm is a method of estimating index positions for individual futures markets such as WTI crude oil based on index positions in agricultural futures markets that are known from the weekly CFTC *Supplemental Commitments of Traders* (SCOT) report. The best-known mapping algorithm—the Masters algorithm—infers index positions in WTI crude oil from a few agricultural commodities (Kansas wheat, feeder cattle, and soybean oil). The algorithm implicitly assumes a constant relationship in index positions between WTI crude oil and the agricultural commodities.

In this article, we provide direct evidence that the relationship between index positions based on mapping algorithms and futures prices for WTI crude oil is spurious. We re-estimate Singleton's (2014) (henceforth "SNG") model and introduce a dummy variable for 2008 and find that the forecasting power of index positions based on the Masters algorithm is limited to 2008, especially the second half of 2008. To analyze the sensitivity of SNG's results, we extend the analysis to a post-sample period from January 19, 2010 though December 29, 2015 and find that index positions based on the Masters algorithm become negatively significant and all the conditional variables lose significance, contradicting the alleged impact of index investment. This suggests that the relationship identified in the earlier period is unstable and does not persist out-of-sample. We then consider two alternative measures of index positions from the iShares S&P GSCI Commodity-Indexed Trust and a large private index fund. These results show no significant impact of index positions on futures returns for WTI crude oil. Altogether, the evidence suggests that the seemingly large impact of index positions based on mapping algorithms is spurious.

To discover why a spurious relationship may arise, we provide an anatomy of mapping algorithms and explore the inaccuracy of index position measures based on mapping algorithms. We show theoretically that in order to replicate a commodity index the positions of any two commodities should maintain annually fixed ratios. The Masters algorithm implicitly assumes fixed ratio relations between WTI crude oil and agricultural commodity futures. Using index positions from the SCOT and IID reports, we develop a formal test and empirically reject the underlying fixed ratio relations. Furthermore, compared with IID positions—the most accurate available—the Masters algorithm provides poor estimates of index positions for WTI crude oil in both direction and magnitude. Index positions from the Masters algorithm show a clear spike during 2007–08 while the IID measure does not. Decomposition shows that the spike in index positions based on the Masters algorithm is largely driven by positions in feeder cattle — one of the unique agricultural markets underlying this mapping algorithm. Within the same regression framework, we show that 13-week changes in index positions of feeder cattle have a significant impact on crude oil prices, which is obviously spurious. In sum, an idiosyncratic spike of agricultural index positions during 2007–08, together with the coincidental spike in crude oil prices, causes the spurious relationship between index investment and crude oil prices found in previous studies that employ mapping algorithms.

2. Literature review

A large number of academic studies have examined the impact of financial index investment on commodity prices.[3] Theoretical models suggest several pathways for financial index investment ("financialization") to impact commodity futures prices. First, the flow demand of index investment may be larger than available liquidity due the large position sizes of index investors, and this flow may temporarily push prices away from fundamental value (e.g., Grossman and Miller 1988). Second, competition from index investment may reduce risk premiums earned by long speculators in commodity futures markets (e.g., Acharya et al., 2013; Hamilton and Wu, 2014, 2015). Third, increased integration of commodity and financial markets brought about by index investment may result in increased exposure of commodity futures prices to financial shocks that increase prices (e.g., Etula, 2013; Basak and Pavlova, 2016). Fourth, other traders may confuse index buying with valuable private information and thus revise their own demands upward which, in turn, pushes commodity futures prices higher (Sockin and Xiong, 2015).

Depending on the way that index positions are measured, empirical research on the impact of index investment on crude oil prices falls into three groups.[4] The first set of studies uses long positions of swap dealers from the CFTC DCOT report as a measure of index positions and find no evidence of significant impacts of swap dealer positions on crude oil futures prices (e.g., Büyükşahin and Harris, 2011; Sanders and Irwin, 2011; Brunetti et al., 2016). While a large fraction of index investment is placed through swap contracts, net swap dealer positions in energy futures markets may be a poor approximation of total index positions because of the large off-setting non-index swap business conducted in these markets.[5] The second group of studies uses index positions from the CFTC IID report or private index funds, also finding no significant impact of index positions on crude oil prices (e.g., Irwin and Sanders, 2012; Sanders and Irwin, 2014). These measures are direct and, in the case of the IID, generally accurate, but subject to limitations on frequency, sample length, and potentially representativeness of private index fund positions. The third group of studies relies on mapping algorithms to estimate crude oil index positions from agricultural index positions, which are available from the weekly CFTC SCOT report. There are two different but related mapping algorithms — the Masters algorithm and the weighted-average algorithm. The Masters algorithm infers crude oil index positions from a few agricultural commodities that are unique to a particular index (Masters, 2008). Using this algorithm, Singleton (2014) (henceforth "SNG") finds an economically large and statistically significant influence of index positions on crude oil futures prices. The weighted-average algorithm derives index positions in crude oil from the aggregate index positions of all twelve SCOT agricultural commodities, with initial period prices as the weight. Using the weighted-average algorithm or a close variant, Mayer (2012) and

[3] See Irwin and Sanders (2011), Fattouh et al. (2014), Cheng and Xiong (2014), and Haase et al. (2016) for thorough reviews.

[4] Instead of linking price changes to index positions, an alternative approach is to apply bubble tests directly to crude oil futures prices (e.g., Phillips and Yu, 2011; Shi and Arora, 2012; Harvey et al., 2016; Tsvetanov et al., 2016). In spite of mixed results, compelling evidence of large and long-lasting bubbles is limited.

[5] Staff report on commodity swap dealers & index traders with commission recommendations, Commodity Futures Trading Commission, 2008. http://www.cftc.gov/idc/groups/public/@newsroom/documents/file/cftcstaffreportonswapdealers09.pdf.