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Commodities Special Report

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Index Inflows and Commodity Price Behavior

Since 2006, commodity indices have attracted billions of dollars of new financial inflows, raising questions about their effect on markets. We find that momentum-chasing and attempts at diversification by investors have driven these inflows. Evidence of the indices' effect on price returns remains ambiguous. Index inflows seem to have a positive, albeit weak, effect on market volatility. The long-term growth of market size and liquidity should eventually improve efficiency and diminish short-run distortions. More market transparency could provide immediate benefits.

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EXECUTIVE SUMMARY

In this inaugural *Commodities Special Report*, we analyze the causes of financial investment into commodity indices and its effects on price returns and volatility.

For the past several years, prices for many commodities, notably food and energy, have risen strongly, contributing to strains in the global economy and signs of political discontent. At the same time, financial markets for commodities have grown rapidly, with daily trading activity for paper crude oil on the NYMEX and ICE exchanges now exceeding total global oil consumption by more than eleven-fold.

Commodities have also attracted billions of dollars of investment from financial investors seeking exposure to its diversification and return properties. We estimate that roughly $98 billion of new financial inflows have entered commodity index funds since January 2006 alone. The concurrence of record high and volatile commodity prices and massive investment inflows on commodity exchanges has led to a politically charged debate about the causality between the two.

Many market watchers and politicians have taken the coincidence of high commodity prices and financial activity as *prima facie* evidence of the role of speculative activity in driving up prices, particularly for oil. But other commentators have questioned the ability of purely financial factors to affect a price that is ultimately linked to fundamental supply and demand. A corollary of this is that prices driven above the fundamental equilibrium price by speculators would cause a market imbalance and excess supply, which must appear in inventory build.

Reality is more complex than either ideological extreme, by our analysis. We argue that while prices must reflect fundamentals in the long run, they can deviate considerably in the short run because of price inelasticity, informational imperfections, and behavioral herding.

Extreme short-term inelasticity causes price volatility, making forecasting difficult

To take the example of oil, supply and demand for oil are highly inelastic and difficult to measure precisely. The high sunk costs necessary to open a new producing basin, such as the Canadian tar sands, or to upgrade infrastructure, such as automobiles and factories, causes a nonlinear response with respect to price. The extreme inelasticity of supply and demand causes violent price responses to small physical imbalances, making it difficult to formulate price expectations. This inelasticity and nonlinearity is a feature not just of oil markets but of many other commodities, such as agricultural goods and metals.

Markets also suffer from informational opacity

Commodity markets are also notoriously opaque. For oil, there are simply no credible data available for key aspects of the fundamental balance, such as the amount of Saudi Arabian spare capacity or the size of Chinese inventories.

Informational imperfections can cause "herding behavior"

The lack of insight into elasticities and fundamentals makes market analysts uncertain about even the validity of their model structure. This model uncertainty forces information-starved market participants to herd and copy the behavior of others.

Lack of data also causes clustering around signals

The shortage of information also leads market observers to focus inordinately on the handful of available signals, such as weekly changes in U.S. inventories. Markets may interpret a sharp drop in U.S. crude inventories as a bullish statement, lending more credence to theories of supply shortages and peak oil, even though the reality may be that global inventories are rising in places where we cannot measure them.

The informational vacuum makes such bullish theories plausible, while the inelasticity of supply and demand prevents an immediate inventory response to persuade markets otherwise. The traditional mechanisms that would cause prices to return to true equilibrium levels—namely, efficient absorption of information and physical adjustment of markets—are thus weak in the short term.

Financial "noise" trading can affect expectations

The "herding" behavior of market participants also creates an opportunity for less-informed financial investors to distort expectations. The relative illiquidity of commodity markets compared with other financial markets allows large traders to create significant intraday price effects.

However, the anonymity of markets allows participants to potentially misinterpret an uninformed investment as a bullish move by a trader with superior information. If participants then "herd" around this investment, prices can shift to a new non-equilibrium level based on market reactions to an invalid signal.

The complexity and importance of the debate surrounding financial activity and commodity prices merit a more nuanced and rigorous approach based on hard data. Using data from the U.S. Commodity Futures Trading Commission (CFTC), we attempt to statistically document the potential effect of index inflows on both commodity price returns and volatility, as well as study potential causes of the inflow.

Empirically, we find that past return performance, as well as flight from equities, dollar weakness, and inflation expectations, has driven substantial inflows into commodity indices. Evidence of their effect on price levels remains ambiguous, depending on the method of measuring speculative activity. Absolute measures of index investment predict positive price effects, but relative measures adjusting for market size do not. A panel approach comparing across commodities rather than across time sees a positive effect on returns. Also, index inflows seem to have a positive, albeit weak, effect on market volatility, in accordance with our theoretical discussion. Also, all of the positive effects are concentrated in the smaller commodity markets, such as agricultural goods, not the energy markets, which have received so much attention.

The maturation of financial markets will strengthen efficiency

The long-term growth of commodity markets due to the continued influx of new speculative investment and commercial hedging should eventually improve efficiency and diminish distortions. The global economy and its consumers will enjoy the benefits of improved risk management opportunities and more liquid and efficient markets.

Improved transparency can help mitigate distortions

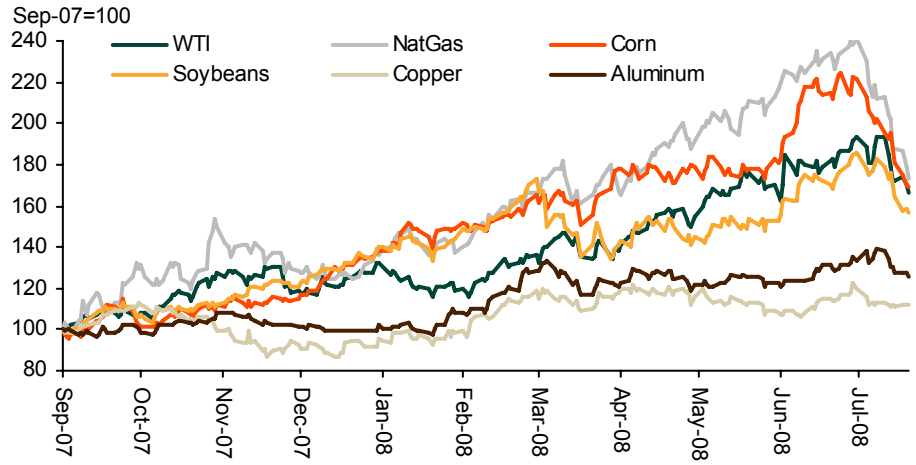
However, in the interim, the nature of commodity markets makes them prone to behavioral overshooting. We believe that devoting more thought and resources to improving transparency and understanding of this important and rapidly growing aspect of commodity markets would provide immediate benefits.

INTRODUCTION

Commodities have been outstanding performers since fall 2007

Commodity prices have risen strongly across the board since fall 2007, despite a recent selloff in some commodities over the past two months. This run-up has occurred across the energy, agricultural, and metals complex. From September 1, 2007, to July 23, 2008, front-month WTI crude oil prices have appreciated by 66%, natural gas by 73%, corn by 69%, copper by 12%, and aluminium by 26% (Figure 1).

Figure 1. Commodity Price Appreciation since September 2007



Source: Bloomberg

Debate over speculative bubbles in commodity markets continues

This dramatic rise in commodity prices has sparked a fierce debate over its nature, with some analysts arguing that the increases are an efficient market response to tight supply-demand fundamentals. However, others have been quick to point to the rise of non-fundamental factors, such as speculative activity.

Index funds are popular vehicles for investment in commodities

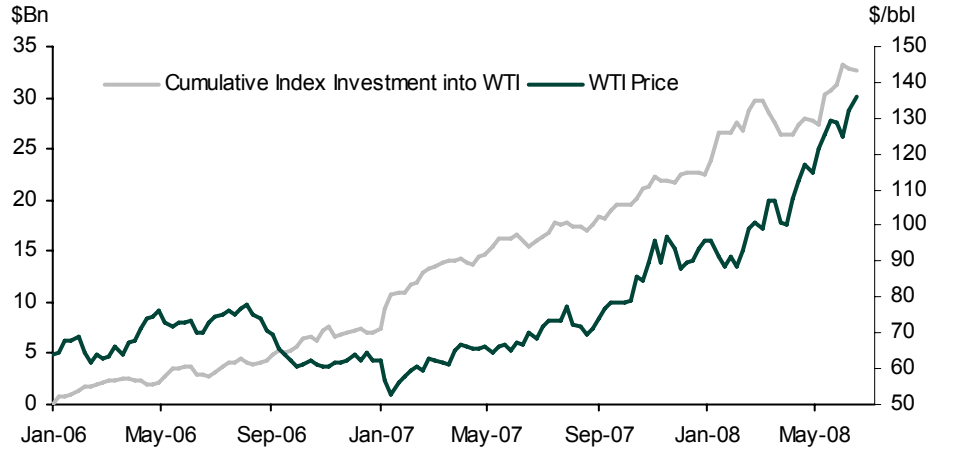
The stellar return performance of commodities as other traditional asset classes have wilted has attracted a large number of purely financial investors to the market. In particular, exchange-traded commodity index funds have emerged as a primary channel for financial investment. These index funds typically operate via total return swap agreements between the investor, notably pension funds and other institutional investors, and the counterparty financial institution, often banks. By engaging through a financial intermediary using swaps, these indices exploit the so-called swap loophole that exempts these investments from speculative position limits imposed by the CFTC.

By far the largest two indices by market share are the S&P Goldman Sachs Commodity Index (GSCI) and the Dow-Jones AIG Commodity Index (DJ-AIG). There are also a proliferation of other indices operated by various institutions, such as the Rogers International and Deutsche Bank Liquid Commodity Indices.

Massive index inflows have coincided with significant price increases for many commodities

Despite their relative youth, commodity index funds have quickly emerged as a major force on the exchange floor. Indeed, as Figure 2 demonstrates for crude oil, index inflows in commodities have coincided with dramatic price increases over the past two years. Many market commentators and politicians have taken this as *prima facie* evidence of the role of speculative activity in driving up commodity prices, particularly for oil.

Figure 2. Price of WTI Crude Oil (RHS), Cumulative Index Inflows into WTI (LHS)



Source: Lehman Brothers estimates, CFTC, Bloomberg

Indeed, political constituents in the United States, frustrated by record high food and energy prices, have pressured Congress to crack down on speculative investment in commodities. But a more nuanced analysis is necessary before placing the blame on the doorstep of speculators.

Speculators play an essential role in adding liquidity to commodity markets

Historically, speculators have played an essential role in providing liquidity in the market for commercial participants to conduct effective risk management, thus bringing costs of the business and ultimately prices down. Impeding healthy speculator activity would be counterproductive to the efficient function of markets.

Dollar weakness, inflation expectations, and flight from equities drive inflows

In this report, we revisit questions about the nature of index investment and their effects on commodity price behavior that were raised in an earlier Energy Special Report (*Is it a Bubble?* May 16, 2008). *Using a refined estimation methodology, updated data, and more sophisticated econometric tools, we find that index investment seems to be driven by commonly cited factors, such as flight from equities, the recent weakness of the dollar, and concerns about future inflation. We also observe a degree of momentum chasing, suggesting that index flows are being driven by tactical rather than strategic factors.*

The evidence for the price and volatility effects of index inflows is mixed

Furthermore, we take a harder look at the potential price effects of index flows. We find the evidence is generally mixed. *By absolute measures, we see statistically significant empirical relationships, but adjusting for market size eliminates the effect.* This may be because much speculative activity is happening in unobservable over-the-counter (OTC) markets. *A panel approach, comparing cross-sectionally across commodities, rather than a time-series approach finds evidence of positive and significant effects on price returns. The empirical evidence for the index flow effect on price volatility is also positive and more consistent, in line with theoretical arguments.*

COMMODITIES AND FINANCIAL MARKETS

The "Financialization" of Commodity Markets

Commodities are the latest asset frontier for portfolio investment

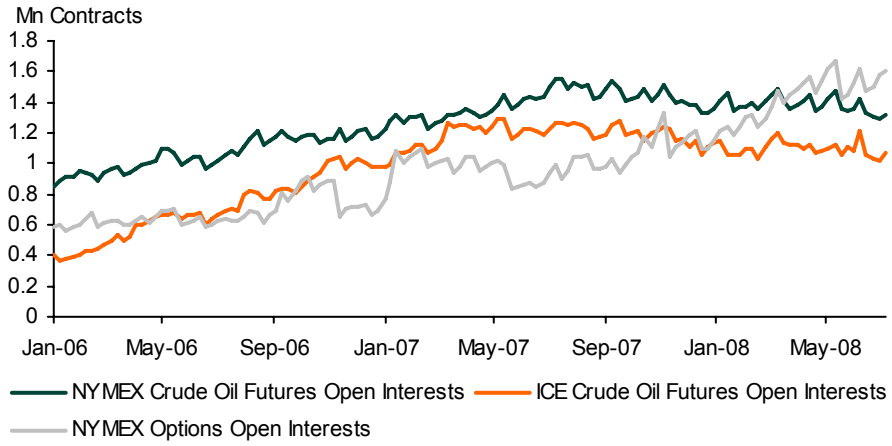
Although financial exchanges for commodities have been around since the 19th Century, they began attracting attention as a frontier asset class for portfolio allocation only recently. Academic studies documented the seemingly good risk-return profiles, low or negative correlations to traditional asset classes and the business cycle, and low cross-commodity

correlations.[1] This research inspired institutional investors, starting with university endowments and pension funds, to explore long-term passive allocations into commodities starting in the early 1990s, also roughly when the GSCI was first created.

Size and activity of commodity exchanges has boomed

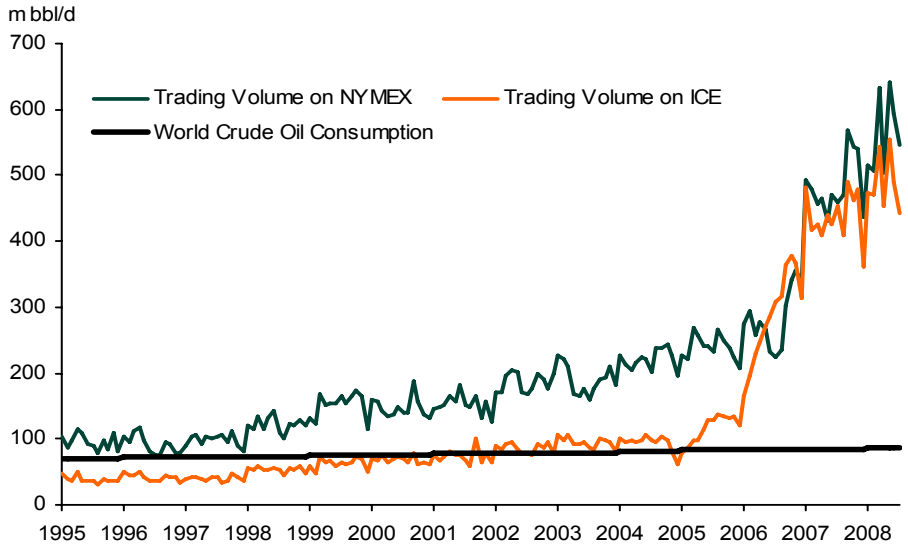
Size and activity on commodity exchanges have boomed since then. Figure 3 shows the total open interest, broken down by futures and options, on the two major exchanges for paper oil: the New York Mercantile Exchange (NYMEX) and the InterContinental Exchange (ICE). Other important commodity exchanges in the United States include the Chicago Mercantile Exchange (COMEX) and the Chicago Board of Trade (CBOT). Furthermore, there has been a proliferation of local exchanges trading commodities around the world, such as in Shanghai, Mumbai, Singapore, Dubai, and elsewhere.

Figure 3. Open Interest for WTI and Brent Crude Oil on NYMEX and ICE



Source: NYMEX, ICE

Figure 4. Daily Trading Volume in WTI and Brent Crudes on NYMEX and ICE



Source: NYMEX, ICE, IEA, Bloomberg.

[1] *For example, see Gorton, Gary and K. Geert Rouwenhorst, "Facts and Fantasies about Commodity Futures," NBER working paper (2004).*

Figure 4 shows how trading activity for crude oil has risen even faster. The rapid increase of trading activity on the NYMEX and ICE for paper oil starting in 2006 has far outpaced the growth in the physical market for crude oil. The daily trading volume on NYMEX is now more than 6x that of entire global oil consumption, while ICE is close behind at more than 5x world consumption. Commodity exchanges have become highly visible and liquid, with hundreds of billions of dollars of paper contracts trading hands every day.

OTC activity for commodities have also grown rapidly

Furthermore, these figures underestimate the true size of financial markets for commodities, as they do not take into account unobservable activity happening directly over the counter (OTC) between counterparties, rather than on public exchanges. But anecdotal reports indicate that OTC activity has risen commensurately with that of exchanges.

"Financialization" raises difficult questions

This "financialization" of commodity markets has stirred practitioners, academics, and policymakers alike to ponder the ramifications. Before we begin our actual empirical analysis, it may be helpful to review some theoretical concepts related to the mechanisms by which financial activity can affect prices.

A Theoretical Discussion on Financial Activity and Prices

The benchmark view sees perfectly efficient markets

The majority of academic literature begins from a benchmark view of perfectly efficient markets. In this idealized world, prices rationally reflect all available information about the true value of assets, and financial demand and supply curves are completely vertical with respect to price, as no one is willing to buy assets at a higher price or sell them below market value.

Real markets suffer from short-term liquidity effects

Clearly, this is a theoretical extreme, and there are short-term liquidity constraints on the supply of financial instruments, in effect determining a sloped short-run supply curve. Hence, large orders can move along this curve and readily cause significant intraday price shifts, although their long-run effect is muted.

Differences of opinion due to imperfect information can drive price movements

Furthermore, market participants must continuously update their expectations about value from an inflow of new public and private information. They do not have perfect and unanimous opinions, but form differing beliefs about the true value of assets.

Market imperfections can cause short-term price under- and overshooting

Many observers have asked if it is possible for purely financial actors to affect a futures price, which is ultimately linked through spot markets to fundamental supply and demand. *Although we believe the answer, in the long run, is no, markets can deviate considerably from fundamentals in the short run.*

A corollary to this skeptical view is the argument that the apparent lack of inventory build is proof that physical tightness rather than speculative activity is driving prices higher. The theory goes: if speculative market prices are above the equilibrium price of oil, consumers would demand less than producers are supplying. The resulting excess supply must appear in inventories.

Weak economics has discouraged observable inventory

Taking the example of crude oil, we offer several objections to this analysis. First, reported inventory numbers come only from the United States and other OECD countries, not the entire globe. And the deteriorating demand outlook in these developed economies has discouraged commercial refiners from holding inventory.

Physical markets are highly inelastic with respect to price in the short run

More important, we argue that the physical spot market for oil is only weakly responsive to financially traded futures prices. Even the low empirical estimates in the academic literature may understate the inelasticity of supply and demand to price. A large supply or demand response requires high upfront fixed costs from producers and consumers, e.g., to open a new producing basin or upgrade the efficiency of equipment, therefore causing a nonlinear reaction to price and extreme short-run inelasticity. This inelasticity

also implies violent price responses to relatively small imbalances in supply and demand, making it difficult for market participants to formulate price expectations.

Furthermore, physical sales for crude take place not on an electronic auction system like their associated futures contracts, but rather on the basis of longer-term negotiated volume contracts between suppliers and buyers. Less than 1% of all NYMEX WTI futures contracts settle physically. Hence, even if the price of nearest-term futures goes up, this has only a limited short-term effect to the economics of physical agents. In academic nomenclature, contract terms for physical oil are "sticky."

The alternative of financial investment has limited physical speculation on inventory

Nor do speculators necessarily accumulate physical inventory stockpiles. The high price of each barrel has driven up the upfront costs necessary to make a physical long purchase of oil, while the fallout of the credit crunch has dried up capital. Quite naturally, speculators have used the less capital-intensive futures and options markets to invest, with no expectation of ever taking oil into storage. With this insulation of physical spot markets, it is not surprising that futures prices can *temporarily* disassociate from physical realities without an immediately apparent inventory build.

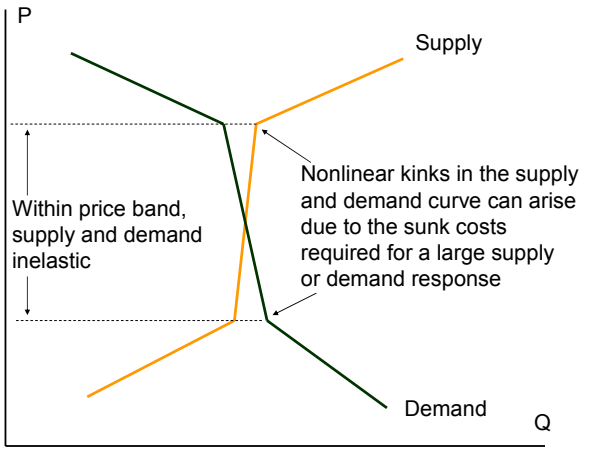
Many commodity markets face informational opacity

The fundamentals of many commodity markets are also notoriously opaque. For example, more than two-thirds of proven reserves of crude oil are kept by non-transparent national oil companies (NOCs), which divulge little information about their fields. There is simply no credible data available for key aspects of the fundamental balance, such as the amount of Saudi spare capacity or the size of Chinese inventories.

Informational imperfections can cause "herding behavior" and signal clustering

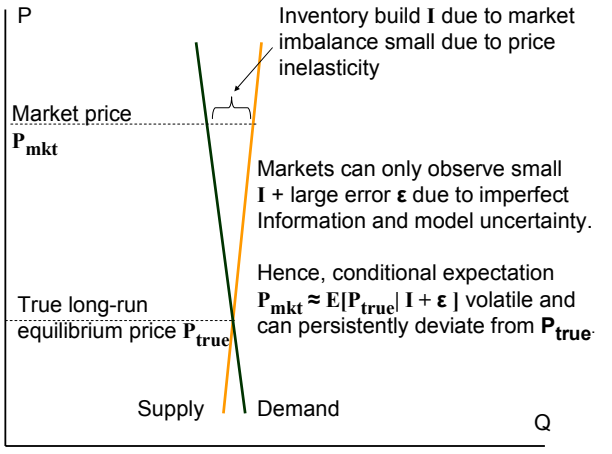
The lack of insight into elasticities and fundamentals makes market observers uncertain about even the validity of their model structure.[2] This model uncertainty forces information-starved market participants to copy the behavior of others, leading to "herding behavior." The shortage of information also leads market observers to focus inordinately on the handful of available signals, such as weekly changes in U.S. inventories. Markets may interpret a sharp drop in U.S. crude inventories as a bullish statement lending more credence to theories of supply shortages and peak oil.

Figure 5. Kinked Supply and Demand Curves



Source: Lehman Brothers Commodities Research

Figure 6. Price Expectations in Imperfect Markets



Source: Lehman Brothers Commodities Research

[2] *See an earlier Commodities Overview, "Uncertainty glut," published on June 20, 2008, in the* Global Weekly Economic Monitor, *for further discussion of the ramifications of model uncertainty for markets.*

Although we believe the alarm over peak oil is premature, the paucity of reliable information lends plausibility to such theories, while the inelasticity of supply and demand prevents an immediate physical response to persuade market participants otherwise. Hence, the traditional mechanisms that would cause prices to return to true equilibrium levels, namely efficient absorption of information and physical adjustment of markets, are weak in the short term.

Financial "noise" trading can affect expectations

The "herding" behavior of market participants also creates an opportunity for the activity of less-informed, purely financial investors to distort expectations. We have already mentioned the microstructure effects of a long index purchase, which must bid up the order price because of limited liquidity and the need to give sellers an incentive to accept the order.

However, it is difficult to claim that index investors possess new information about fundamentals that was not already absorbed by market participants. Yet the anonymity of markets allows participants potentially to misinterpret an uninformed index investment as a bullish statement by a trader with superior information. If participants then "herd" around this investment, prices can shift to a new level based on market reactions to an invalid signal[3] (Figure 6).

Index investors would be classified as "noise" traders

Index investors are what the academic literature would term "noise traders" (i.e., market participants who make trades not based on new information about fundamentals but rather for private, idiosyncratic reasons). But in anonymous markets, traders cannot distinguish well between a long trade made by a true speculator with bullish information and a long trade made by an index investor.[4]

Noise trading can affect both prices and volatility

Hence, index inflow can affect market expectations and, thus, have medium-term price effects beyond the simple microstructure effect. We consider the estimated index inflow numbers as a proxy for the increasing presence of commodity indices on exchanges. As index investments are unique in being almost entirely long purchases of commodities, their increased presence introduces more long-biased noise into markets. *Thus, index purchases can drive an upward revision of market expectations about the true value of oil because of market inability to distinguish between a large index purchase and a long bid due to new information about fundamentals. The noise trading also raises market uncertainty about valuations and, thus, increases price volatility.*[5]

Simple bans on speculator activity are counterproductive; better transparency is helpful

From a policymaking viewpoint, the discussion emphasizes the need for measured caution and sensitivity when regulating markets. An outright ban of futures market activity would defeat the purpose of preventing financial overshooting, as it eliminates the very market in which physical participants seek to manage risk. However, increased transparency about market activity would help markets identify which trades are fundamentally driven versus which are simply noise, thus improving market efficiency and mitigating behavioral overshooting.

HOW LARGE ARE INDEX INVESTORS?

The CFTC gathers index data for 12 agricultural commodities

As detailed in the Technical Appendix, we have refined a method to estimate the total assets under management (AUM) and investment inflow into various commodities. We rely heavily on the Commodity Index Trading (CIT) report published weekly by the U.S. Commodity Futures and Trading Commission (CFTC) as a supplement to the traditional Commitment of Traders (COT) reports.

[3] *The academic literature terms these "sunspot" equilibria.*
[4] *See Kyle, Albert, "Continuous Auctions and Insider Trading,"* Econometrica*, (1985).*
[5] *For a more rigorous analysis of this effect, see Grossman, Sanford J. and Joseph E. Stiglitz, "On the Impossibility of Informationally Efficient Markets,"* American Economic Review*, (1980).*

The CIT reports break down the aggregate futures and options positions into commercial, non-commercial, and index trader categories and by long and short positions. The CIT reports begin in January 2006 and cover only 12 agricultural commodities. Thus, a method is needed to estimate index investment in other commodities such as energy and metals.

A method to estimate inflows from CFTC data and cross-commodity weightings

With a statistically estimated market share of commodity indices into the two largest representatives (GSCI and DJ-AIG) and their public rolling calendar structure and cross-commodity weightings, we can provide an estimate for both the total AUM and the net financial investment into every one of the 25 commodities covered by these two indices. See Figure 7 for a list of the commodities covered and a sample of their cross-commodity weighting.

Figure 7. Commodities in the S&P GSCI and the DJ-AIG and Sample Weightings from June 1320,08

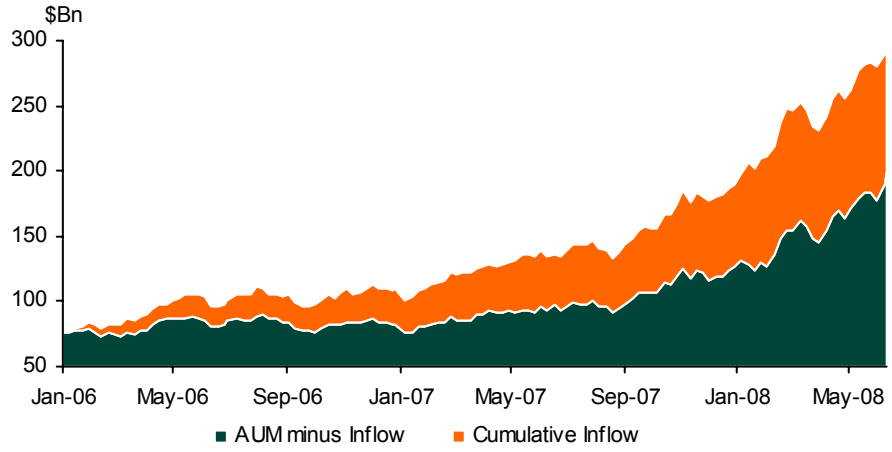
Commodity	Symbol	DJ-AIG Weights	GSCI Weights
Agriculturals			
Live Cattle	LC	3.97%	1.69%
Lean Hogs	LH	2.05%	0.95%
Feeder Cattle	FC	0.00%	0.31%
Kansas Wheat	KW	0.00%	0.75%
Chicago Wheat	W	3.81%	3.12%
Corn	C	6.64%	3.69%
Soybeans	S	7.86%	2.03%
Soybean Oil	BO	2.95%	0.00%
Base Metals			
Aluminum	AL	6.62%	2.18%
Copper	CU	6.62%	2.63%
Zinc	ZN	1.65%	0.38%
Nickel	NI	2.79%	0.54%
Lead	PB	0.00%	0.25%
Precious Metals			
Gold	GC	6.04%	1.48%
Silver	SI	2.27%	0.21%
Softs			
Cotton	CT	2.07%	0.72%
Coffee	KC	2.46%	0.49%
Sugar	SB	2.27%	0.84%
Cocoa	CC	0.22%	0.22%
Energy			
Brent Crude Oil	CO	0.00%	14.57%
Crude Oil	CL	16.05%	40.18%
Natural Gas	NG	15.88%	7.58%
Gasoline	RB	4.25%	4.56%
Heating Oil	HO	4.91%	5.27%
Gasoil	GO	0.00%	5.36%

Source: S&P GSCI, DJ-AIG

This method can both under- and overestimate the amount of financial investment. First, it assumes that all index investment takes place in basic "first-generation" indices offered by the GSCI and the DJ-AIG and ignores the emergence of sector-specific indices and non-lookalike indices. Any distortion that increases the overall market exposure to agricultural commodities relative to the first-generation GSCI and DJ-AIG indices will cause the method to overvalue the true AUM of commodities. But it is not immediately obvious whether there will be higher or lower bias toward agriculturals, given that there are also many non-agricultural-specific indices.

At the same time, it also ignores non-index financial investment in commodities. Indices are but one of several investment vehicles available to investors seeking exposure to commodities. There are also commodity mutual funds, commodity-related exchange-traded funds (ETFs), exchange-traded notes (ETNs), equities of companies in the commodities business, and direct physical holdings. Estimates of the aggregate size of ETFs go as large as $50 billion and are likely the next largest investment vehicle after indices. Furthermore, we miss the OTC index look-alikes and non-U.S.-based activity.

Figure 8. Index Assets under Management (AUM) in All 25 Commodities



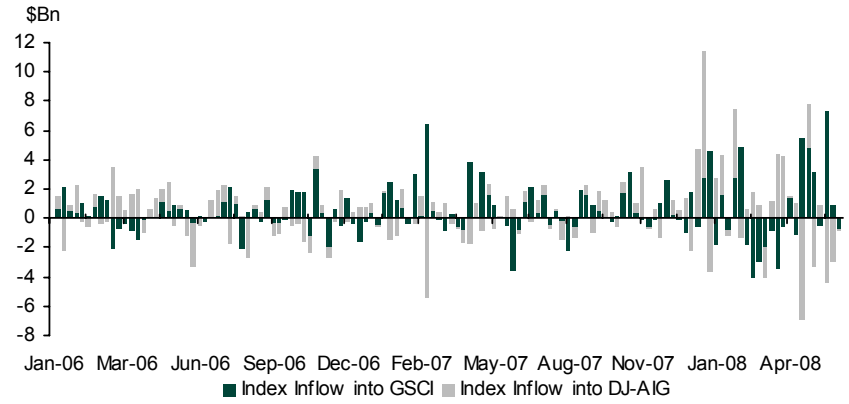
Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers Estimates.

Total AUM in indices is $297 billion, of which $98 billion was new inflow

So how large are index investors? In absolute terms, overall AUM of commodity indices has risen impressively. From negligible size in 2003, they reached an estimated $76.7 billion in January 2006 and ballooned to $297 billion by June 2008. Of this $219.3 billion increase since 2006, $98.1 billion has been new financial inflow, with the remainder due to the appreciation of the underlying commodities. Figures 7 and 8 show the growth in the total AUM of commodity indices and the weekly estimated inflow.

For WTI crude oil, we estimate there has been a cumulative index inflow of $32.5 billion into a total AUM of $94.2 billion by June 2008. By comparison, the entire market capitalization of all WTI open interest on the NYMEX is $381.8 billion. Hence, we estimate that commodity indices now account for roughly a quarter of all long interest in paper oil.

Figure 9. Estimated Financial Inflows for S&P GSCI and DJ-AIG Indices

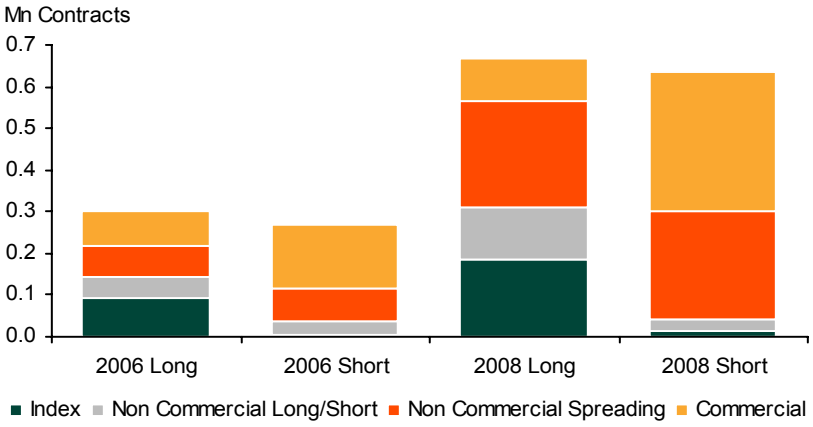


Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers estimates

Index investment is heavily long biased

Furthermore, index investment is almost purely represented by long positions. Figure 10 shows the breakdown in the soybean market of long and short positions by trader category: index, non-commercial regular positions, non-commercial spreading positions, and commercial positions. Note how both the size and distribution of long positions has shifted from January 3, 2006, to June 17, 2008.

Figure 10. Breakdown of Long/Short Positions by Category in Soybeans



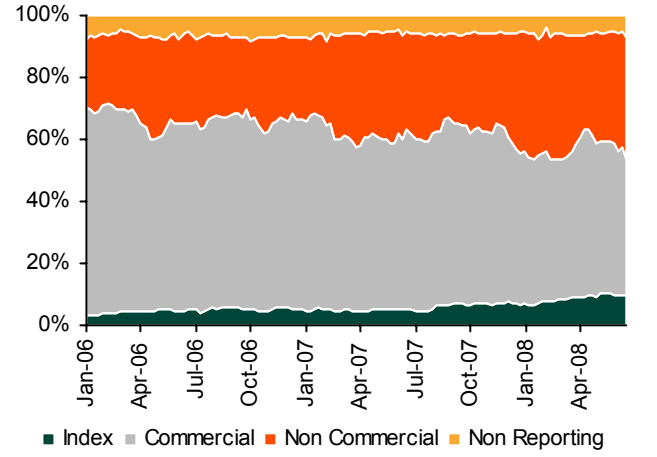
Source: CFTC

Relative to overall market size, indices are fairly stable

The available data suggest dramatic absolute increases of financial index investment into commodities. However, our discussion above suggests that the inflow must also be understood in the context of an explosive growth of the broader market. As a percentage of the overall size of the market and relative to non-index non-commercial traders, index positions stay relatively flat, with only scattered increases in various commodities. We also see that compared with ex-index non-commercial investors, which many view as a measure for traditional "speculators," index investors are smaller and relatively stable. Figures 10 and 11 show the breakdown for cocoa and for wheat.

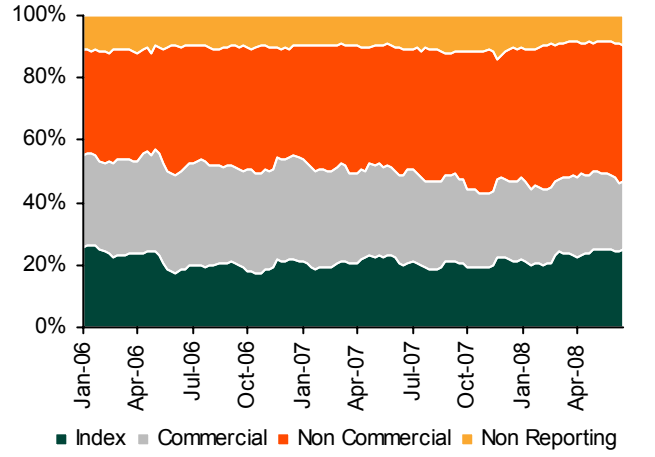
But from an individual trader perspective, index investors again appear to be the elephants of the trading pits. Dividing the total index open interest by the number of reported index traders, we can solve for the average trading size of index investors. We can do this only for the 12 agricultural commodities, as our method cannot estimate the number of index investors in the non-agricultural commodities.

Figure 11. Breakdown of Open Interest by Type for Cocoa



Source: CFTC, S&P GSCI, DJ-AIG, Lehman Brothers estimates

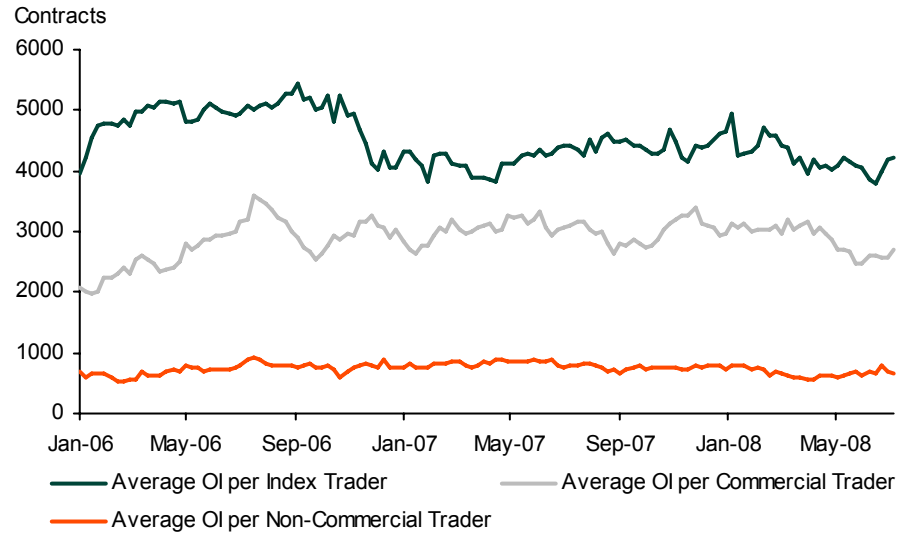
Figure 12. Breakdown of Open Interest by Type for Wheat



Source: CFTC, S&P GSCI, DJ-AIG, Lehman Brothers estimates

Given that there are only a handful of index vehicles making strategic portfolio allocations on behalf of large institutional clients, it is not surprising that the average position size of index investors surpasses the average size for both commercial traders and non-index non-commercial speculators (Figure 13).

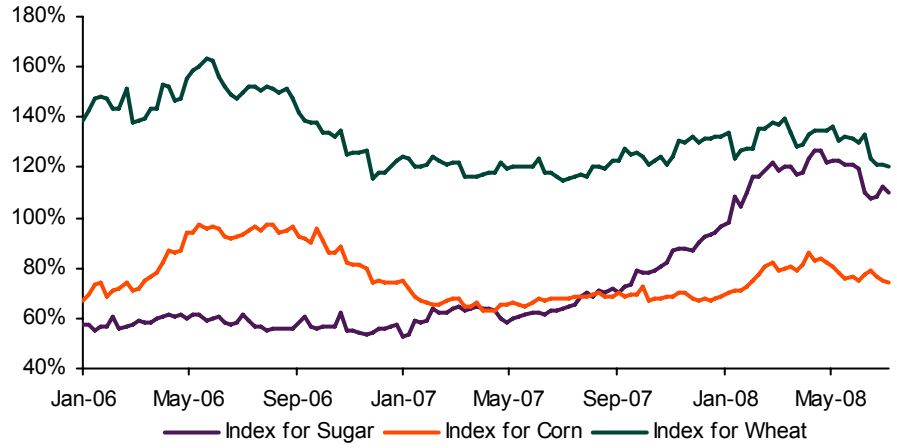
Figure 13. Average Open Interest Size for Commercial, Non-Commercial, and Index Traders in Soybean Oil



Source: CFTC.

As Figure 14 shows, for some commodities such as wheat, the average index trader size exceeds the speculative position limit imposed by the CFTC, providing evidence that the "swap" loophole allows institutional investors to exceed the limits imposed on regular speculators.

Figure 14. Average Size of Index Investors as a % of Speculative Position Limits



Source: CFTC

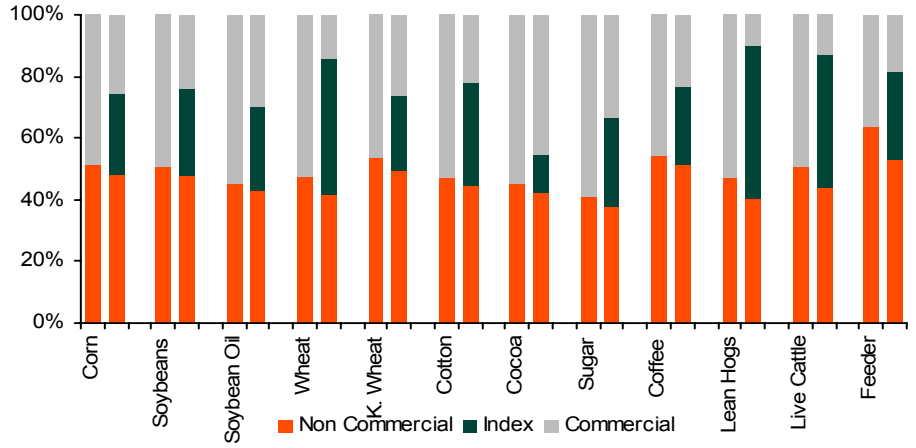
Given their large individual trading sizes, it is entirely plausible that index trades can have significant intra-day effects on prices. Indeed, there are widespread anecdotes from the trading community of the visible price effect of the "GSCI roll" in commodity prices, as this index rolls its portfolio from the nearest-term futures contract to a further one to avoid the delivery date. However, the longer-term effect on prices may be limited because of their fairly small share of total market interest.

Financial intermediaries can cloud the CFTC index data

As a disclaimer, there are rising concerns about the accuracy of this picture. As banks receive index orders from institutional investors and other clients, they do not necessarily pass through the investments unadulterated to the exchanges. Instead, they may internalize the position with others made from a different part of the bank. Banks are multi-functional organizations with branches that may invest in commodities for legitimate commercial reasons, as well as for financial purposes. The CFTC has found it challenging to disentangle the bank positions made for commercial versus non-commercial and index reasons.

Even the simple distinctions between commercial and non-commercial in the ordinary COT reports have become suspect. The commercial category was to encompass bona fide hedgers seeking to risk manage their physical exposure to commodities. Meanwhile, the non-commercial category was widely identified as being made up of "speculators." Hence, when comparing the COT breakdown (into commercial and non-commercial) with the CIT breakdown (into commercial, non-commercial, and index) side by side, we expect most of the index length to come from the non-commercial category. Yet a comparison of the long positions between the normal COT reports and the supplemental CIT reports for the 12 agriculturals (Figure 15) suggests that most of the index length was being categorized as commercial rather than non-commercial length.

Figure 15. Comparison between CFTC COT (Left) and CIT (Right) Data on the Breakdown of Long Positions for the 12 Agricultural Commodities

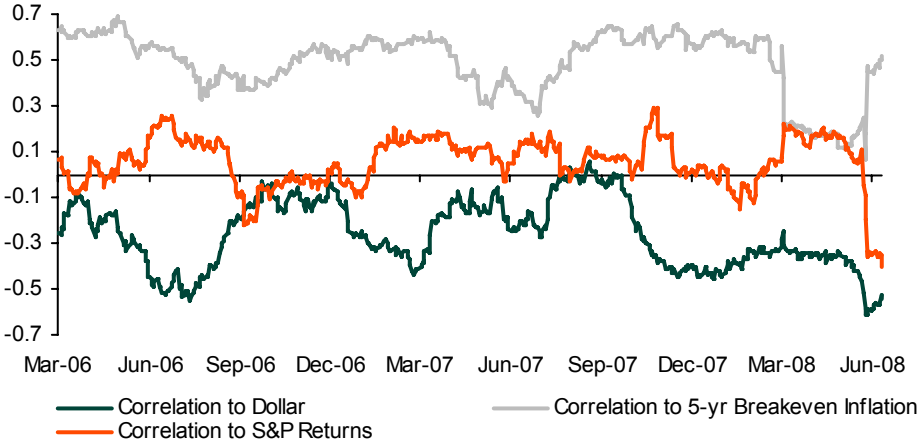


Source: CFTC

WHAT CAUSES INDEX INFLOWS?

We can divide the motivations for financial investment into commodity indices in two categories. First, there are strategic reasons for investing in commodities. Commodities have good diversification properties, as they serve as excellent hedges against dollar and equity weakness and higher inflation, particularly in recent months. Figure 16 shows how WTI has been generally negatively correlated with the dollar, uncorrelated with the S&P (save recently), and positively correlated with 5-year breakeven inflation, which is a common measure of future inflation expectations derived from the 5-year forward U.S. TIPS market.

Figure 16. 60-day Rolling Correlations of WTI to the Dollar, S&P, and 5-year Breakeven Inflation



Source: Bloomberg

The strategic and tactical motivations for commodity investment have blurred

However, the strategic motivations for investing in commodities have become increasingly blurred with tactical reasons, as investors turned off by the dismal recent performance of traditional asset classes such as equities have sought higher performance elsewhere. Of course, the distinction between these two categories is slightly artificial, as the outstanding performance of commodities has naturally provided both higher returns and better counter-variation to the overall economy. Nevertheless, it is a useful distinction to make for our discussion below.

Weakness in the dollar and equities, as well as higher inflation expectations, drive inflow

Using our estimates of inflow, we test to see whether the following factors have positive explanatory power for inflows to commodities: weakness in the dollar, lower S&P returns, higher inflation expectations, higher VIX index (a common measure of market anxiety), and finally, prior-week performance of the associated commodity index, i.e., GSCI or DJ-AIG. We examine whether these factors have predictive power in inflows to their respective indices.

We confirm our findings from our previous study (Figure 17). Again, all of the factors go in the correct direction. Dollar weakness and breakeven inflation have positive significance in predicting GSCI inflow, while dollar returns and past performance predict inflows to the DJ-AIG.

Several factors have lost statistical significance since we used our updated estimation method, suggesting some concern about the robustness of the estimation procedure (discussed in the Appendix). However, we derive some comfort in the fact that all coefficient signs point as expected and in the same direction as our previous study.

Figure 17. Causes of Index Inflows to GSCI and DJ-AIG

GSCI Inflow (R^2=9%)	Coeff.	p-value	DJ-AIG Inflow (R^2=11%)	Coeff.	p-value
Dollar Returns	**-7.57**	**0.000**	**Dollar Returns**	**-6.48**	**0.000**
Breakeven Inflation	**+3.98**	**0.000**	Breakeven Inflation	+0.32	0.678
S&P Returns	-1.37	0.499	S&P Returns	-0.54	0.698
VIX levels	+0.30	0.359	VIX levels	+0.22	0.324
GSCI Past Performance	+0.56	0.432	**DJ-AIG Past Performance**	**+3.14**	**0.000**

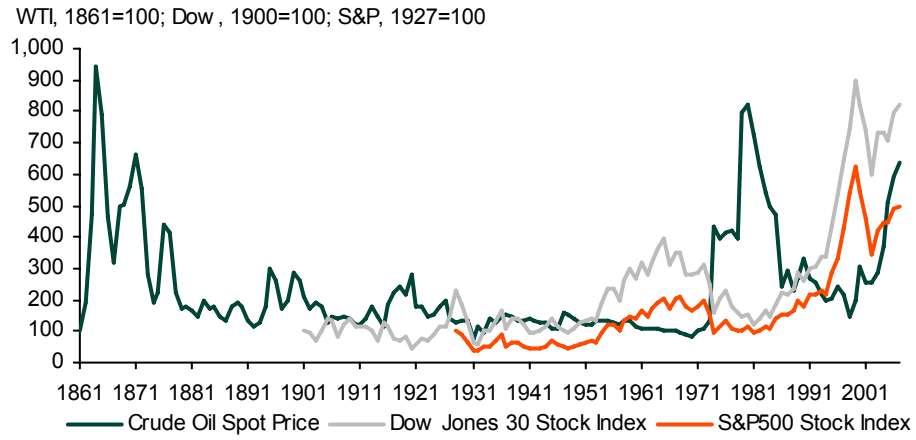
Source : CFTC, S&P GSCI, DJ-AIG, Lehman Brothers estimates
(Note: Bold represents statistical significance at the 1% level of confidence and italics at the 5% level of confidence.)

Nevertheless, given that we have only weekly data starting since January 2006 (120 observations), as well as a large degree of idiosyncrasy in the timing of index investment, the overall regression performance is poor, with R^2 around 10% for both regressions.

Strategic versus Tactical Investment in Commodity Indices

The results above are in line with widely cited stories of the dollar and inflation being drivers of financial investment. The value of commodities as a hedge against economic downturns, a falling dollar, and higher inflation is also consistent with a long-term strategic investment by large institutional investors in commodities. However, we stress that investment driven by past performance of the commodity indices is not.

Figure 18. Inflation-Adjusted Oil, the S&P, and the Dow Jones Index, 1861-2007



Source: BP, Bloomberg

Past performance also drives momentum investment

The momentum-chasing nature of index investment is a potentially worrisome finding. In the hullaballoo over commodities, investors may be forgetting the obvious: commodities are inherently static assets whose prices fluctuate around some long-term (but potentially changing) equilibrium level, while equities are shares in the future cash flow of dynamic firms providing long-term returns from technological progress. In other words, commodities do not deliver returns, they deliver appreciation. Adjustment to a higher equilibrium price may mimic superior returns in the short term, but it cannot last forever. Figure 18 shows the long-run cyclical nature of oil as opposed to the dynamic return of the S&P and the Dow Jones Index.

Commodities are a cyclical investment with zero long-run excess returns

An investment into a cyclical asset with a long-run expected excess rate of return of zero such as commodities will *always* decrease a portfolio's long-run expected excess return. However, the portfolio may see an improved Sharpe ratio as the diversification benefits and the reduction in the variance of the portfolio outweighs the loss in expected return.

Strategic diversification into commodities should focus on finding the ideal portfolio allocation balance to maximize the risk-return profile, but should not focus solely on seeking returns on the basis of momentum from past historical returns. This is particularly the case for a mean-reverting factor such as commodity prices, for which higher past performance predicts lower to negative future performance.

In fact, as we stated in our previous special report, *Is it a Bubble?*, we view momentum-trading as a key building block of a speculative asset bubble. Bubbles occur when investors lose sight of the fundamental inherent value of an asset, but make long purchases simply in anticipation of finding another investor who would be willing to buy the position at an even higher price. Relying on the positive feedback of momentum-trading is a tactical investment strategy inconsistent with a vision of commodities as a strategic asset class.

WHAT EFFECT DO INDEX FLOWS HAVE?

Having discussed the potential drivers of commodity investment, we next turn to the trickier question of their effect on price levels and volatility. In our previous study, we presented preliminary evidence that suggested there was a positive price effect of index investment inflow, particularly on less liquid agricultural and metals markets.

With our improved estimation procedure, we re-test for this effect using various measures of index investment and a battery of econometric tests.

Time Series Price Regression Using Absolute Measures of Inflow

In our first test, we again regress the history of commodity price returns on our absolute measure of financial index inflows (in $ billion) using our new estimates. We say that this is a time series regression since we compare over time whether additional inflows in dollars are correlated with higher returns for each commodity. This is essentially the same empirical approach used in our earlier study (although we now account for autocorrelation with a lag and use heteroskedasticity-consistent t-statistics).

Figure 19. Regression on Price Returns Using Absolute Measures of Inflow

Commodity	Coeff.	p-value
Soybean Oil	**21.12**	**0.000**
Corn	**4.86**	**0.029**
Cocoa	4.97	0.755
WTI Crude Oil	-0.57	0.266
Cotton	**7.45**	**0.036**
Feeder Cattle	-6.96	0.652
Gold	**6.17**	**0.010**
Heating Oil	**4.70**	**0.011**
Coffee	**10.68**	**0.037**
Kansas Wheat	4.13	0.759
Live Cattle	0.54	0.856
Lean Hogs	1.61	0.786
Copper	3.39	0.141
Natural Gas	-0.06	0.959
RBOB Gasoline	0.68	0.557
Soybeans	**6.64**	**0.000**
Sugar	4.19	0.289
Silver	*14.91*	*0.061*
Wheat	3.98	0.312

Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers estimates
(Note: Bold and underlined represents statistical significance at the 1% level of confidence, bold at the 5% level of confidence, and italics at the 10% level of confidence.)

Figure 19 summarizes our results. Again, we find that the coefficients are generally positive and statistically significant in many cases. Our results can be restated as follows: A $100 million dollar inflow to the soybean oil market by index investors within a week predicts a 2.11% increase in the weekly return of soybean oil.

Using absolute measures, inflows drive returns higher in illiquid markets, not WTI

As in our previous study, the largest-magnitude effects occur in less liquid commodities such as silver and coffee (with the curious exception of soybean oil, a relatively large market). Interestingly, the coefficient in front of WTI crude oil is negative but not statistically significant.

Time Series Volatility Regression Using Absolute Measures of Inflow

Next, we conduct a similar set of regressions to examine the effect of index inflows on price volatility rather than returns. The details of the regression are provided in the Appendix. We take the absolute value of estimated dollar inflow, since theoretically,

additional noise trading has a positive effect on volatility, whether the trading is net positive or negative.

Using absolute measures, inflow also drives volatility higher in illiquid markets

Figure 20 shows our regression results. We see, as expected, that there is again a positive effect on volatility for most commodities. To take the numbers literally, a $100 million inflow causes a 5.14% increase in the annualized volatility of soybean oil. Cocoa shows the largest effect on volatility, followed by wheat and soybean oil. None of the markets for energy commodities shows particularly high or significant effects on volatility.

Figure 20. Regression on Volatility Using Absolute Measures of Inflow

Commodity	Coeff.	p-value
Soybean Oil	**54.17**	**0.012**
Corn	10.20	0.222
Cocoa	**117.83**	**0.037**
WTI Crude Oil	2.82	0.153
Cotton	**26.67**	**0.022**
Feeder Cattle	34.63	0.490
Gold	-0.32	0.974
Heating Oil	*11.76*	*0.068*
Coffee	32.92	0.144
Kansas Wheat	25.73	0.603
Live Cattle	5.65	0.508
Lean Hogs	14.10	0.420
Copper	8.21	0.698
Natural Gas	1.77	0.823
RBOB Gasoline	0.87	0.012
Soybeans	**16.98**	**0.014**
Sugar	6.95	0.707
Silver	13.20	0.676
Wheat	**66.24**	**0.000**

Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers estimates
(Note: Bold and underlined represents statistical significance at the 1% level of confidence, bold at the 5% level of confidence, and italics at the 10% level of confidence.)

Time Series Price Regression Using Relative Measures of Inflow

Using percentage size as a relative measure removes liquidity effects

One might argue that the results for the return regression using absolute measures of inflow above is to be expected, as the same $100 million dollar inflow would naturally have a larger effect on smaller and less liquid commodity markets. To adjust for the size of the market and eliminate this "liquidity" effect, we construct a relative measure of inflow by considering the inflow not in absolute dollar terms but as a percentage size of the total open interest of the market. Please see the Technical Appendix for details.

Using relative measures, the previous positive effect of inflow on returns is lost

When we use this relative measure, the regression results change dramatically. For most commodities, the impact coefficients are negative rather than positive. An increase of one basis point in the index share of total open interest for corn within a week is associated with a 1.47% *decrease* in price returns.

Figure 21. Regression on Price Returns Using Relative Measures of Inflow

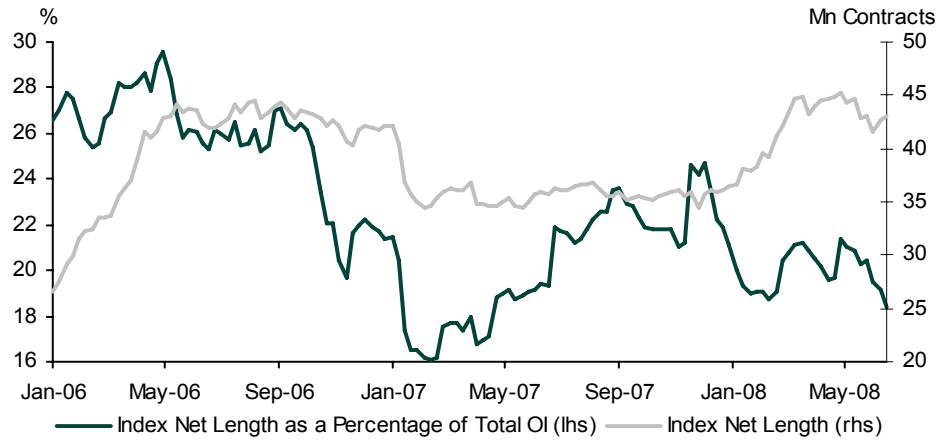
Commodity	Coeff.	p-value
Soybean Oil	-21.47	0.458
Corn	**-146.96**	**0.002**
Cocoa	**-158.78**	**0.003**
WTI Crude Oil	-47.96	0.181
Cotton	**-67.25**	**0.001**
Feeder Cattle	-2.17	0.857
Gold	**-101.15**	**0.000**
Heating Oil	-17.65	0.338
Coffee	**-65.44**	**0.031**
Kansas Wheat	-40.47	0.282
Live Cattle	*-22.18*	*0.098*
Lean Hogs	*-45.17*	*0.078*
Copper	-11.47	0.542
Natural Gas	21.89	0.841
RBOB Gasoline	-5.30	0.325
Soybeans	**-77.91**	**0.002**
Sugar	-29.11	0.349
Silver	**-167.94**	**0.001**
Wheat	**-82.89**	**0.003**

Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers estimates
(Note: Bold and underlined represents statistical significance at the 1% level of confidence, bold at the 5% level of confidence, and italics at the 10% level of confidence.)

The relative measures suffer from exogenous decreases due to market growth

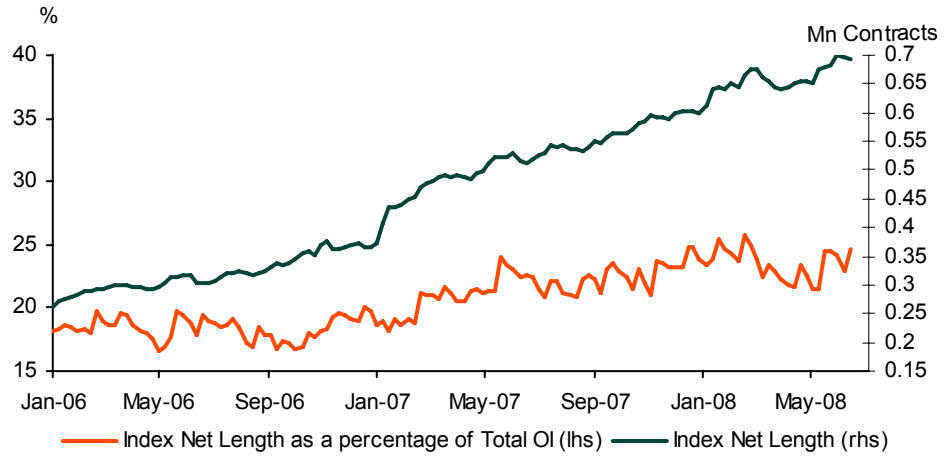
But looking at the history of this relative measure of index inflow, perhaps these negative results are to be expected. For many commodities, the relative size of index net positions is shrinking even as their absolute size and prices are increasing. For example, the net open interest of index positions for corn rose from 260,000 to 420,000 contracts, but their percentage size over the total open interest declined from 27% to 18% (Figure 22).

Figure 22. Net Length of Index Positions in Contracts and as a % of Total Open Interest for Corn



Source: CFTC

Figure 23. Net Length of Index Positions in Contracts and as a % of Total Open Interest for WTI Crude Oil



Source: CFTC

For WTI crude oil (Figure 23), the net index length has more than doubled since January 2006, but the percentage of total open interest increased only from 18% to 25%. The CFTC and other financial analysts have indeed pointed to the stable or declining relative measures as evidence against index investors' having any relation to the recent price increases.

The asymmetry in measures drives the negative results

Given the opposite movement of the relative compared with the absolute measure, the negative coefficients become more understandable. This asymmetry between the absolute and relative measures occurs because of the general growth of the commodity markets, as both commercial and non-commercial participants have also increased their exposure to commodities.

This exogenous growth in market size due to the general maturation of commodity futures markets poses problems to our relative measure. The previously used absolute measure of index inflows, while failing to adjust for market liquidity, nevertheless better captures the story of increasing index investment over time. *Hence, we face a trade-off in using the relative measure: we can adjust for liquidity but suffer an exogenous decrease in the measure due to financial maturation.* In a later section, we attempt a pooled panel regression to remove the effect of this upward time-trend in market size.

Time Series Volatility Regression Using Relative Measures of Inflow

But before we turn to the panel regression, we also test to see whether our relative measure of inflow positively predicts higher volatility.

Using relative measures, we still see a positive effect on volatility but no significance

As Figure 25 shows, the coefficients remain generally positive but are rarely significant (with no coefficient significant at the 1% level of confidence). The only significant coefficient at the 5% confidence level is for corn, with a one basis point increase in the relative index share predicting a 4.44% increase in annualized price volatility.

Figure 24. Regression Volatility Using Relative Measures of Inflow

Commodity	Coeff.	p-value
Soybean Oil	104.30	0.360
Corn	**444.20**	**0.011**
Cocoa	198.54	0.369
WTI Crude Oil	127.99	0.434
Cotton	81.93	0.230
Feeder Cattle	56.97	0.169
Gold	86.20	0.507
Heating Oil	*145.13*	*0.057*
Coffee	-201.60	0.229
Kansas Wheat	0.60	0.997
Live Cattle	-1.06	0.982
Lean Hogs	-53.21	0.563
Copper	129.18	0.215
Natural Gas	-68.96	0.886
RBOB Gasoline	13.64	0.437
Soybeans	61.18	0.599
Sugar	149.60	0.317
Silver	344.57	0.165
Wheat	19.03	0.862

Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers estimates
(Note: Bold and underlined represents statistical significance at the 1% level of confidence, bold at the 5% level of confidence, and italics at the 10% level of confidence.)

Panel Price and Volatility Regression Using Relative Measures of Investment

The potential flaws in the relative measure of index inflow discussed above encourage us to seek an alternative econometric approach that eliminates the time-trend effect of increasing market size from the regression. Happily, we can exploit the multiple commodity panel structure of the CIT data to test for the purely cross-sectional effects of increased index size on both returns and volatility.

A panel regression removes the time-trend effects that affected the relative measure

Intuitively, rather than considering the effects of increased inflow over time and observing their effect over time on returns and volatility, we consider differences in inflow investment across commodities and try to statistically observe differences in return and volatility behavior from one commodity to another. Because time variation is captured in dummy variables, we can avoid spurious correlation of the increasing trend in returns and volatility with the negative trends in relative inflow. However, the nature of the panel regression prevents any analysis of any specific commodity market. The details are in the Technical Appendix.

Figure 25. Panel Regression on Price Returns and Volatility Using Relative Measures of Inflow

Model	Coeff.	t-statistic	p-value
Returns	**0.22**	**2.92**	**0.00**
Volatility	**0.54**	**2.10**	**0.04**

Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers estimates
(Note: Bold and underlined represents statistical significance at the 1% level of confidence, bold at the 5% level of confidence, and italics at the 10% level of confidence.)

Panel study shows positive, significant, but small effects on returns and volatility

The results are presented in Figure 25. We find that a one percent increase in the relative index position over the total open interest over a week increases the weekly rate of return by 22 basis points and the annualized volatility by 54 basis points. Both effects are statistically significant at the 5% level, with the return effect significant even at the 1% level.

We feel more confident in the theoretical soundness of these results, as they use the relative measure to adjust for liquidity but remove the time trend in market size. However, while we do find a positive and significant effect from index inflows on both price levels and volatility, the coefficients are minimal in magnitude.

DISCUSSION AND CONCLUSION

To recapitulate our main findings, we found that since January 2006, commodity indices have attracted about $98.1 billion of new financial investment into a total AUM of $297 billion. Indices now form a sizeable fraction of total market activity, as much as 25% of total open interest for WTI crude oil.

We unsurprisingly find dollar returns, weakness in equities, and higher inflation expectations to be important drivers of index inflows to commodities, consistent with a story of strategic diversification. But we also find a potentially alarming degree of past performance-chasing momentum.

Commodity indices are an important innovation, but there is room for more

We recognize that indices present an important financial innovation in opening up a previously obscure asset class to a wider pool of investors, helping macroeconomic risk management. However, investors should not be lulled into a false sense of security by the recent outstanding performance of commodities. It is important to recognize the limitations inherent in commodities given their cyclicality and high volatility. Furthermore, commodity indices are somewhat peculiar in that they allow investors to express a long-term view on commodities through short-term rolling instruments. We feel that there is room for further financial innovation in the vehicles available to investors. The rise of so-called second-generation indices with injections into the back end of the forward curve is a promising development.

Heightened political tensions surrounding speculative activity in energy markets

The massive inflow of index investment has also raised difficult questions about whether any of the recent rise in energy and other prices can be attributed to this inflow. This has become a very politically charged debate. Several testimonies in Congressional hearings have argued for a causal link between financial speculators and high energy prices. On June 26, 2008, the U.S. House of Representatives passed bills to curb so-called excessive speculation in energy markets. As of this writing, the bill has been blocked in the Senate. The legislation effort is backed by an angry public groaning under record high food and energy prices and seeking an easy scapegoat. Regulators have also moved to close the "London" loophole, extending CFTC position limits to WTI and Brent crude contracts on the U.K.-based ICE exchange.

Others argue there is no theoretical basis for any effect on prices

On the other side of the debate, many observers have opposed these initiatives, arguing that there is no evidence, either empirical or theoretical, that speculative activity affects prices. A common argument states that the purely "financial" nature of index investment implies that they cannot affect a price that is determined by physical markets.

Reality is complex, with potential for short-term distortions

Our analysis suggests that reality is considerably more complex and does not align with either extreme of the debate. We feel that while prices ultimately reflect long-term supply and demand fundamentals, imperfections due to temporary liquidity constraints and asymmetric information in markets allow financial activity to potentially drive short-run deviations in prices.

The empirical evidence for return effects is mixed, depending upon approach

The empirical evidence returns a mixed bag. Estimates of the price impact vary depending on whether one uses absolute or relative measures of index investment. Furthermore, the positive effect is concentrated in the smaller agricultural commodity markets, not in oil markets, which have received so much limelight. The U.S. CFTC made a prescient first step by deciding to first track index positions in the less liquid agricultural markets.

Evidence for an effect on volatility is more consistent

For volatility, the picture is a little more consistent. For both absolute and relative measures, index investment does seem to predict higher volatility, as expected given our discussion on noise trading. However, the magnitudes of the effect are small and will likely shrink further if efforts are made to improve transparency.

Economists find it difficult to conclusively call a speculative bubble

Of course, it is easier in hindsight to call a price trajectory a speculative bubble (and the recent dramatic fall in commodity prices is suggestive). However, the line between an irrational bubble and an overshooting by rational but ill-informed markets is thin. Even for the NASDAQ in the 1990s, which many accept as a classic example of a bubble, economists have found it difficult to prove conclusively that speculators drove prices upward fully cognizant that the price was unreflective of fundamental value.[6]

Better data would raise confidence and robustness in the analysis

The whole debate is unfortunately clouded by both the short history and doubts about the accuracy of available data on index investment in commodities. It is also possible that the weekly frequency is too low to capture the significant intra-day or intra-week effects on returns from index investment. New data-gathering and transparency initiatives by the CFTC would provide a wealth of additional data to help frame the debate.

The spectacular growth of financial markets for commodities presents exciting new opportunities for hedging by commercial enterprises and portfolio allocations by financial investors. The global economy and its consumers will reap the accumulating benefits from improved risk management and more liquid and efficient markets.

Complex reality of markets requires an intelligent response

However, commodities markets, like all financial markets, are not theoretical ideals but imperfect human constructs. Distortions can arise as markets adapt to the inflow from indices and other participants. The complexity of the issue warrants intelligent and judicious regulatory consideration. As markets continue to mature from an influx of speculative activity and commercial hedging, these distortions should eventually diminish.

Improved transparency can help mitigate distortions

But in the interim, devoting more thought and resources to improving transparency and understanding of this important and rapidly growing aspect of commodity markets is an excellent first step.

[6] *See Pastor, Lubos and Pietro Veronesi, "Was there a Nasdaq bubble in the late 1990s?"* Journal of Financial Economics*, (2006).*

TECHNICAL APPENDIX

Estimation Method

The U.S. Commodity Futures Trading Commission (CFTC), which has the mandate to regulate commodity futures and options traded on exchanges in the United States, releases the Commitments of Traders (COT) report on a weekly basis. The report provides a breakdown of every Tuesday's positions for exchange-traded futures and options on U.S.-based exchanges. The COT report separates open interest by reportable and non-reportable positions. For reportable positions, additional data are provided: a breakdown into commercial and non-commercial holdings, spreading positions, changes from previous reports, percentages of open interest by category, and the numbers of reporting traders.

In January 2007, the CFTC began releasing a supplemental Commodity Index Traders (CIT) report, which shows positions of index traders for 12 agricultural commodities: soybean oil, corn, cocoa, cotton, feeder cattle, coffee, Kansas wheat, live cattle, lean hogs, soybeans, sugar, and Chicago wheat.

According to the CFTC, the index trader positions include both pension funds that had previously been classified as non-commercial traders and swap dealers that had been classified as commercial traders hedging their swap transactions. The CIT data also include the traditional long and short positions held by non-commercials (less index traders) and commercials (less index traders) and non-reporting traders.

This CIT data make it possible to estimate the AUM on other commodities besides the 12 agricultural commodities covered by the CIT on a weekly basis. One commonly used method is to assume that the entire universe of commodity indices can be divided into either the S&P GSCI or the DJ-AIG index and associated look-alikes, with imposed fixed market shares.

We recognize that there are other indices apart from the GSCI, the DJ-AIG, and associated look-alikes. However, most should fall between the energy-heavy GSCI and the agricultural-heavy DJ-AIG. Hence, using a linear combination of the two to span the index universe is not an unreasonable simplification. Furthermore, anecdotally, the two indices account for at least 80% of all index investment.

Then one can choose an agricultural commodity that appears only in the GSCI but not the DJ-AIG, e.g., feeder cattle. Given the calendar structure of the GSCI and knowledge of the specific feeder cattle contract the index is invested in, one can calculate the dollar value of its position. Dividing by the dollar weight of that commodity in the GSCI commodity weightings, we derive the implied total AUM in GSCI. Then we can apply the same method to estimate the AUM in DJAIG. (Indeed, this is the method used in our previous study, *Is it a Bubble?*, March 17, 2008.)

However, we feel that a narrow reliance on a single commodity can worsen the estimation accuracy and efficiency, as we throw away the available information from the other eleven commodities. Furthermore, this assumes a fixed market share, which clearly is a simplification.

And it turns out that the estimated AUM is sensitive to the selection of commodity. For instance, using corn gives an estimate for the total AUM at $312.6 billion, while using wheat gives $234.7 billion. The average AUM is $297.0 billion.

We adopt a different method to allow the market share of GSCI and DJ-AIG to vary dynamically over time, exploiting all information available in the CIT reports.

- First, some notation:
  - We use the indicator t for time and i for a specific commodity. We use superscript j to denote either GS or DJ. The absence of an indicator will represent a sum over that indicator.
  - Let X_t to be the total AUM of all indices into all commodities at time t. Then $X_{i,t}$ is the total AUM into commodity i at time t, X^j_t is the total AUM by index j into all commodities at time t, and $X^j_{i,t}$ is the total AUM by index j into commodity i at time t. Hence, $X_t = \Sigma_i X_{i,t} = \Sigma_i \Sigma_j X^j_{i,t}$.
  - Let β^j_t be the market share of index j at time t.
  - Let $\alpha^j_{i,t}$ be the dollar weighting of index j into commodity i at time t. Hence, $\alpha^{GS}_{C,t}$ would be the GSCI allocation into corn at time t.
  - Let $P^j_{i,t}$ be price of the futures contract for i structured in the calendar for index j at time t. These may be different because of the differences in calendar structure of the GSCI and DJ-AIG.
  - And finally, $I_{i,t}$ is the CFTC CIT data for the net contract length held by all indices in commodity i at time t. $I^j_{i,t}$ is the net contract length held by index j in commodity i at time t

The method for estimation is executed in two steps:

- In the first step, we try to estimate the time varying market share of GSCI, β_t.
  - Our first assumption can be written as: $I_{i,t} = I^{GS}_{i,t} + I^{DJ}_{i,t}$.
  - In turn, $I^j_{i,t} = X^j_{i,t} / P^j_{i,t} = \alpha^j_{i,t} * X^j_t / P^j_{i,t} = \alpha^j_{i,t} * \beta_t * X_t / P^j_{i,t}$
  - Hence, we can derive equation (1):

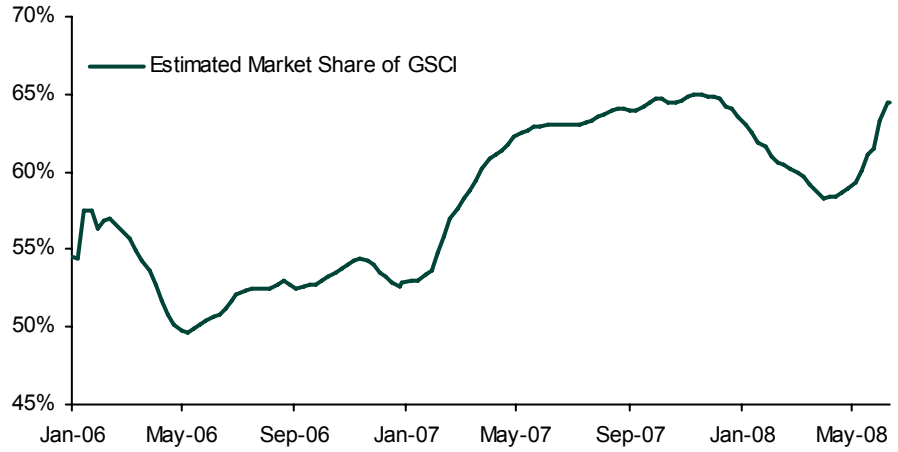
    $$I_{i,t} = (\Sigma_j \alpha^j_{i,t} * \beta_t / P^j_{i,t}) X_t \qquad (1)$$

  - With the exception of β_t and X_t, all variables in equation (1) are known for the 12 agricultural commodities. With 12 equations and two unknowns, we recursively search for the optimal β_t between [0,1] to minimize the mean squared error (MSE) of the differentiation between the individual estimated X_t|using commodity i and the mean of the estimates.
  - In other words, we minimize:

    $$MSE(\beta_t) = \Sigma_i [X_t|\text{using commodity i} - (\Sigma_i X_t|\text{using commodity i} / 12)]^2$$

  - Figure 19 shows our estimated time-varying market share of the S&P GSCI in the index universe.

Figure 19. Estimate of the Time-Varying Market Share of the S&P GSCI



Source: CFTC, S&P GSCI, DJ-AIG, Bloomberg, Lehman Brothers estimates.

- In the second step, given the optimally derived dynamically varying β_t, we repeat step 1 to estimate X_t using the average of X_t|using commodity i. Now given β_t and X_t , we have all the ingredients to determine every single variable. In particular, we now have a measure of financial investment into commodity i at time t in contract terms and absolute dollar terms.
  - Contract Inflow $\Delta I^{j}_{i,t} = I^{j}_{i,t} - I^{j}_{i,t-1}$
- One additional twist occurs because we have weekly derived variables because of the weekly frequency of the CIT reports, but we have daily price data. Hence, we assume that there is a proportionate inflow of the weekly number on each trading day of that week. Equivalently, we take the average price over that week to convert the contract inflow into a dollar figure.
  - Dollar Inflow $\Delta DI^{j}_{i,t} = \Delta I^{j}_{i,t}$ * (sum of $P^{j}_{i,t}$ / # of trading days in that week)

With our estimates for the dollar and contract inflow, we can now run our econometric regressions to test for both the causes of inflows and their effect on returns and volatility:

Causes of Index Flow Regression

- The first set of regression equations is the following:
- $\Delta DI^{j}_{t} = a^{j} + b^{j} * \Delta DI^{j}_{t-1} + c^{j} *$ Dollar $\text{Return}_t + d^{j} *$ Breakeven $\text{Inflation}_t + e^{j} *$ S&P $\text{Returns}_t + f^{j} *$ VIX $\text{Levels}_t + g^{j} *$ Index Return $\text{Performance}^{j}_{t-1}$
- We account for autocorrelation with a one-period lag (chosen by the Akaike information criterion) and use Newey-West heteroskedasticity-consistent t-statistics. We run this regression for all j, i.e., for the S&P GSCI and the DJ-AIG Commodity Index.

Time Series Price Regression Using Absolute Measures of Investment

- We regress each individual commodity i's return $R_{i,t}$ on absolute dollar inflow:
- $R_{i,t} = a_i + b_i * R_{i,t-1} + c_i * \Delta DI_{i,t}$
- Again, we account for autocorrelation with a one-period lag and use Newey-West heteroskedasticity-consistent t-statistics.

Time Series Price Regression Using Absolute Measures of Investment

- We regress each individual commodity i's change in the weekly volatility of returns, denoted by $\Delta V_{i,t}$ on the absolute value of dollar inflow:
- $\Delta V_{i,t} = a_i + b_i * \Delta V_{i,t-1} + c_i * |\Delta DI_{i,t}|$
- Again, we account for autocorrelation with a one-period lag and use Newey-West heteroskedasticity-consistent t-statistics.

Time Series Price Regression using Relative Measures of Investment

- In contrast to the previous pair of regressions, we now use a relative measure of investment by considering the change in the net index length in commodity i divided by the total open interest in commodity i.
- $R_{i,t} = a_i + b_i * R_{i,t-1} + c_i * \Delta(I_{i,t} / OI_{i,t})$
- Again, we account for autocorrelation with a one-period lag and use Newey-West heteroskedasticity-consistent t-statistics.

Time Series Volatility Regression Using Relative Measures of Investment

- In parallel to the above regression, we use our new relative measure of investment to see its effect on weekly volatility of commodity returns:
- $\Delta V_{i,t} = a_i + b_i * \Delta V_{i,t-1} + c_i * |\Delta(I_{i,t} / OI_{i,t})|$
- Again, we account for autocorrelation with a one-period lag and use Newey-West heteroskedasticity-consistent t-statistics.

Panel Price and Volatility Regression Using Relative Measures of Investment

- In this set of regressions, we used a pooled panel regression with two-way fixed effects to exploit the panel structure of the CIT data. Rather than looking at the increase in investment (whether measured absolutely or relatively) over time and examining its effect on the time series of commodity returns and volatility, we consider the effect across commodities. This allows use to avoid potential trends in the time series data.
- We regress each individual commodity i's return $R_{i,t}$ on absolute dollar inflow:
- $R_{i,t} = a_i + b_t + c * R_{i,t-1} + d * \Delta(I_{i,t} / OI_{i,t})$
- $\Delta V_{i,t} = a_i + b_t + c * \Delta V_{i,t-1} + d * |\Delta(I_{i,t} / OI_{i,t})|$
- a_i and b_t are the commodity-specific and weekly time dummy variables respectively.
- Notice that the coefficients c and d have no time or commodity indicator. Under the panel regression, the time variation is captured entirely in the time dummy variable.
- Differences in investment across commodities are used to account for differences in return and volatility behavior. Again, we account for autocorrelation with a one-period lag and use Newey-West heteroskedasticity-consistent t-statistics.

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