Mispricing Premia

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Abstract

We document violations of the no-arbitrage relationship between equity index futures and their underlying spot markets across a set of eighteen international, liquidly traded indices. These mispricings, or bases, co-move across markets and tend to rise and fall contemporaneously with equity markets. We present evidence that links these bases with end-user demand for futures exposure operating in concert with intermediary financing frictions and costs. Studying the futures-spot basis in equity index futures markets in conjunction with covered interest rate parity violations in currency markets, we uncover that futures mispricings negatively forecast the cross-section of returns in both futures and spot markets. We present evidence that the return predictability of futures mispricings is consistent with, but not fully explained by, liquidity providers receiving compensation for providing liquidity to equity and currency investors.

PRELIMINARY AND INCOMPLETE

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1 Extended Abstract

From 2000-2017, in an international set of eighteen, liquidly traded equity indices, we document persistent violations of the no-arbitrage relationship between futures contracts and their underlying spot indices. These violations, or bases as they are commonly described, are prevalent across time and across indices, a puzzling result that we document and seek to economically characterize.

The simple existence of bases in equity index futures markets has been previously documented by others. Our paper follows and complements an existing literature that considers the futures-spot basis of the nascent equity index futures market of the 1980s and early 1990s\(^1\). Notably, our results suggest the continued existence of significant bases despite the substantial evolution of equity markets and increases in both market liquidity and arbitrage forces in play over the past three decades\(^2\), a surprising result. While other studies have largely focused on the absolute value of the basis, we also consider potential drivers of the sign of the basis and and variation in the signed basis.

We first present a set of stylized empirical facts about the futures-spot basis. Particularly, we find that

1. The average magnitude of the basis is 69 basis points annualized in our sample, a substantial amount, though smaller than the basis reported in the US market of the 1980s.

2. The basis is substantially autocorrelated at a daily frequency. The daily AR(1) coefficient for the basis is 0.53. Autocorrelations of the basis remain significant for lags of up to 90 days, indicating the presence of a persistent driver of the basis across indices.

3. Bases tend to co-move across different equity indices. The average pairwise correlation of the basis across indices is 0.23, and a common factor drives time-series variation in the basis. The first principal component of the basis correlation matrix explains over 40% of the variation of the monthly basis correlation matrix.

4. Bases rise and fall with equity markets, with futures richening relative to spot indices as equity markets trend upwards and futures cheapening relative to spot indices as equity markets trend downwards.

These facts suggests that not only do futures-spot bases exist in certain markets, but that they are ubiquitous across global equity markets, naturally begging the question as to what their economic drivers might be.

\(^1\)Amongst others, Cornell and French [1983], Figlewski [1984], MacKinlay and Ramaswamy [1988], Harris [1989], Miller et al. [1994], Yadav and Pope [1994], CHEN et al. [1995] document the existence of a futures-spot basis within a single or a few equity markets, and post different theories regarding whether the basis represents a true arbitrage opportunity or whether it is driven by alternative factors such as asynchronous trading hours, without a clear consensus emerging. More recently, Roll et al. [2007] find a two-way granger causal relationship between the basis and market liquidity, and document that the basis converges to zero more quickly with increased market liquidity, considering futures contracts of the now-defunct NYSE Composite futures market across different maturities.

\(^2\)E.g. electronic trading
In the first part of this paper, we link variation in the futures-spot basis to a combination of demand for futures exposure by non-intermediaries ("end-users"), and financing costs that intermediaries face to meet that demand. In the second part of this paper, we consider the relationship between the futures-spot basis and expected returns, and provide evidence that the futures-spot basis negatively predicts returns in both futures and spot markets, consistent with liquidity providers earning compensation for providing liquidity in these markets.

A recent strand of literature regarding intermediary funding frictions provides us with testable economic theories regarding the existence of the futures-spot basis. Particularly, we test and provide evidence consistent with the futures-spot basis arising as a result of financing costs that intermediaries face to meet the demand of end-users for futures exposure. While the textbook definition of no-arbitrage pricing assumes that dealers may finance their market-making activities at the risk-free rate, this assumption often times does not hold in practice, depending upon, amongst other factors, the strategy that dealers use to finance their market-making activities and potential costs that they face to meet legislated capital requirements. We summarize the general mechanics of the market making activities of dealers in equity index futures markets in Figure 1. In equity index futures markets, dealers generally seek to hold hedged positions that are not exposed to market risk, and thus hedge their futures inventory by buying (or selling) shares in the underlying. Since dealers are often cash-constrained, they must obtain financing for their hedge positions, which accounts for a significant portion of their financing costs. When forced to take on short futures positions to meet end-user demand for long exposure, dealers prefer to finance their long cash equity hedge positions by lending out the very stocks they have purchased. In the most common stock lending transaction, lenders (dealers in this case) provide shares of stock to borrowers and receive collateral (usually cash) in exchange. The lender pays a rebate rate (analogous to the repo rate in bond markets) to the borrower, which is the prevailing risk-free rate less a stock loan fee charged by the lender that is increasing in the difficulty of borrowing the given stock. As rebate rates represent a substantial portion of the financing charge that dealers must pay, when security lending fees are high and shares are hard to borrow for an index, financing costs are lower for dealers, while they are higher when index security lending fees are low and the shares are easy to borrow. Hence, we can test the two pronged hypothesis that intermediaries finance their hedges via security lending and that the cost of their financing is embedded in the pricing of futures by considering the relationship between the futures cash basis and security lending markets. If these hypotheses are jointly true, we would...

\footnote{Song [2016] suggests that intermediaries include financing costs in their bid/ask quotations and that repo financing is the preferred financing strategy for intermediaries, as it results in cheaper borrowing rates than uncollateralized borrowing, with counterparties holding the stock as collateral in case the intermediary defaults. Omprakash [2014] similarly argues that repo financing rates are the preferred financing strategy for intermediaries in equity derivatives markets.}

\footnote{Rebate rates can be and do become negative for certain stocks at certain points in time, doing so when stock loan fees exceed the risk-free rate. Such situations often coincide with a substantial amount of borrowing demand relative to supply for those given stocks. See D’Avolio [2002] for an in-depth discussion of the mechanics of the equity security lending market.}
expect variation in the security lending fees and levels of the shares of an equity index to explain variation in the futures-spot basis in that index. Particularly, we would expect a more positive basis when security lending rates are low and the shares of the index are easy to borrow, while we would expect a more negative basis to correspond with higher security lending rates and scarce supply of index shares in security lending markets.

We provide empirical evidence consistent with the futures basis varying with security lending rates and the availability of shares in the security lending market. We utilize an extensive dataset on the market for borrowing and lending individual stocks from Markit Securities Finance (MSF), which provides the average fee paid on outstanding loans above the risk free rate, as well as the ratio of shares lent out relative to the available supply of shares to be lent out (security lending utilization) for a number of stocks. Using this data to construct a time-series of index security lending fees and index security lending utilization for each index, we find that variation in index security lending utilization and security lending rates is significantly negatively related with the futures-spot basis, consistent with our hypothesis. The relationship between the futures-spot basis and security lending utilization also provides us with an interesting economic insight. The primary purpose of the security lending market is to facilitate shorting. Our results hence can be consistent with expensive futures corresponding with little demand by end-users for short exposure in the cash equity market, or consistent with expensive futures corresponding with intermediaries hedging their short equity futures exposure substantially increasing the supply of available securities in the security lending market, or both.

If intermediary costs are embedded in the futures-spot basis, we would also expect the futures-spot basis to increase with dealer inventory in futures, given that dealers face increasing costs from capital requirements and increasing financing costs as their inventories increase. For American index futures, we directly test and provide support for the hypothesis that the basis should be increasing in dealer inventories by measuring the relationship between the futures-spot basis, dealer inventories, and end-user positioning using a unique dataset that provides us with aggregate positioning of various types of investors in futures markets. From 2010 onwards (and backfilled to 2007), the U.S. Commodity Futures Trading Commission (CFTC) has published the Traders in Financial Futures report, providing net positioning information of equity futures traders consolidated into one of four groups: Dealer/Intermediaries, Institutional Asset Managers, Leveraged

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5 The example presented corresponds with futures dealers facilitating long futures demand by end-users. The relationship between securities lending and the futures-spot basis does follow in the same direction when dealers are meeting short futures demand by end-users.

6 Formerly known as Data Explorers

7 E.g., If dealers finance their positions via equity repo, increased dealer inventories in futures correspond with increased security lending supply of stocks and thus increased financing costs for intermediaries.

8 In a related spirit, Garleanu et al. [2009] develop a model of risk-averse intermediaries who cannot perfectly hedge their derivative positions, and find theoretically and empirically that derivatives become more expensively priced as end-user demand for those derivatives increases.
Funds, and Other. Using this data, we find that dealers are on average net short futures in US markets, and their positioning is strongly negatively correlated with end-user positioning in futures, consistent with dealers providing liquidity to end-users demanding futures exposure. As predicted by the theory, dealer net positioning in futures is strongly negatively related with the futures-spot basis, while end-user net positioning is positively related with the basis, both cross-sectionally and in the time-series. Additionally, we find a substantial correlation of time-variation in dealer positioning across equity indices, suggesting that commonality in the futures-spot basis may partially be driven by commonality in time-variation in end-user demand for different equity indices. We also find that end-user positioning in futures is negatively correlated with our measures of index security lending utilization and security lending fees, consistent with the story that we tell for the relationship between security lending utilization and the futures-cash basis.

We further explore the nature of the end-user demand driving the futures-spot basis by considering the relationship between the basis and expected returns. We explore this relationship in conjunction with another well known violation of the law of one price, violations of covered interest rate parity (CIP) in currency markets. Similar to the link we document between the basis, end-user demand, and intermediary financing costs, Du et al. [2017] document violations in covered interest rate parity and link such violations to costs arising from bank balance sheet constraints, while Borio et al. [2016] also document violations of covered interest rate parity and link such violations to demand for currency derivatives by banks, institutional investors, and non-financial firms seeking to hedge their currency exposure. In both currency and equity index futures markets, we find that the futures-spot basis strongly negatively forecasts returns; markets where futures are cheap relative to their spot-implied fair value tend to underperform markets where futures are cheap relative to their spot-implied fair values. While related to other predictors documented in the literature, most notably carry (Koijen et al. [2016]), the returns to a diversified mispricing strategy that goes long cheaply priced futures and short expensively priced futures within an asset class earns significant abnormal returns, at 50 basis points per month, with an annualized Sharpe ratio of 1.21 and an annualized information ratio of 0.91 when controlling for exposure to other known return predictors. Furthermore, the returns to the mispricing portfolio are a multiple of the expected profits from futures simply converging to their spot-price implied fair values, indicating that the futures-spot basis negatively forecasts returns in

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9 These designations come from Form 40 filings mandatorily completed by reportable traders by the CFTC. The CFTC expounds on these designations, describing Dealers/Intermediaries as participants that “tend to have matched books or offset their risk across markets and clients.” These include large banks (U.S. and non-U.S.) and dealers in securities, swaps, and other derivatives.” The Institutional Asset Manager designation, meanwhile, includes “pension funds, endowments, insurance companies, mutual funds, and portfolio/investment managers whose clients are predominantly institutional,” while Leveraged Funds are described as including “hedge funds and various types of money managers, including registered commodity trading advisors (CTAs); registered commodity pool operators (CPOs) or unregistered funds identified by the CFTC.” The “Other” category includes traders not included in one of the former three categories, who “mostly are using markets to hedge business risk, whether that risk is related to foreign exchange, equities, or interest rates.”

10 The Russell 2000 index is the exception, where dealers are net long the futures and end-users are net short.
the spot market in addition to negatively forecasting returns in the futures market. Put differently, the
source of the return predictability of the described mispricing strategy is distinct from the returns to a
cash-and-carry arbitrage trade. Returning to Figure 1, the figure illustrates that when end-users in futures
markets demand liquidity, liquidity providers in the spot market facilitate the trade by meeting the hedging
demand of futures dealers, taking on adverse selection and inventory risk as they hold exposures opposing the
futures end-users. Given the relationship between end-user demand for futures and the basis, part, but not
all, of the profitability of the mispricing strategy appears to be consistent with liquidity providers receiving
compensation for providing liquidity to meet end-user demand in futures markets, as suggested by models
of liquidity provision such as Grossman and Miller [1988]. Consistent with the liquidity provision channel,
we show that the component of the mispricing strategy that is related to changes in mispricing (and, by
proxy, changes in liquidity provider inventories) loads negatively on volatility risk, and market and funding
liquidity risk. An additional explanation for the profitability of the mispricing strategy may come from
persistent end-user demand for particular equity indices or currencies. Jiang et al. [2017] present a related
analysis to our paper, finding that the treasury-based dollar basis, a measure of covered interest rate parity
violations measured using forward rates, spot rates, and government bond yields, negatively predicts future
dollar returns. They attribute their results to a convenience yield that investors impute to US treasuries as
a safe asset versus government bonds in other countries.

Jointly, the facts that we present paint a picture of the dynamics at play in the relative pricing of
equity index futures and their underlying markets. Particularly, equity futures become rich relative to
their underlying as equity markets trend upwards, with dealers facing increasing financing costs to provide
liquidity for end users, while futures become cheaper as markets trend downwards, with more end-users in
cash and futures markets demanding short exposure and easing the hedging costs that dealers face. Given
the commonality in return patterns across global equity markets\(^{11}\) and the commonality in end-user demand
for futures across indices, we observe common time-series variation in futures bases across indices. Capital
from institutional investors and hedge funds, whom one might expect to step in to close the basis, is often
invested in the direction of the basis, potentially explaining why arbitrage capital does not close the basis.
Furthermore, while the basis rises contemporaneously with markets, the basis also negatively forecasts future
returns, which is partially explained as compensation to liquidity providers in these markets.

In addition to our paper’s relationship with already mentioned works, our paper contributes further
evidence to the literature that highlights the important role that intermediaries and financing frictions
play in determining asset prices across a variety of asset classes. On the theory side, Shleifer and Vishny
[1997], He and Krishnamurthy [2013], Brunnermeier and Sannikov [2014] present models that propose that
\(^{11}\)For example, see Bekaert and Harvey [2000], Quinn and Voth [2008]
intermediaries play an important role in determining asset prices, while Brunnermeier and Pedersen [2008], Duffie [2010] present models that highlight the importance that funding frictions can play in asset prices. Etula [2013], Adrian et al. [2014], He et al. [2017] present evidence consistent with intermediaries being the marginal investor across a variety of asset classes, including commodities, corporate and sovereign bonds, currencies, and derivatives. While the primary focus of most of the intermediary asset pricing literature has been on the US, our paper considers intermediary financing costs in global markets and presents evidence that suggest the importance of intermediaries in international markets as well\textsuperscript{12}. Our paper also contributes further evidence to the existing literature that considers the impact of end-user demand and dealer risk-bearing capacity on asset prices (Grossman and Miller [1988], De Roon et al. [2000], Bollen and Whaley [2004], Hendershott and Seasholes [2007], Hitzemann et al. [2016], Drechsler et al. [2018]). Additionally, our paper contributes to the literature that documents violations of the law of one price and links such violations to financial frictions across various asset classes, including equity index options (Longstaff [1995], Bondarenko [2003], Constantinides et al. [2008], Garleanu et al. [2009], Lou [2014]), currencies (Garleanu and Pedersen [2011], Borio et al. [2016], Du et al. [2017]), CDS/bonds (Duffie [2010], Garleanu and Pedersen [2011]), TIPS/treasuries (Fleckenstein et al. [2014]), and corporate bonds (Lewis et al. [2017])

Two papers are most closely related to our results linking the futures-spot basis with intermediary financing constraints and end-user demand for futures exposure. Du et al. [2017] present evidence on violations of covered interest rate parity in currency markets and link these to intermediary financing constraints and end-user demand to execute the carry trade. Lewis et al. [2017] present evidence of mispricings in FDIC insured corporate bonds, and link these mispricings to theories regarding funding frictions and intermediary constraints. Our results presents complementary evidence to these works by considering how end-user demand and financing frictions relate to violations of the law of one price in equity index futures markets, some of the most liquidly traded markets in the world.


The rest of the paper proceeds as follows. Section 2 presents the methodology and data used for calculating the basis. Section 3 presents summary statistics and analysis on the basis. Section 4 links variation in the basis with the security lending market. Section 5 analyzes the basis in relation to dealer and end-user

\textsuperscript{12}Chougosakes [2017] presents evidence in the spirit of Adrian et al. [2014], He et al. [2017] that suggests that an intermediary stochastic discount factor (SDF) that incorporates information from an international set of intermediaries can price a variety of international portfolios.
positioning. Section 6 presents evidence on the relationship between the futures-spot basis, covered interest rate parity violations, and expected returns in currency and equity index futures markets. Section 7 concludes.
References


Wujiang Lou. Extending the black-scholes option pricing theory to account for an option market maker’s funding costs. 2014.


Figures

Figure 1: Mechanics of Futures Trading