

The Future of Inflation Futures

Michael Ashton, CFA

Enduring Investments LLC

12 Ironwood Road

Morristown, NJ 07960

m.ashton@enduringinvestments.com

December 4, 2014

Abstract:

Various futures exchanges have considered launching two new futures contracts related to inflation: a Consumer Price Index (CPI) futures contract and a deliverable TIPS futures contract. These contracts would be new in an obvious sense, but inflation-related futures are not a new idea. Since at least the 1970s, economists have anticipated that these instruments would one day be available. Several previous attempts, dating back to as early as the mid-1980s, have failed for various reasons – too early, too different, bad structure. So why are futures exchanges considering new versions of these contracts, when prior experience has been consistently negative? Are these contracts important, in some larger sense? What can we expect from a successful futures market? How will these contracts be valued, how will they trade, and how can they be used? This paper will examine each of these questions, and address a couple of persistent critiques that have been made about these instruments. At root, inflation futures are important for the health of the liquidity ecosystem in inflation markets and in rates markets themselves. Adding these products will likely increase the volumes and the liquidity of all inflation products, as well as giving policymakers a better window into inflation expectations.

In 2012, the Chicago Mercantile Exchange (CME) had discussions with market participants about the possibility of launching two new futures contracts related to inflation: a Consumer Price Index (CPI) futures contract and a deliverable TIPS futures contract. While the CME has not yet decided to launch such products, other exchanges are also looking at the possibility of launching inflation-related futures if the CME demurs. These contracts would be new in an obvious sense, but they are also conceptually similar in some ways to prior contracts that various exchange(s) have listed in the past, but that have failed:

In July 1997, the Chicago Board of Trade listed 5-year and 10-year TIPS futures contracts, and added 30-year TIPS futures in April 1998. The contracts were de-listed in 2001. The contract failed mainly due to a paucity of deliverable issues – when the 5-year TIPS futures were readied for trading, there were no 5-year TIPS in existence nor did the Treasury have any plans to issue them. Also, the cash issues that *did* trade were quite illiquid compared to nominal Treasuries, and the CBOT also failed to appreciate the difficulty of deriving a forward price for TIPS.

In June 1985, the Coffee, Sugar, and Cocoa Exchange (CSCE) in New York offered a CPI futures contract indexed to the CPI for Urban Wage Earners and Clerical Workers (aka the CPI-W), in a form very similar to what the CME most recently proposed¹ and with maturities extending out three years.² The novelty of the contract, the fact that the financial futures markets themselves were still developing, and the fact that there were no other instruments indexed to CPI at the time, all contributed to the contract's eventual de-listing.

In February 2004, the CME launched Consumer Price Index (CPI) futures. The contracts were designed to echo the structure of Eurodollar futures, so they traded on a price defined as 100 minus the annualized quarterly inflation rate. Three years of quarterly contracts were listed. There was only one market maker of the contract at launch³ up until the time the contract died, and this was surely one cause of its demise. The structure did not match the needs of the underlying cash market, nor of the inflation derivatives market that developed at almost exactly the same time. The CME later tried a different approach by listing a single year of twelve monthly expiries that tracked year-on-year inflation. This design modestly suited the derivatives market, but almost no one else, and that contract also vanished quickly.

So why are exchanges considering the listing of new versions of these contracts, when prior experience has been consistently negative? Are these contracts *important*, in some larger sense? What can we expect from a successful futures market? How will these contracts be valued, how will they trade, and how can they be used? This paper will examine each of these questions, and address a couple of persistent critiques that have been made about these instruments.

Why Inflation Futures Matter

It is a fact of financial life that most mature markets enjoy three legs of a liquidity ecosystem:⁴ cash markets, over-the-counter (OTC) derivatives, and exchange-traded derivatives. For example, in the nominal interest rates market Treasuries provide a deep and liquid cash market, there is a large and

¹ The CME contract would settle to the broader CPI-U, which is the same index used for TIPS and inflation swaps.

² Quarterly on a January, April, July, and October cycle for the first year, and semiannually on a January/July cycle for the next two years.

³ This author was that market-maker, during his tenure at Barclays Capital.

⁴ I am indebted to Keith Black for his suggestion of this term.

well-functioning market for LIBOR swaps, and there is efficient and transparent pricing in the futures markets as represented by Bond, Note, 5-year Note, 2-year Note, UltraBond, and Eurodollar contracts.

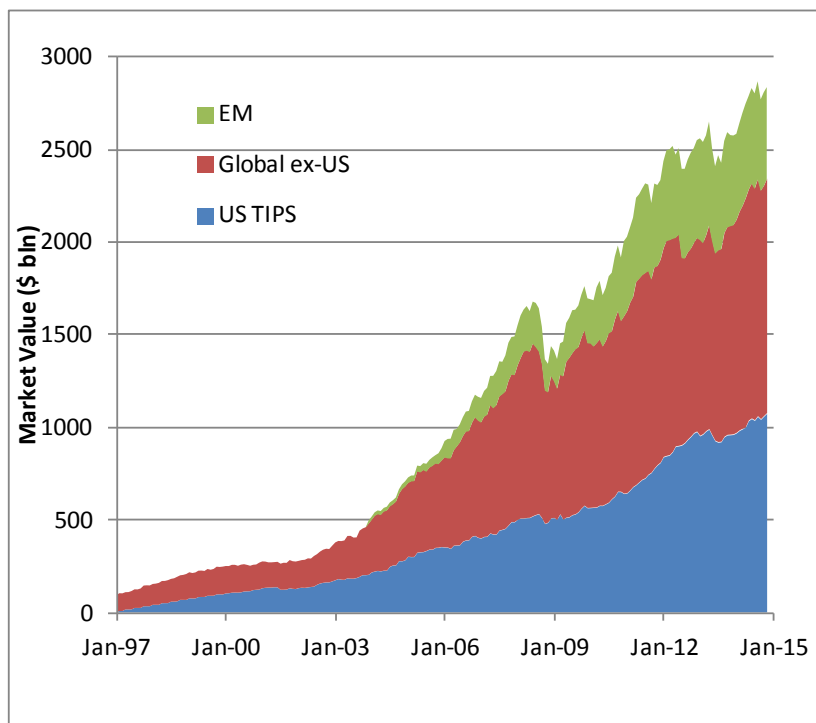
The presence of three legs, rather than only one or two, in this ecosystem is important. With two legs, there are only two directions of liquidity transmission: A to B and B to A. But with three legs, there are six ways that liquidity can be transferred: A to B, A to C, B to A, B to C, C to A and C to B. By adding the third leg, the avenues of liquidity transmission aren't increased 50%, but threefold.

This richer liquidity ecosystem matters the most in crisis situations, such as during the credit crisis of 2008. Consider that during the crisis, credit and inflation markets became quite illiquid at times while equities, nominal rates, and commodities remained liquid. The main difference between these two sets is that the latter three markets all have cash, OTC, and exchange-traded instruments while the former two markets have only two (in both cases, cash and OTC derivatives).

Accordingly, while the inflation-linked bond market has become truly huge (Exhibit 1) and the inflation-linked swap market has enjoyed an almost uninterrupted rise in volumes since 2006 (Exhibit 2), investors need the third component of the ecosystem: exchange-traded futures contracts on inflation and/or real rates. It is interesting to note that one analysis of the original CPI futures contract traded on the CSCC suggested that a prime cause of the contract's failing was that "...the CPI futures market, unlike other futures markets, has no underlying asset which is storable or traded on an active spot market, which reduces the opportunities for arbitrageurs and speculators to participate in the market." (Horrigan, 1987)

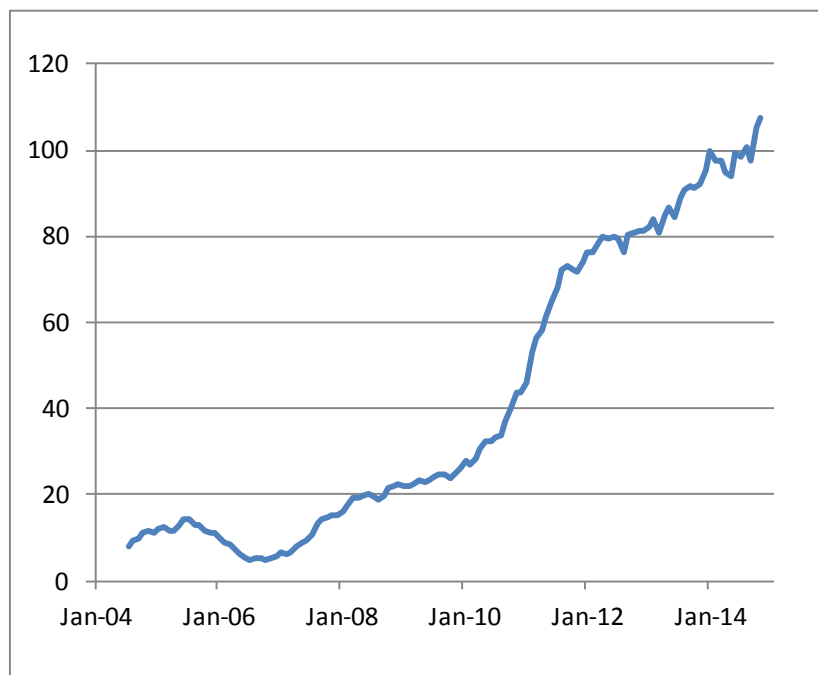
Adding these products will likely increase the volumes and the liquidity of **all** inflation products, which liquidity will also remove the main lingering concern among those investors who have not yet made meaningful investments in the market.

Exhibit 1 - Market Value of Inflation -Linked Bonds Globally⁵



⁵ Source: Barclays Capital

Exhibit 2 - Rolling 12-month Interbank Derivatives Volume, \$bln⁶



Previous Research

The first authors to propose a CPI futures contract were Michael C. Lovell and Robert C. Vogel (1973), in a paper which demonstrated some of the potential uses of such an instrument – for example, to “allow the conversion of monthly pension payments of fixed nominal value into a constant flow of purchasing power.” They also perceived that what they called “constant-purchasing-power bonds,” which had principal and interest tied to a cost-of-living index, were effectively fully-funded portfolios of inflation futures contracts. As an aside, they also suggested that CPI Futures contracts ought not merely trade on the basis of headline inflation, but “to have markets quoted in components of the CPI index.” (Ibid.)⁷

Other authors followed. Kurt Dew (1978) discussed CPI futures in the context of the novel proposal (for the time) of a Dow Jones Industrial Average futures contract. Ederington (1980) issued a proposal for new futures and options markets linked to CPI. He perceived that such contracts not only would provide “a continuous measure of consensus expectations regarding inflation,” but also may encourage indexation itself because they would facilitate the transfer of inflation risk to the speculator willing to bear it. Writing in the midst of the biggest non-war inflation spike in American history, Ederington was motivated in his proposal by the need to “alleviat[e] the pain and suffering that inflation generates,” and he suggested that creating this market would help do just that.

In 1983-84, a couple of Nobel laureates registered their views. Samuelson (1983) wrote a short treatise on behalf of the Coffee, Sugar, & Cocoa Exchange, which was significant since fewer than two years later

⁶ Source: BGC Partners

⁷ Interestingly, in 2013 Deutsche Bank began to offer swaps in an index designed to replicate reasonably closely the performance of Core CPI, the first meaningful effort to fulfill Lovell and Vogel’s suggestion of almost forty years ago and Friedman’s of nearly thirty years ago.

the CSCE would actually list such a futures contract as noted above. Shortly thereafter, Friedman (1984) discussed the concept (which, as he pointed out, dates to the nineteenth-century concept of “tabular standards” introduced by W. Stanley Jevons and named such by Alfred Marshall) in generous tones, while observing that “indexation has been extensive only when inflation has been extremely high and variable as in some South American countries and Israel – and has generally fallen into disuse when inflation has been conquered.” Furthermore, he echoed Lovell and Vogel in suggesting that “a variety of such indexes” might become popular: “There would presumably be futures in the consumer price index, perhaps in the producer’s price index, perhaps in components of the one or the other, such as, for example, construction costs or prices of metals and their products.”

There is no prior research on TIPS futures, although there is ample research on bond futures (see for example Burghardt, Belton, Lane, & Papa (2005)), on the embedded delivery options thereof Rendleman (2004), and on TIPS themselves - as a small sample of the latter, consider Simon and Hunter (2002), Roll (2004), Siegel and Waring (2004), Chu et. al. (2011), and Grishchenko et. al. (2010).

New Contract Specifications

The most-recently proposed contract details from the CME are presented in the Appendix. Note that none of these specifications are “final,” and as yet no launch date has been scheduled by any exchange.

CPI Futures

The CPI futures differ markedly from the prior attempts at structure. The most-recent two CPI contracts were both based on inflation rates, which introduced several issues.

First, the quarterly contracts traded at very different prices because of the seasonality of the underlying price dynamics. Instruments based on the Consumer Price Index, including both TIPS and inflation swaps, use the Not-Seasonally Adjusted index, which means that the natural undulations of price dynamics (for example, the tendency of prices to rise more quickly in the summer and to decline outright in December) are not corrected by seasonal adjustment factors. Therefore, a quarterly contract that covers the September, October, and November CPI prints would trade at a higher implied inflation rate than the contract that covers December, January, and February. These optics were accentuated by the quarterly structure, since the rate was multiplied by four to annualize.

More importantly, the fact that the initial setting of a deferred contract was not known until three months before the contract’s expiry created sticky convexity issues and complicated the use of the contract for hedging purposes (especially since there was no easy way to isolate a *single* month’s CPI print). While the second version of the contract corrected this issue, by trading only annual rates for twelve months – so that the starting index value was always known – the use of the rates analogy meant that only one year’s worth of contracts could be listed without re-introducing this problem.

The new specifications, however, correct these flaws by having the contract settle to an index value, just as the extremely successful S&P futures do and as the 1985 CPI-W contract did. The section on valuation will explain why this structure ties the contract much more closely to other existing inflation-indexed instruments.

TIPS futures

The contract design for 10-Year TIPS futures should be familiar to any futures veteran. The specifications call for the physical delivery of a notional quantity of TIPS bonds with a remaining maturity between eight years and ten years, as of the first day of the delivery month; the price which the buyer pays on

delivery is determined by the CME's invoice pricing system to be the exchange-determined "conversion factor" times the futures price, plus the accrued interest on the bond. The main differences in the TIPS contract from the late-90s version and the Treasury Note contract of today are (1) the delivery basket is narrower for the current TIPS contract; contract grade for the Note contract calls for bonds of *seven* to ten years remaining maturity rather than *eight* to ten years, and (2) the conversion factor for the TIPS contract is based on a real yield of 0% rather than the 6% nominal yield of the Note contract.

Both of these specification details will have the tendency to lengthen the effective duration of the TIPS contract by increasing the tendency for longer-maturity bonds to be delivered.

How These Contracts May Be Used

What is interesting about these contracts is not necessarily the contracts themselves, but how they would fit into the financial market taxonomy – how they would enrich the set of possible investment alternatives. Of course, any new instrument adds the possibilities of being "long the instrument" or "short the instrument," but a successful new instrument broadens the opportunity set appreciably further by means of its interactions with other instruments. While this section by no means exhausts the possibilities, several strategies that will be newly available as a result of the launch of these futures contracts are discussed below.

TIPS basis

Obviously, the interaction of the futures contract with its cash counterpart is a crucial consideration in the design and launch of a new contract. By making the TIPS futures contract deliverable, the CME created the same relationship between cash TIPS and the TIPS futures as exists for the Bond futures versus cash bonds, and for the 10-year Note, 5-year Note, 2-year Note, and Ultra contracts versus their deliverable baskets.

The difference between the cash price of a deliverable bond and the futures price, adjusted by the factor of the bond, is called the bond's *basis*. In the nominal bond world, basis is traded both implicitly, when a bond trader hedges with futures, and explicitly when the basis itself is traded between two counterparties, who then assign futures and cash prices and execute an "Exchange For Physical" (EFP) transaction to effect the trade. Much has been written about the bond basis, including Rendleman (2004) and Burghardt, Belton, Lane, and Papa (2005).

The bases of the deliverable TIPS will operate similarly, with a few important valuation caveats discussed in a later section. What is worth mentioning here, though, is the probable effect on the liquidity of the off-the-run TIPS. The liquidity of off-the-run nominal Treasuries has been greatly enhanced over the years by the liquidity of the futures contracts and the ease of trading the basis directly, in size. Deliverable off-the-run TIPS, which are presently much less liquid than on-the-run TIPS, would probably gain substantial liquidity by this agency.

Forward TIPS

It may seem odd, but it is currently not easy to trade forward TIPS. The reason that this is so is relatively straightforward. Recall that to create a forward nominal bond, one need only buy a bond in the spot market and enter into a repurchase agreement (repo) to lend the bond and borrow cash to the desired forward date. Then the forward price of the bond is simply the spot price minus the bond's carry over that horizon, or

$$\text{Price}_{\text{forward}} = \text{Price}_{\text{spot}} - (\text{Accrued Interest earned}_{t_0 \rightarrow t_1} - \text{repo interest paid}_{t_0 \rightarrow t_1})$$

But for an inflation-linked bond, this becomes problematic. The accrual of the bond's value, if it is an inflation-linked bond, depends upon not only the stated coupon rate but also the realized inflation over the holding period. Accordingly, for short forward dates during which the accrual factors are known (due to the slight lag associated with the indexing of a TIPS bond's notional value to CPI), a forward price is calculable since it is effectively a nominal bond over that period. That is, since no future change in the price index can affect the accrual which has already been scheduled, it can be treated like a nominal bond for all intents and purposes and forward prices and yields calculated on that basis.

But the situation changes when the forward date takes us into a period for which the inflation accrual has not yet been determined. We can still *estimate* a forward price, by guessing at what inflation accrual will occur, but we cannot *create* an arbitrage-free forward bond. In the above example, the dealer asked to bid or offer Treasuries forward can show a tight two-way price based on the tight spot market price of the bond and the fairly tight market in term repo. But the same dealer cannot offer a tight two-way price in forward TIPS, because the forward cannot be fully hedged. If a dealer agrees to deliver TIPS to a customer at a given forward price, and the dealer hedges by buying TIPS and reposing them out to the forward date, then the dealer has naked exposure on the inflation accrual. This happens because the dealer is financing an inflation-linked bond using nominal repo rates – if there were inflation-linked repo rates, the problem would not exist.

Once CPI futures begin to trade, however, a dealer will now be able not only to *estimate* the forward price of a bond, but actually to create such a bond by buying TIPS, reposing out the bond, and selling CPI futures to lock in the market's expectations of the future inflation accruals. The implications of this seemingly small development are on the contrary quite large. The ability to create forward TIPS is important for arbitrageurs who keep the TIPS contract in line with fair value, and critical for buyers and sellers of options on TIPS. To date, the market for "TIPTions" has been small and short-dated, but the launch of the CPI futures contract should eventually have a profound effect on the liquidity of the inflation-linked bond options (and inflation swaptions) market.

Seasonality Discovery

To date, all CPI-linked products have been tied to the not-seasonally-adjusted (NSA) version of the CPI index. This is proper, since an investor in such products is exposed to the actual price change that occurs, not to the price change adjusted by the 'normal' price change at this time of year. However, since prices in the U.S. follow a distinct seasonal pattern, in which they tend to rise in the summer and decline late in the year,⁸ the TIPS yield curve and inflation swaps curves display unmistakable undulations (see Exhibits 3 and 4 in later sections).

These undulations are, however, mere estimates of what future seasonality is expected to be. Since the persistence of the seasonal pattern is strong but not immutable, some traders believe that the amplitude of expected seasonality ought to gradually dampen out at longer maturities. In practice, what happens is that the 'expected' seasonality is propagated throughout the curve at a constant relative amplitude, but the confidence of traders in the curve (away from the integer-year points, which trade in the inflation swaps market) grows lower for more-distant swap maturities. This contributes to wider bid/offer spreads and therefore to higher unwind costs for odd-period inflation swaps, as the trader is forced to be increasingly conservative about the seasonality assumption.

⁸ Other countries' prices also experience seasonal undulations, but interestingly each country and/or region has seasonality that is distinctly different.

The over-the-counter broker swap market has developed an awkward solution to this problem for short-dated exposures; one interbank broker conducts a periodic call auction at which dealers submit mid-market quotes for one-year inflation swaps maturing each month for the next twelve months; two-year inflation swaps maturing in each of the following twelve months; and three-year inflation swaps maturing in each of the twelve months from year 2 to 3. Since the denominator in each case is known, this effectively becomes a market on the final price index for each month going out for three years. The broker computes a consensus mid-market quotation; in a second round of the auction dealers can transact at those prices if there are offsetting interests.

Once the CPI futures are trading, year-one seasonality will be explicitly discovered in the market because the first twelve contract months will trade, and semiannual seasonality will be apparent in the June and December contracts listed for ten years. This does not fully solve the problem, especially since the first twelve contracts will have other idiosyncratic factors (a gasoline price spike, for example) that obscure the seasonal pattern, but it *will* increase the granularity of seasonality observations.

Exchange-Traded Breakevens

In a 'breakeven' trade, an investor who wants to profit when inflation expectations are rising (falling) may buy (sell) a cash TIPS bond and sell (buy) a cash nominal Treasury bond of approximately equal maturity. In principle, a breakeven trade ought to be more liquid than an outright TIPS trade, because instead of having outright rate risk the counterparties to the trade have only the spread risk.⁹ This is often true, but on occasion – such as during the peak of the crisis in 2008, when some off-the-run Treasury securities became so hard to source that the Treasury had to do selective taps of off-the-run securities to relieve fails in the repo market - off-the-run breakevens become *less* liquid than TIPS outright because a breakeven position has two (potentially idiosyncratic) cash bonds rather than only one.

A bigger problem with using breakevens to effect an opinion on the direction of inflation expectations is that some types of investors have difficulty shorting bonds. The reverse repo leg of a short sale generates Unrelated Business Taxable Income (UBTI), which is radioactive to ERISA accounts. However, the selling short of a futures contract does not generate UBTI, which makes it more attractive for these accounts to take short positions in futures than in cash.

For these reasons, it may be more attractive for some investors to establish a breakeven trade with futures. For example, an investor who wishes to be long breakevens and to profit when inflation expectations rise might buy TIPS futures and short 10-year Treasury Note futures instead of doing the trade in the cash markets. This trade is not without complexity of its own; because the different contracts have a different range of maturities in the delivery basket and may often trade to different effective durations based on whether the longer deliverables or the shorter deliverables are currently cheapest-to-deliver, a futures breakeven trade may not trade in lockstep with the desired inflation expectations. However, as noted above the 'traditional' breakeven trade also has drawbacks; the exchange-traded version at least creates an alternative that some investors, at some times, will prefer.

⁹ This is, however, less obvious than it appears, for both real rates and expected inflation (proxied here by breakevens) appear on the right-hand side of the Fisher equation $(1+n)=(1+r)(1+i)(1+\rho)$; it isn't *a priori* clear from theory whether real rates (r) or expected inflation (i) naturally has less volatility. As it happens, over most time frames in the last 15 years real rates have been significantly more volatile than breakevens, which is why a breakeven trade "ought" to be less volatile in VAR terms and hence, it should be easier to move size.

Exchange-Traded Forward Real Rates

As noted above, trading forward TIPS has previously been difficult to do. With the advent of these futures contracts, however, not only can forward TIPS be created but a whole yield curve of forward real rates. By spreading two CPI futures contracts against each other, a forward inflation rate can be computed; this can be compared to forward nominal rates constructed from strips of Eurodollar futures in order to construct an entire forward real yield curve.

For example, suppose that on August 24, 20X1 the December 20X1 CPI contract was at 230.33 and the December 20X2 CPI contract was at 235.97. An investor can conclude from this that inflation for November 20X1-November 20X2¹⁰ is expected to be $235.97 / 230.33 - 1 = 2.45\%$, and can lock in this rate by buying (or selling) the spread.

At the same time, suppose that the following prices exist in the Eurodollar futures market:

December 20X1:	99.615
March 20X2:	99.615
June 20X2:	99.595
September 20X2:	99.585

These four prices imply that the forward nominal rate priced in the market from mid-December 20X1 to mid-December 20X2 is 0.398%, and an investor can lock in that rate by buying or selling the strip.

Therefore, if an investor expects forward real rates for the period from November 20X1-November 20X2 to decline, then he or she can buy the Eurodollar strip shown above and sell the Dec 20X1-Dec 20X2 CPI contract spread (that is, sell the December 20X1 and buy the December 20X2 contract). As expectations for real rates decline, then either nominal rates will decline, inflation expectations will rise, or some combination of such factors.

This example is meant as an illustration only, and abstracts from some indelicate complexities. For instance, the end dates of the strip do not match up with the end dates of the CPI period, so some stub calculation would be required in this case.

More importantly, calculation of forward rates based on futures contracts requires an adjustment for convexity.¹¹ The convexity of Eurodollar futures contracts has been amply discussed in the literature; as a small subset see Burghardt (1994) and Pozdnyakov and Steele (2009). There is no such richness in the literature, yet, on inflation convexity, but for a reasonably direct treatment see Peng (2006).

Valuation Considerations

The sections above have mentioned a number of issues involved in assessing the fair value of these new futures contracts; this section addresses these issues more directly.

CPI Contract

Because of the structure of the CPI contract, valuing the futures will be much more straightforward than with efforts in the past. This is because the contract now looks very much like other inflation-indexed structures, and such structures actually trade regularly now.

¹⁰ Incorporating the 1-month lag in the release.

¹¹ No such adjustment is needed for the futures contract itself, because the structure makes the payoff analogous to that of an inflation swap; and, since the two instruments are now margined similarly, there are no important differences in margining.

To see this connection, first consider the structure of a zero coupon (ZC) inflation swap. In a ZC swap, there is only one exchange of flows. At the end date of the swap, the fixed-rate payer pays a fixed rate that is compounded for the life of the swap; the inflation payer pays total compounded inflation over the life of the swap.

Fixed-Rate Payer: $\text{notional} * (1 + r)^{\text{tenor}}$

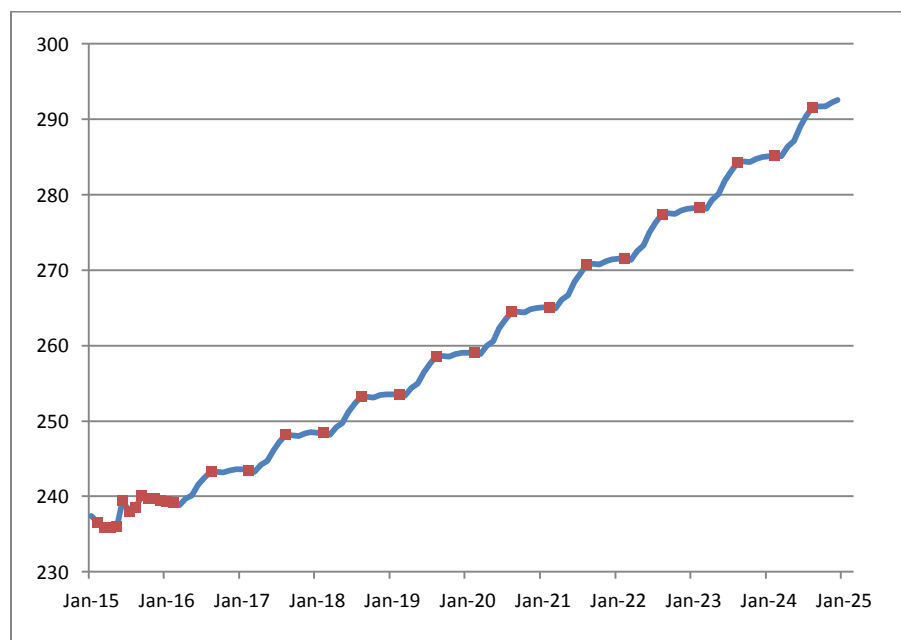
Inflation Payer: $\text{notional} * (\text{CPI}_{\text{end}}/\text{CPI}_{\text{begin}})$

Since $\text{CPI}_{\text{begin}}$ is set when the swap is consummated, and the rate r is the detail on which the swap is traded and therefore *also* known in advance, it should be apparent (since only unknown parameter remains) that an at-the-market ZC swap is essentially a transaction based on the terminal index value only. The mark-to-market value of a ZC swap is the present value of the difference between the contracted CPI index level and the market's current expectation of the index level for that date. Therefore, in most respects an inflation swap looks very much like a CPI futures contract, except for the fact that it is actually *quoted* on the basis of the compounded rate that causes the NPVs of both sides to be equal.

To evaluate the fair value of a CPI futures contract that expires in December of 2016, for example, begin by extracting from the inflation swap curve the expected CPI index value for the November, 2016 CPI release. Because of the way the Treasury maps CPI index values for the purpose of computing TIPS inflation accretion, which by default has become the way the inflation swaps market maps CPI index values for the purpose of ZC swap arrangements, the November 2016 CPI index value corresponds to the terminal index on a February 1, 2017 ZC CPI swap.

Exhibit 3 below shows the CPI curve as it existed on December 4, 2014. Note the undulations in the implied index value over time. This corresponds to the expected annual seasonality, and is one important wrinkle to be aware of in the construction of an inflation swaps curve.

Exhibit 3 – CPI Swap Curve on December 4, 2014¹²



¹² Source: Enduring Investments LLC.

The squares correspond to dates associated with CPI futures expiry: monthly for one year, then June and December expiries, implying May and November CPI prints, which in turn implies August 1 and February 1 points on the CPI curve.

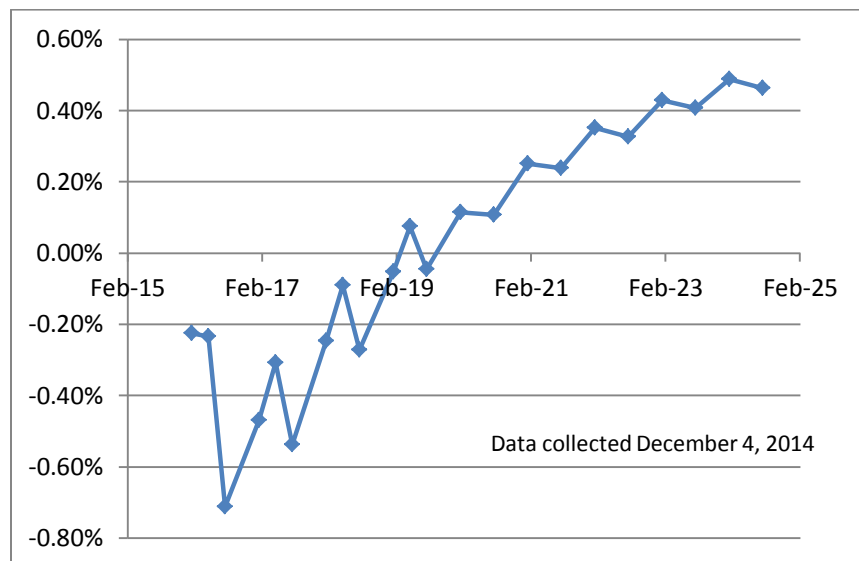
Notice that in general, the June-Dec spread will be expected to be lower than the Dec-June spread, because of the typical seasonality of the price level. As noted in a section above, tracking how these spreads vary will give important clues as to the pricing of seasonality in the marketplace, even if it does not allow full discovery of seasonality.

Astute readers will observe that the short end of the inflation curve does not appear to be as smooth as many parts of the rest of the curve. This may occur because the fair value of short-dated contracts will be heavily influenced by arbitrage available against other markets, in particular energy futures markets, that inform the pricing more than does the static seasonality assumption. Most of the short-term volatility in the inflation index is due to fluctuations in energy prices, which have much greater volatility than many more important items in the consumption basket (e.g., shelter). Consequently, valuation of the shorter CPI futures contracts will have to lean very heavily on signals from energy markets, and on estimating the degree of pass-through of price movements in other consumption items.

TIPS Contract

One interesting aspect of TIPS futures is the way the delivery basket will evolve not merely as a function of yield curve slope and maturity, but also responding to changes in the market's evaluation of seasonal patterns and the value of embedded floors in the TIPS structure. TIPS, even more than Treasuries, are very idiosyncratic, albeit in some fairly predictable ways. Exhibit 4 shows the TIPS yield curve out to ten year maturities. Obviously, only the 8-10 year part of the curve is deliverable, but the undulations of the curve as a whole will help make the following point.

Exhibit 4 – TIPS Yield Curve, December 4, 2014, 1-10 years¹³



The undulations in the TIPS curve reflect two different phenomena. First, because the price index itself tends to fluctuate with a regular seasonal pattern, inflation-linked bonds that mature in April tend to

¹³ Source: Bloomberg. I have omitted bonds with a maturity less than 1 year to maturity.

trade cheap (higher yields) to those that mature in January or July.¹⁴ For example, on December 4th, 2014 the yield on the April-2019 TIPS was +0.075%, while the yield of the January-2019 TIPS was -0.052% and the yield of the July-2019 TIPS was -0.045%.

Since the futures contract does not distinguish between maturities, as a result of this effect certain maturity months will tend to be closer to CTD than other months. Exhibit 5 shows the calculated bond bases as of December 4th, 2014, based on a hypothetical TIPS futures price of 106-13, for the bonds that would have constituted the deliverable basket into that contract:

Exhibit 5 – Bond Basis Analysis for Hypothetical June TIPS Futures Contract, December 4, 2014

Coupon	Maturity	Price	Factor	Basis ¹⁵ (% of par)	Carry (% of par)	Net Basis (% of par)	Implied Repo
0.375%	Jul 2023	99-22¾	1.0305	1.86	0.04	1.81	-2.66%
0.625%	Jan 2024	101-06+	1.0539	1.10	0.17	0.94	-1.14%
0.125%	Jul 2024	96-26¾	1.0114	0.74	-0.08	0.82	-1.09%
2.375%	Jan 2025	118-02+	1.2285	1.73	1.28	0.46	0.09%

Based on the Implied Repo column, the January 2025 TIPS (which is an old 20-year bond) would be cheapest-to-deliver.¹⁶ Note immediately the heterogeneity of the deliverable basket. Because of the high coupon, the modified duration of the Jan '25s is actually **shorter** than that of the July '24s (9.11 vs 9.53), but because of the much greater accretion that the Jan '25s have had since issuance the DV01 of the Jan '25s is much **higher** than that of the July '24s (\$1361 vs \$925). What is more unusual is that the second-cheapest bond is the longest-duration, current on-the-run bond (Jul '24s). With various configurations of curve slope and seasonality preferences, the behavior of the deliverable basket for TIPS futures will be dynamic.

Another interesting effect, although not apparent at the moment, will manifest when inflation expectations are very low. The principal redemption amount of a TIPS security is tied to the price level, but only if the price level rises during the period during which the bond is outstanding. If the price level actually falls, the investor is assured of receiving par back in *nominal*, rather than in real terms. Since a nominal dollar is worth more than a real dollar, conditional on the price level having fallen over the observation period, this adds extra value to TIPS when this “principal floor” is perceived as having some chance of ending up in-the-money. Different TIPS have floors that are different amounts out-of-the-money; for example, as of December 4th, 2014 the January 2024 TIPS had an inflation ratio of 1.01981 while the January 2025 TIPS had an inflation ratio of 1.26238. This difference occurred because, between the base date of the January 2025 bond, in 2005, and the base date of the January 2024 bond, in 2014, prices rose about 23.8% (about 2.16%/year).

¹⁴ Of course, the real yield curve *ought* to be smooth and rather the nominal curve should show the undulations, reflecting the fact that nominal dollars received in November, in most years, will buy more than dollars received in the following January. But investors have evolved to believe that it is the nominal curve which should be smooth.

¹⁵ Note that the basis, carry, and net basis columns are in inflation-adjusted amounts, rather than in terms of the clean price. To avoid confusion, these are showed in points of nominal par, rather than in 32nds as is traditional with nominal Treasury futures.

¹⁶ It is even more important to rank by breakeven repo in TIPS futures than in nominal Note futures, because the full prices of the bonds include not only accrued interest and differences of the clean prices from par but also an inflation accretion to par. This means the par amounts financed can be very different, and hence the return on investment very different, even for similar net bases.

The difference in the value of these two floors is negligible at the moment as both are worth approximately zero. With the inflation curve expecting 2.1% inflation for the next ten years, even the nearer option is approximately 25% out-of-the-money forward, while the further option is nearly 50% out-of-the-money forward. Neither option has much chance at the moment of ending up in-the-money, and so it matters little whether the option is 25% or 50% out-of-the-money. However, when inflation expectations decline, these floors will get closer to the money, and there could consequently be some value differential. This has become especially poignant recently, as old TIPS bonds have rolled into the deliverable range, as those bonds have much more inflation accrual already and therefore a potentially large difference in option value. It will also be more important if an exchange ever begins to trade a 5-year TIPS contract, for in the 5-year bucket there are both new issues (which also have April maturities, incidentally) and seasoned 10-year issues that now have 5-year lives. At this writing, the April 2019 TIPS have an index ratio of 1.01559, but the *July* 2019 TIPS (an old 10-year) have an index ratio of 1.11453. That's a big difference, with only three months' difference in maturity and only five years left until those maturities.

As with seasonality, the futures contract doesn't distinguish between true *value* and simple price. The bond with the highest cash-and-carry arbitrage, or (more normally) the lowest cash-and-carry cost, is the cheapest-to-deliver in the very immediate sense of causing larger gains or smaller losses to be immediately realized upon delivery. But because the price and yield of the bond express variations in actual value to maturity, there will frequently be odd circumstances when the "cheapest" bond for delivery is actually the most expensive bond, once adjusting for the value of seasonality and the embedded floor.

This is also true with the existing nominal contracts, of course! However, in the nominal bond world the structural idiosyncrasies are less glaring, and this oddity less apparent.

Another key difference between the TIPS deliverable basket and the Note deliverable basket can also be seen in Exhibit 5 above. Ordinarily, determining the deliverability cheapness of the bonds by the implied repo rate produces a similar ranking to that obtained by ordering the bonds by their Basis Net of Carry (BNOC). However, in TIPS the BNOC can be very misleading, because the invoice prices of the bonds can be so drastically different. In this case, the invoice price of the CTD bond is roughly 150 while the invoice price of the on-the-run bond is 97. The implied repo formula, as an internal-rate-of-return measure, is the proper way to order the bonds (see Burghardt et. al. (2005)).

Not discussed here in detail are the nuances of valuing the delivery options that accrue to the TIPS futures short, which are analogous to those possessed by the futures short for the conventional Ultra, Bond, and Note contracts. Do note, however, that there is one effect which will tend to make the option value smaller, and several effects which will tend to make the option value larger, than analogous options on nominal bond futures contracts.

Tending to make the option value lower is the small size of the deliverable basket. The 10-year Note contract typically has 15-20 deliverable bonds in the basket; the 5-year Note contract, eight to ten. The 2-year Note, Bond and Ultra contracts are similarly large. But the TIPS contract will typically only have four deliverables, unless the Treasury expands the issuance calendar to include other than January and July maturities. The narrow maturity range covered by the delivery provisions will also tend to make these four bonds fairly homogeneous, which reduces the option value since if there's scant difference between the bonds, there's scant advantage in switching between them (although, as mentioned above, this homogeneity is shattered when old bonds now in the delivery range of maturities are included).

When the original contract specs were discussed, there were some concerns that the narrowness of the deliverable basket would make the option value so small as to make the opportunity for speculative

arbitrage in the contract – a key source of liquidity – uninteresting. Those concerns were misplaced, however, for there are a number of factors that will tend to *increase* the option value, compared to the other CME bond contracts.

The most ephemeral of these factors is the placement of the ‘coupon’ of the futures contract much nearer to the current yield of the bonds in the basket. A 0% futures coupon is reasonably close to the yields of the bonds in the basket. By contrast, the 2-2.25% yields on the deliverables into the 10-year Note contract are 375-400bps away from the 6% notional coupon of the contract, which means that to a high degree of certainty the CTD bond *will be* the shortest-duration bonds which are deliverable. While TIPS yields will change over time, they will very rarely be more than 250bps away from the notional coupon, and probably will never be *lower* than the notional coupon by that much.

As noted above, there are also two sources of variation in the values of the individual bonds that do not occur in nominal bonds. There is seasonality, which acts like additional inter-bond spread volatility to increase the potential value of the option to switch, and the embedded ‘deflation floor,’ which affects the behavior of the bond through gamma and vega effects. Changes in implied volatility, for the nominal Note contract, do not affect the bonds directly but only through the modeling parameters (that is, more volatility in prices generally increases the likelihood and value of the switch option). But in TIPS, a change in inflation volatility will affect the current value of the embedded delivery option while changes in real rate volatility will affect the modeling parameters. When inflation expectations are very low, this has the potential to be an enormous source of switching value.

Finally, there is the early-delivery option. The futures short has the option to deliver bonds any time during the delivery month. Typically, delivery is elected as late in the month as is feasible, so that the short may extract as much carry from the long bond position as possible. Even when carry is mildly negative, the short may not deliver early because to do so forces him to surrender the remaining value of the switch and other options. As a result, the early-delivery option typically has very low value. This is not necessarily the case with the TIPS futures contract, however, because carry on TIPS incorporates not just the coupon (earned by the short futures/long bond trader) and repo (paid by the short futures/long bond trader), but also the inflation accrual. This latter element may be positive or negative, and since monthly unadjusted CPI prints can vary widely there are many cases in which TIPS carry is significantly negative even when the real yield curve is positively sloped. The inflation-accretion part of carry, moreover, is not known until the accretion schedule for the delivery month is set. For the March contract, this will happen when the NSA CPI for January is known; this will occur in mid-February only a few weeks before the delivery window opens, and in fact that will be the schedule for each expiry – only a few weeks before actual delivery will the short be fairly confident of what carry will be in the delivery month.

Obviously, proper valuation of the TIPS contract is quite a complex assignment. However, arbitrageurs are likely to be up to the task. An important point to make here is that TIPS contract arbitrage becomes more feasible, and therefore the contract is likely to track fair-value more closely, with the existence of CPI futures. It is important for the cash-and-carry arbitrageur to be able to lock in not just the repo rate to maturity, but also the inflation accretion, and this is very difficult to do with extremely short-dated over-the-counter inflation swaps. There is a symbiosis between the CPI futures and TIPS futures, in other words, that is likely to make both contracts together more successful than either would be in isolation.

Conclusion

Inflation-related futures are not a new idea. Since at least the 1970s, economists have anticipated that these instruments would one day be available. Several previous attempts, dating back to as early as the mid-1980s, have failed for various reasons – too early, too different, bad structure. But futures that present a different method of investing in, trading, or hedging inflation and real rate exposures are needed, not only because they create opportunities to make different sorts of trades or to trade more efficiently but also for the good of the market itself. Healthy markets in CPI futures and TIPS futures will create a better liquidity ecosystem for the entire inflation market, including for off-the-run TIPS bonds and seasoned inflation swaps.

This paper has illustrated some of the fascinating complexity that made the earlier versions of these futures contracts difficult to handle for a market and an analytical community that did not yet fully grasp the ways in which inflation markets and nominal markets differ. Today's investors and analysts, on the contrary, **do** understand these differences and the other two legs of the liquidity triangle – inflation-linked cash bonds and inflation swaps – have enjoyed manifest success because of it. The market is finally ready for these contracts, and these structures appear to be the correct ones. It remains to be seen if that is enough, but there is great reason for optimism that the inflation market is at last ready to become a 'complete' market like those of equities, nominal interest rates, and commodities.

Appendix – Proposed Contract Specifications

Below are the most-recently proposed contract specifications for the Consumer Price Index (CPI) Futures and the 10-Year TIPS Futures, respectively.¹⁷ Note that there is currently no launch scheduled by the CME or any other exchange.

Consumer Price Index Futures

Contract Size	Contract Valued at \$1,000 times Reference Index
Reference Index	Consumer Price Index, U.S. city average for All Urban Consumers, All Items, not seasonally adjusted (CPI-U)
Minimum Fluctuation	.01 Index Points = \$10 per contract
Contract Months	First 12 consecutive calendar months; plus, June and December listings out ten (10) years
Last Trading Day	7:00 a.m. (CT) on scheduled CPI release in contract month. If scheduled date for release of CPI is undetermined when initially listed, Last Trading Day shall tentatively be set on last business day of contract month. Upon announcement of CPI release schedule, Last Trading Day reset to scheduled CPI release date.
Final Settlement	By cash settlement on last trading day.
Venue and Hours	CME Globex® SUN – Fri: 5:00 p.m. to 4:00 p.m. (Central Time)

¹⁷ The source for these contract specifications is in both cases the Chicago Mercantile Exchange.

10-Year TIPS Futures

Underlying Unit	U.S. Treasury Inflation Protected Security (TIPS) with original face value of \$100,000
Deliverable Grades	TIPS with remaining term to maturity of at least 8 years, but not more than 10 years, from 1st day of delivery month.
Pricing Basis	Priced in % of par in minimum increments of 1/32nd of point. E.g., 126-16 = 126+16/32nds; 128-28 = 126+28/32nds. Par is on basis of 100 points
Minimum Tick Size	Outrights: 1/32nd of one point (\$31.25) Calendar Spreads: 1/4th of 1/32nd of one point (\$7.8125)
Contract Months	The 1st three consecutive contracts in the March, June, September, and December quarterly cycle.
Last Trading	Last business day of the delivery month. Trading in expiring contracts closes at 12:01pm on Last Trading Day
Last Delivery Day	Third business day following the Last Trading Day
Delivery Method	Federal Reserve book-entry wire-transfer system where Delivery Invoice Amount = $[\$1000 \times P \times CF \times \text{Index Ratio (IR)}] + \text{Accrued Interest}$ P = Futures settlement price on day short tenders intent to deliver CF = Conversion factor calculated as price of delivered note (\$1 par value) to yield 0% Index Ratio = Ratio of Reference CPI-U on futures delivery date to Reference CPI-U value TIPS issue dated date as published by US Treasury Bureau of the Public Debt
Venue and Hours	CME Globex®: 17:00–16:00, Chicago time, Sunday–Friday Open Outcry: 07:20–14:00, Chicago time, Monday–Friday

Bibliography

Burghardt, G. D., Belton, T. M., Lane, M., & Papa, J. (2005). *The Treasury Bond Basis* (3rd ed.). New York: McGraw-Hill.

Burghardt, G., & Hoskins, W. (1994). The Convexity Bias in Eurodollar Futures. *Dean Witter Institutional Futures Research Note* .

Chu, Q. C., Pittman, D. N., & Yu, L. Q. (2011). When Do TIPS Prices Adjust to Inflation Information. *Financial Analysts Journal* , 67 (2), 59-73.

Cowen, T. (1997). Should Central Banks Target CPI Futures. *Journal of Money, Credit and Banking* , 29 (3), 275-285.

Dew, K. (1978, September 22). CPI Futures? *FRBSF Economic Letter* , pp. 1-3.

Ederington, L. H. (1980). Living With Inflation: A Proposal for New Futures and Options Markets. *Financial Analysts Journal* , 36 (1), 42-48.

Friedman, M. (1984). Financial Futures Markets and Tabular Standards. *Journal of Political Economy* , 92 (1), 165-167.

Grishchenko, O. V., Vanden, J. M., & Zhang, J. (2010). The Informational Content of the Embedded Deflation Option in TIPS. *Paris December 2010 Finance Meeting EUROFIDAI - AFFI*. Paris.

Horrigan, B. R. (1987, May/June). The CPI Futures Market: The Inflation Hedge That Won't Grow. *Federal Reserve Bank of Philadelphia Business Review* , 3-14.

Lovell, M. C., & Vogel, R. C. (1973). A CPI-Futures Market. *Journal of Political Economy* , 81 (4), 1009-1012.

Peng, W. (2006). *Understanding Inflation Convexity*. New York: Unpublished Paper. Available at <http://inflationinfo.com/CPIConv.pdf>.

Pozdnyakov, V., & Steele, J. M. (2009). Convexity Bias in Eurodollar Futures: A Dimension Free HJM Criterion. *Methodology and Computing in Applied Probability* , 551-560.

Richard J. Rendleman, J. (2004). Delivery Options in the Pricing and Hedging of Treasury Bond and Note Futures. *The Journal of Fixed Income* , 14 (2), 20-31.

Roll, R. (2004). Empirical TIPS. *Financial Analysts Journal* , 60 (1), 31-53.

Samuelson, P. (1983). *Economic Index Futures: An Introduction to the Concept of Shifting Macroeconomic Risk*. New York: Coffee, Sugar, & Cocoa Exchange, Inc.

Siegel, L. B., & Waring, M. B. (2004). TIPS, the Dual Duration, and the Pension Plan. *Financial Analysts Journal* , 60 (5), 52-64.

Simon, D. P., & Hunter, D. M. (2002). Are TIPS the 'Real' Deal?: A Conditional Assessment of their Role in a Nominal Portfolio. *EFMA 2003 Helsinki Meetings*. Helsinki.