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Comité de Normalisation Obligataire

CNO ILB SEASONALITY WORKINGPAPER

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8 rue du Mail 75002 Paris

http://www.cnofrance.org

Inflation-linked bonds and seasonality

Summary

For a few years inflation-linked bond (ILB) markets have experienced a strong growth all over the world, with about EUR 3.000bn outstanding of Government Inflation-linked debt in January 2016. One can say that each year a new sovereign has joined the club of ILB sovereign issuers since 1996.
Just considering the Eurozone, the size of the Euro linker is exceeding €500bn. The 4 largest Eurozone countries (by GDP) are dominating this market i.e. France, Italy, Germany and Spain with an annual supply of circa €60-70bn.

Moreover this market includes a high diversity of CPI fixing dates in the euro linker market:

- Since February 2015 Investors could buy OATi based on 2 different French CPI fixing dates either 25th July based on April and May CPI or 1st March based on December CPI
- France, Italy, Germany and Spain are issuing ILB linked to EU HICP ex-tobacco on different fixing dates, respectively 1st of March & 25th July for France, 15th May & 15th September for Italy, 15th April for Germany and 30th November for Spain.
- 11 different HICP linked bonds, representing more than €135bn, will mature within 5 years and will be significantly impacted by seasonality effect whom impact increases as the term to maturity shortens[1].

Considering that seasonality and complexity of the underlying asset could act as a potential barrier to enter the market for investors, **the French bond association (CNO)**, which has been on the forefront of ILB's since the beginning of the Euro ILB market, has decided to set up a working group[2] on this topic.

Our paper aims therefore at enlightening this importance of seasonality and at suggesting a methodology to correct its effect on inflation-linked bond valuation. We hope to contribute to a better understanding and a clearer overview of the main issues regarding worldwide inflation-bond markets. Such topics and issues should be of interest for investors, banks, issuers (debt management office teams) and capital markets specialists.

Our working paper has the following structure:

After a brief presentation of the working group members (part I), we present the investors' point of view (part II), followed by the issuer perspectives (part III). In part IV we introduce the CPI seasonality. In Part V, we develop a methodology to extract the seasonal factors. Finally in part VI,

[1] Ejsing and al. (2007). The term structure of euro area break-even inflation rates. The impact of seasonality
[2] Philippe Laroche is leading this working group. See section I for the list of the working group members

we use these seasonal factors in order to seasonally adjust prices and yields of the inflation linked bonds. Appendixes serve to detail mathematic formula, go deeper on some topics and provide useful references.

Key words: FBA, ILB, Inflation linked bond, Linker, seasonality, real yield, seasonally adjusted real yield, breakeven inflation rate, seasonal factors, optical illusion, market efficiency, risk management, portfolio, valuation, government bond debt

Mots-clés: CNO, Obligations indexées inflation, saisonnalité, taux réel, point mort, taux d'inflation, facteurs saisonniers, illusion d'optique, efficience de marché, gestion du risque, portfolio, valorisation, dette publique, obligation d'état

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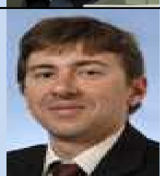
The French bond association (CNO) thanks all the following working group members including **<u>Eloïse LAPP</u>** (ESCP Europe), DCM intern at HSBC France, for their availability, contribution and their support in this working group.

I) Working group members

Jonathan BALTORA is a Senior Portfolio Manager in the Global rates team in AXA Investment Managers Paris office. In addition to the flagship Global Inflation Bonds strategy Mr Baltora is managing the Universal Inflation Bonds strategy as well as a large range of Euro Inflation Bonds strategies.



Jerome COFFINET is head of statistical methods division at Banque de France. Previously, he occupied various functions in monetary policy and financial stability.

Simon DELBOS is the head of research and strategy at Agence France Trésor (AFT). Graduated from Ecole normale supérieure de Cachan and ENSAE where he studied statistics and economic modeling, he started his career at Natixis as a quantitative economist before joining AFT in 2014.

Philippe LAROCHE is Debt Capital Markets Director at HSBC. In charge of Public sector issuers, Philippe is also Inflation product sponsor within HSBC Capital Financing. He held various positions at HSBC and Chase Manhattan within structuring and derivatives team.

Matthieu MILAN is a dynamic financial market professional with strong front-office and monetary policy experience. At Banque de France, he is deputy head for the Eurosystem credit assessment framework (ECAF) working group. Before joining the Eurosystem, he held various positions in fixed income structuring teams at Credit Suisse and Barclays Capital.

Dariush MIRFENDERESKI has been the global head of Inflation trading at HSBC since 2013. Dariush has traded inflation products since 1998, first at Barclays Capital where he started one of the first inflation derivative market-making books and was head of inflation derivatives until 2004, and then at UBS. Dariush holds a PhD from University of California at Berkeley and is the co-author of "Inflation-Indexed Securities (Wiley, 2004)"

Jean-Michel MOINADE joined Oddo Corporate Finance in 2007 as director of the Market Solutions practice. Jean-Michel worked at the Crédit Lyonnais and the Chemical Bank in corporate banking, then joining Indosuez/ CAI / CALYON to hold various positions in trading, deal structuring and advisory in Paris and Asia. He's a member of the Société Française des Evaluateurs and the Comité de Normalisation Obligatoire. Jean-Michel holds a degree from the Ecole Polytechnique and Ponts et Chaussées.

Georges SITBON is Global head of Inflation Trading at Societé Générale since January 2011. Georges started to work in the inflation industry in 2000 at Credit Lyonnais then CACIB from 2003. Aside from his experience in the inflation business, he has been sequentially trading and managing interest rate swaps, options and currency swaps from 1996 to 2003 at Credit Lyonnais. Georges Sitbon graduated from HEC (France).

II) Investor point of view: thoughts from the Real Money Side

Impact of seasonality on end users of the inflation linked bonds market

Inflation seasonality is at the same time an opportunity and a challenge for both retail and long term institutional investors.

Seasonality is an unnecessary complexity

From an investor’s perspective the seasonality of inflation indexation is a complex issue. Seasonality blurs coupon accrual, real yield and inflation breakeven measurement (in particular at the front end of the curve). In the end, long term investors get paid annual inflation and their coupon. Seasonality is only distorting coupon accruals. Adding inflation seasonality on top of the inflation indexation process is often proved to be a challenge, in an inflation linked bond market already considered as a “complex” product.

We need to adjust screen pricing for optical illusions

The inflation linked bond market is full of optical illusions. Real yields are pushed lower and inflation breakevens higher in securities benefiting from positive seasonal coupon payment while the opposite is also true. Retail investors will be essentially focused on real yields; these distortions are a challenge for those investors. Long term and sophisticated investors suffer less from such optical illusions since they tend to buy longer maturities on the curve that are less subject to such distortions and since they are more financially sophisticated. Neither the current real yields and inflation breakevens, nor historical series can be used without retreatment being processed. That makes accurate investment decisions almost impossible without adjusting for seasonality

Asset swaps transactions enable long term investors to take advantage of seasonality induced distortions

While not being very sensitive to inflation from a liability perspective, insurance companies have been very active in extracting liquidity and credit premiums from the inflation linked bond market, exploiting as many opportunities as possible through Asset Swap Transactions (ASW). ASW deals are generally traded with the insurance company buying an inflation linked bond and paying inflation to a counterparty in an inflation swap. The use of ASW while not being 100% unbiased because of bond specificities (liquidity premium in particular), remains very helpful to assess the best opportunities on a consistent scale. Seasonality distortions have created opportunities for long term investors with efficient operational capabilities in inflation swaps derivatives.

Mutual fund investors need education, simplicity & transparency

Mutual fund investors are by definition a less technical and sophisticated audience. Our experience shows that retail investors will consider inflation linked bonds simply as a hedge against inflation. They are as a consequence chasing the rising coupons in a period of increasing inflation.

While generating a higher portfolio turnover rate, the seasonal switch from inflation-linked to nominal and back is widely used by mutual funds managers trying to benefit from seasonal coupon accrual shift induced by monthly inflation swings. The drawback of such strategies is that they may not be fully understood by investors that do not have full knowledge of the seasonal picture. Again, while being a portfolio optimization opportunity, seasonality creates complexity in risk and performance analysis. Consequently the explanation of inflation seasonality and its impact on the inflation linked bond market should help investors better understand the performance of inflation linked bonds.

Challenges arising from inflation seasonality in the inflation derivatives market

The views presented above are a very simplistic approach to Real Money Investors approach to inflation linked bonds. As insurance companies as well as mutual funds are active in the swaps market, derivatives valuations is a critical issue.

Derivatives pricing & valuation

As end-users, the real money community will use internal models to value OTC transactions mark-to-market. Inputs to run the models are both coming from internal research and the market-making community. While, on the one hand, end-users learn about the newest techniques later than the average market-maker, they have the opportunity of easily comparing inputs from different counterparties.

Calculation agent in derivatives transactions will generally be the market-maker's institution ("The Bank"). The Bank will send valuations for the derivatives transactions to its client on a regular basis mid-point. Client's risk department will then check valuation using internal tools and models.

At this stage and because every market participant will use proprietary data, differences in valuation could surface. When differences occur, the client's risk department will challenge the inputs provided by the Bank and value the transaction based on new calculation assumptions provided by the Bank.

This experience shows how seasonality estimates used in valuing inflation derivatives transactions could adversely impact market players. We believe that such an uncertainty is a drawback for transparency and liquidity.

Need for transparency & market benchmarks

The experience shows how seasonality estimates used in valuing inflation derivatives transactions could adversely impact market players. We believe that such an uncertainty is a drawback for transparency and liquidity.

We welcome the most recent innovations such as Markit's Totem benchmark, the introduction of clearing and a more active front-end inflation swaps trading.

Inflation swaps clearing, while being an achievement in risk management, is also good news for inflation derivatives as it is somehow forcing market players to benchmark their methodologies against peers. We note that such an approach doesn't necessarily reward research and innovation as it should.

A greater standardization of maturities (potentially matching inflation linked bonds') could help transparency & liquidity in the market. In this context, inflation swap market participants could be interested in looking at Big & Small Bang protocols in the CDS market.

III) Issuer perspective

From an issuer's point of view, choosing a maturity month when issuing an inflation-indexed bond is not necessarily more challenging than with nominal bonds. Indeed, infra-annual seasonality arising with inflation indexing has no influence on the coupon payment as inflation-linked bonds' coupons are paid on a whole-year basis. However, if coupons are paid on a semi-annual basis, as is the case in the United States, in the United Kingdom and in Italy for example, there can be an asymmetry in coupons payments, depending on the months on which coupon payments occur and the inflation seasonality pattern.

In the case of France, the first inflation-linked bond was launched in September 1998 with an approximate 11-year maturity (25th July 2009). The reference index was the French CPI index excluding tobacco and the date of coupon payment was July 25th with annual coupons. This date allowed smoothing redemptions and easing cash management as the traditional months of maturity for OATs were April and October. In October 2001, the first bond indexed on the euro HICP was launched, with a maturity of approximately 11 years (25th July 2012). The maturity dates of subsequent French inflation-linked bonds (OATi and OAT€i) were July 25th, which had two advantages: i) easing the bond rollover for investors and ii) simplifying the seasonality issues: all bonds of a given category (French or euro area inflation) exhibited the same seasonal pattern (see parts V and VI on how to calculate seasonally-adjusted prices and yields). It has also its drawbacks as all coupon payments are subject to the same inflation fixing, inducing a lack of diversification compared to bonds with various maturity months. In 2015, the OATi March 1st 2025 was launched, in response to investor demand for a diversification in payment dates and to match the revision date of the Livret A (regulated savings account) rate: indeed every year the Livret A interest rate can be revised on February 1st and August 1st, according to a formula (although some discretionary deviations from it are allowed); the potential revision in February makes uses of the December French inflation fixing, just as the OATi March 1st 2025 which makes it ideal for banks to hedge Livret A liabilities.

A possible side effect with the choice of the maturity month is the apparent cheapness/richness of a bond in terms of non-seasonally adjusted yields and breakevens. As an example, when comparing German and French bonds indexed on euro area inflation, considering non-seasonally adjusted prices and yields can lead to erroneous conclusions in terms of relative value. Indeed, German bonds mature on April 15th while French bonds mature on July 25th and given the indexation lag and the seasonal pattern of euro area inflation, the former are exposed to a very negative seasonality (as shown below in Part V figure 4) while the latter are exposed to a very positive seasonality (April and May display the highest seasonal factors). As a consequence, as a pure effect of seasonality, French inflation-linked bonds look artificially expensive and German bonds artificially cheap. While this effect is limited when looking at long-dated bonds, it becomes increasingly important as maturity declines.

To conclude, seasonality induced by inflation-linked bonds is generally not a crucial issue for an issuer as long as market players efficiently adjust raw prices and have access to relevant products in order to hedge their position (zero-coupon inflation swaps for example). In terms of cash management, the seasonality of cash flows has an impact only in the case of bonds with cash flows more than once a year. That being said, in that case this effect can still be managed by carefully estimating seasonal coefficients and choosing the maturity month best corresponding to the issuer's specific need. That being said, this effect can still be managed by carefully estimating seasonal coefficients and choosing the maturity month best corresponding to the issuer's specific need. However it is worth noting that efficiently adjusting inflation-linked bonds prices for seasonality supposes that price seasonality can be accurately modeled and forecast. A change in inflation seasonal pattern would involve a change in inflation seasonal coefficients, and as a consequence a change in seasonally-adjusted prices. If the cause of this seasonality change is not precisely identified, in the case of an exogenous change in consumer behavior for example (as opposed to the case where it is due to a reweighting of the index components and thus clearly identified), due to the uncertainty surrounding inflation coefficients estimation, this change could be reflected only gradually in market prices as operators would probably adjust gradually their seasonality models.

IV) Statistical Treatment of seasonality

Various methodologies can be used across countries and institutions in order to estimate seasonal adjustments.

Two different types of models are available, namely the additive model and the multiplicative model. For each time series considered, it is therefore necessary to clarify which of the two models describe the data in the best way. There are some quite general differences between the structures in the two models: In the additive model, the seasonal variation is independent of the absolute level of the time series, but it takes approximately the same magnitude each year. In the multiplicative model, the seasonal variation takes the same relative magnitude each year, which means that the seasonal variation equals a certain percentage of the level of the time series. The amplitude of the seasonal factor varies with the level of the time series.

The estimation of seasonality essentially relies on moving-average (MA) methods. The most used methodologies are X12-ARIMA and TRAMO-SEATS. Using X-12-ARIMA and TRAMO-SEATS for the seasonal adjustment of a given HICP series will generally yield similar patterns. However, in some cases the results of standard seasonal adjustments with the two programs may differ substantially. Such differences can be interpreted as calling for a more fine-tuned adjustment which could benefit from the cross-checking of the X-12 estimates and TRAMO-SEATS results.

Statistical analyses in the four largest Eurozone economies of the euro area (Germany, France, Italy, Spain) show that the attributes of inflation-linked bonds may differ. Hence, inflation-linked bonds with reference to national indexes are specific, e.g. in France they do not necessarily refer to Harmonized index, but also to specific local indices relevant to IL bond markets (Consumer prices index).

A simple analysis of the euro area, French and German HICPs shows how the seasonal patterns of harmonized indices may differ. For instance, seasonal effects appear ample in Germany over the months November-December-January, while in France this effect is more important over June-July-August.

This tends to rest especially on the sales period in France, in which the effect on the clothing component of HICP is more ample.

In that respect, it is important to notice that even if there is no single fully harmonized methodology across the world, best practices are shared among statistic offices[3]. Eurostat aggregates national HCPI series which harmonized with same methodology.

Some recommendations might be drawn from this. For instance, seasonally adjusted series should be compiled for the total HICP and for its main components, provided that identifiable seasonality occurs. In order to obtain consistency of the total HICP and its main components, it is useful to seasonally adjust the total HICP indirectly by aggregating main component series. Direct seasonal adjustment of the aggregate is relevant only if seasonal profile of adjusted component indices are similar. Furthermore, euro area HICPs are seasonally adjusted at the euro area level, i.e. they are not obtained by aggregating the respective national HICPs.

This is all the more important than the weights of different categories among national harmonized indexes might differ across countries and over time.

Overall HICP index in the euro area: weight of different components

Euro area	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Food	192,8	195,6	195,0	193,3	191,7	193,0	190,7	193,7	197,6	196,6	195,3
Industry	394,6	391,1	391,0	387,7	383,2	388,2	392,1	383,4	374,6	368,9	362,9
Energy	92,0	96,2	98,2	95,7	95,6	103,6	109,9	109,6	108,1	106,1	97,4
Services	412,7	413,4	414,0	419,0	425,1	418,8	417,2	422,9	427,9	434,5	441,8

Sources: Eurostat, INSEE

[3] ESS Guidelines on seasonal adjustment : http://ec.europa.eu/eurostat/documents/1014855/1016008/ESS-GUIDELINES-ON-SA.pdf/1948feee-7b37-4a8a-85b1-62e086b5f246

Overall HICP index in France: weight of different components

France	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Food	201,8	199,5	198,7	198,6	196,0	199,1	202,9	206,3	207,4	206,8	202,4
Industry	381,1	377,2	378,2	371,7	369,3	381,1	390,9	371,7	365,6	359,1	356,1
Energy	90,7	87,7	87,5	81,0	82,1	92,9	99,3	94,5	98,5	94,1	89,7
Services	417,1	423,3	423,2	429,7	434,7	419,8	406,2	421,9	427,0	434,1	441,5

Sources: Eurostat, INSEE

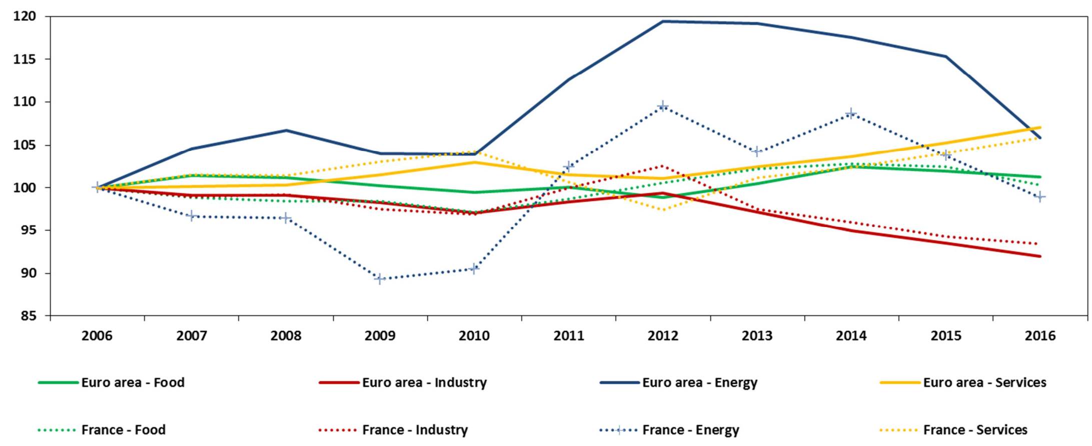


Figure 1: Comparative analysis HICP index in Euro Area and in France: weight of different components. Base 100: 2006

The crisis of 2008-2009 allowed to highlight that an exogenous shock requires specific consideration in the seasonal adjustment models. Indeed, poorly modelled, a break in a series can artificially increase some seasonal factors around the rupture point, resulting in erroneous corrections of seasonal factors. The case of the series of employment in the United States highlighted in an article by J. Wright discusses deformations subsequently caused by a rupture[4]. In that respect, when a crisis or an exogenous shock temporarily introduced a break in a series, seasonal adjustment should be carried out with two joint points of attention: i) specific modelling of the period as atypical shock; ii) adaptation of the seasonal adjustment model, starting from the previous model and changing it, as long as the shock is not widely past. If these precautions prevent a distortion of seasonal components, it is not possible to consider a seasonally-adjusted series at a too accurate detail level, with regard to the level of the series and its seasonal amplitude.

Of course, most of macroeconomic aggregates display seasonality that varies slowly over time and depends on the phase of the economic cycle. In particular, exogenous shocks move the "trend-cycle" component and modify the seasonal component pattern.

If the model is rejected, several actions are possible: stop the production of s.a. data; search for a new model; start from the previous model and change it marginally (outliers ...); completely

[4]http://www.brookings.edu/~/media/Projects/BPEA/Fall2013/2013b_wright_unseasonal_seasonals.pdf?la=en

rebuilding a model is not necessarily appropriate. In the end, until the crisis is over, the statistician has a lack of hindsight to understand precisely the new configuration

So, the first step is to model outliers precisely:

- study the outliers detected by automatic procedures
- refine these outliers or complete them at the end of period, if necessary using a ramp (linear evolution on a specific time interval)
- add appropriate regressors

If necessary, the statistician should adjust the settings of the models:

- change the parameters of the model one by one until a satisfactory result is reached
- at the moment of the observed break in the series, try to stay as close to the original model as possible
- close monitoring of the process until the series is stabilized

In practical terms, the ESS guidelines state that seasonal adjustment should be conducted according to a controlled current adjustment or partial concurrent adjustment:

- "Partial concurrent adjustment: The model, filters, outliers and calendar regressors are re-identified once a year and the respective parameters and factors re-estimated every time a new or revised data becomes available.

- Controlled current adjustment: Forecasted seasonal and calendar factors derived from a current adjustment are used to seasonally adjust the new or revised raw data. However, an internal check is performed against the results of the "partial concurrent adjustment", which is preferred if a perceptible difference exists. This means that each series needs to be seasonally adjusted twice. […] A full review of all seasonal adjustment parameters should be undertaken at least once a year and whenever significant revisions occur (e.g. annual benchmark)."

Revisions caused by re-estimated parameters, newly specified models and outliers should be monitored whenever a new specification is taken into consideration. Outliers, in particular level shifts and temporary changes, which have been identified to be significant, are meaningful from an economic perspective and make a difference in the respective seasonal factors should be fixed in terms of dating and type. When ARIMA models and seasonal moving-average filters are reviewed, choices should be preferred, ceteris paribus, which keep revisions in backdata reasonably small.

Finally, it should be noted that unlike in the US, where seasonal factors are published by the Bureau of Labor Statisctics [5] this is not the case in the euro area.

[5] http://www.bls.gov/cpi/cpisapage.htm

V) Seasonal factors' calculation

Unlike the accrual interest, consumer prices do not rise at a constant pace each day. It is a variable adjusted on a monthly basis (month-on-month) and its annual trend (y-o-y) is affected by a (monthly) seasonal component. Time to time seasonal behaviour could also outweigh the trend; however, as shown above, patterns tend to occur on a regular basis and tend to do so every year. That's why they are called seasonal.

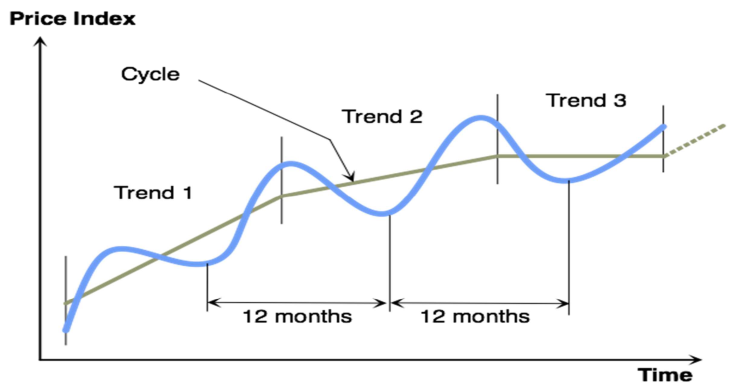


Figure 2: CPI Trend and annual seasonality

Trend and Seasonal

Depending on their maturities and coupon frequency, ILB valuation, inflation ratio and accrual interest are differently affected by this seasonality. Without a seasonal adjustment, any analysis that uses directly or indirectly real yields is flawed[6].

In 2009 Paul Canty[7] defined a method to assess these seasonal factors. More recently in 2015 Theologis Chapsalis also described this method. Two approaches (multiplicative or addictive) are usually presented.

The protocol of Seasonal factor assessment is based on the principle that one can decompose a CPI Index "I" with a long pluri-annual Cycle "C", an annual trend component "T", a seasonal & repetitive component "S" within the annual period and noises/ irregular factors "W". Neither the pluriannual cycles nor the final terms will be raised in this paper. We only focus on T (Trend) and S (Seasonal) and we also assume that Seasonal factors remain constant over time.

For the purpose of this working paper, we have followed - set by step- the methodology presented by Theologis Chapsalis.

[6] "Seasonal illusions" Theologis Chapsalis – 14 October 2015 HSBC Research
[7] "Seasonally adjusted prices for inflation-linked bonds" Risk magazine January 2009 Paul Canty

Below calculations are based on the HCPI Euro Index over 10 years as recommended by Market participants. The methodology presented hereafter can be applied on any monthly CPI series.

year n	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2015	115,13	115,87	117,2	117,5	117,76	117,74	116,96	116,97	117,23	117,4	117,22	117,21
2014	115,93	116,28	117,39	117,57	117,44	117,57	116,78	116,91	117,43	117,35	117,12	117,01
2013	115,13	115,55	116,94	116,83	116,95	117,07	116,39	116,53	117,11	116,96	116,86	117,28
2012	112,96	113,53	115,03	115,56	115,38	115,29	114,65	115,1	115,97	116,21	115,97	116,39
2011	110,11	110,57	112,11	112,75	112,74	112,75	112,03	112,23	113,08	113,44	113,54	113,91
2010	107,75	108,02	109,09	109,58	109,71	109,7	109,32	109,54	109,77	110,15	110,27	110,93
2009	106,82	107,26	107,66	108,04	108,1	108,27	107,51	107,89	107,91	108,17	108,28	108,61
2008	105,67	106,04	107,11	107,46	108,14	108,54	108,38	108,22	108,42	108,45	107,9	107,75
2007	102,38	102,7	103,39	104,05	104,31	104,41	104,14	104,19	104,59	105,12	105,69	106,12
2006	100,62	100,91	101,47	102,16	102,44	102,51	102,36	102,46	102,48	102,51	102,55	102,96
2005	98,2	98,54	99,31	99,73	99,99	100,08	99,99	100,25	100,67	100,93	100,67	101,1

Table 1: HCPI Index 2005 - 2015, source: Eurostat

The method uses the CPI of each month of the year and the index from December of the previous year. Therefore we need series of 13 CPI indexes for each year.

At first, since we consider by simplification that only the Trend and the Seasonal have an impact on the index CPI, we have to first identify the Trend and to isolate the Seasonal in a second stage.

The Trend is equal to:

$$\textbf{Trend} = \ln\left(\frac{\text{CPI last}}{\text{CPI first}}\right) \times \left(\frac{365}{Date\ last - Date\ first}\right)$$

Considering the year 2015, we have the following data:
CPI last = December 2015 CPI (value: 117.21)
Date last = 365.
CPI first = December 2014 CPI (value: 117.01)
Date first = 0
In order to assess the Seasonal factor for each month, we need to assess the "adjusted CPI" representing the impact of the Trend on the CPI with the following formula:

$$\textbf{Adjusted CPI}_i = \textbf{CPI}_0 \times \exp\left(\textbf{Trend} \times \frac{\text{Date i} - \text{Date0}}{365}\right)$$

Where i, $0 \le i \le 12$, is the month's number in the year: 0 being December 2014 and 12, December 2015.
On December 2015, Adjusted CPI = CPI last 2015 = 117.21

We assume that the Adjusted CPI depends only on the Trend of the year, according to the linear blue line in the graph.
The next stage will consist in assessing the seasonal component as follow:

$$r_i = \frac{\text{CPI}}{\text{Adjusted CPI}}$$

By definition $r_0 = r_{12} = 1$

$$mr_i = \frac{ri}{r(i-1)}, \text{ where } 1 \leq i \leq 12$$

The multiplicative approach is based on seasonal coefficients calculated as following

$s_i = \prod_{j=1}^{i}(mrj)$

By definition the $s_{12} = \prod_{j=1}^{12}(mrj) = 1$

There additive and multiplicative coefficients are presented in the graphs below (respectively Fig.3 and Fig.4)

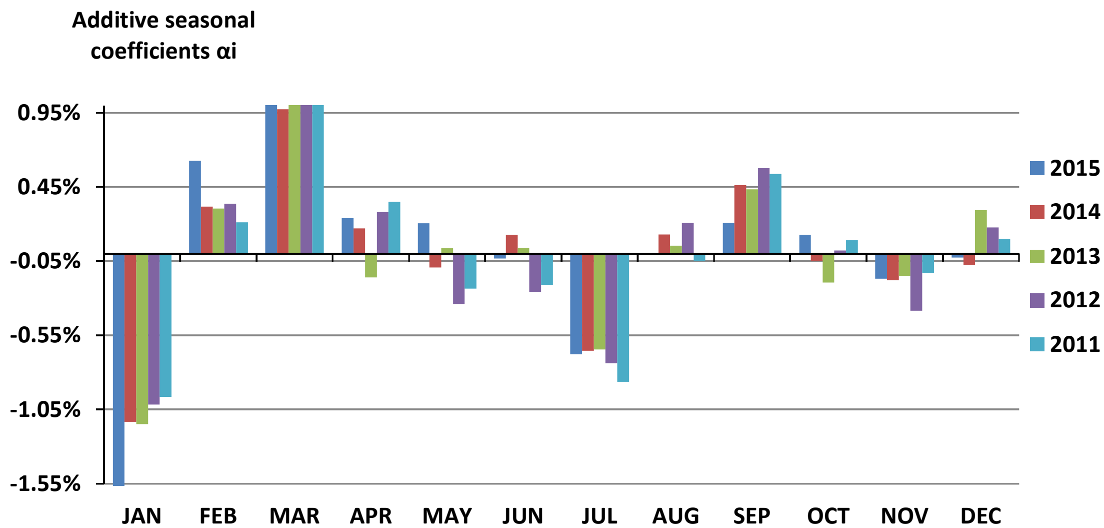


Figure 3: CPI additive seasonal factors from 2011 to 2015

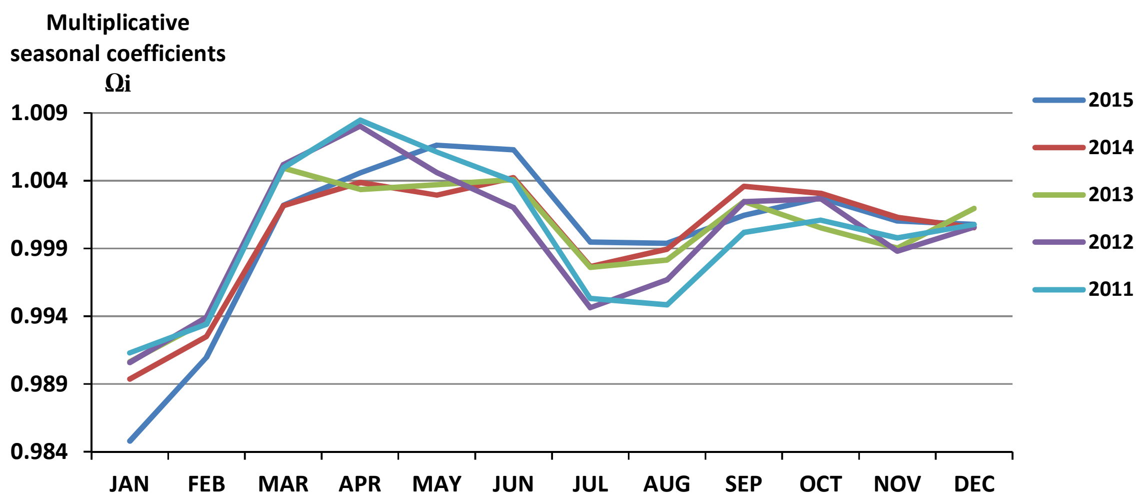


Figure 4: CPI multiplicative seasonal factors from 2011 to 2015

Graphically we can see that in Eurozone, consumer prices tend to rise at a fast pace in March while seasonal discounts allow for a fall in January and we can also highlight that the seasonal behavior seems to be consistent every year.

In general, when we compare the various seasonality factors over time, we can observe a relative stability and consensus among market participants however each market participant can compute its own series of seasonal factors, depending on its own expectations. Usually market participants average 10 years of seasonality factor in order to build up a stable seasonality structure.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2015	0,98477993	0,99095924	1,00216769	1,00457111	1,00662709	1,00629400	0,99946183	0,99938160	1,00144167	1,00272765	1,00102896	1,00077764
2014	0,98934658	0,99249617	1,00215372	1,00386761	1,00294101	1,00422851	0,99766314	0,99895642	1,00357683	1,00307656	1,00128736	1,00052990
2013	0,99062815	0,99364675	1,00493477	1,00334649	1,00371289	1,00409932	0,99760689	0,99814637	1,00247199	1,00052591	0,99903026	1,00195780
2012	0,99058414	0,99392338	1,00519910	1,00802855	1,00460315	1,00202825	0,99462892	0,99669218	1,00243382	1,00265669	0,99880048	1,00056995
2011	0,99129367	0,99339770	1,00495322	1,00847522	1,00610280	1,00398695	0,99531718	0,99483665	1,00017455	1,00108711	0,99977375	1,00076092
2010	0,99372674	0,99459374	1,00263509	1,00538132	1,00475955	1,00291497	0,99763923	0,99784490	0,99819532	0,99984522	0,99918799	1,00335647
2009	0,99384349	0,99732073	1,00035624	1,00322328	1,00309479	1,00400791	0,99627932	0,99911782	0,99864221	1,00036459	1,00071969	1,00308391
2008	0,98830195	0,99059467	0,99928692	1,00128813	1,00631167	1,00876037	1,00596127	1,00316773	1,00375444	1,00272432	0,99638111	0,99369988
2007	0,99566389	0,99645614	1,00057233	1,00445437	1,00437589	1,00283759	0,99767316	0,99558642	0,99692218	0,99939842	1,00231764	1,00380863
2006	0,99356606	0,99503265	0,99900210	1,00428490	1,00547491	1,00465097	1,00162434	1,00104722	0,99973900	0,99848000	0,99736956	0,99980337
Average	0,99117346	0,99384212	1,00212612	1,00469210	1,00480038	1,00438088	0,99838553	0,99847773	1,00073520	1,00108865	0,99958968	1,00083485

Indeed if we look at the chart below, we can be in a situation where the seasonality has been computed differently by various actors (e.g. two banks and two investors). Results could be quite similar but with few differences in the curve of Investor 2 though.

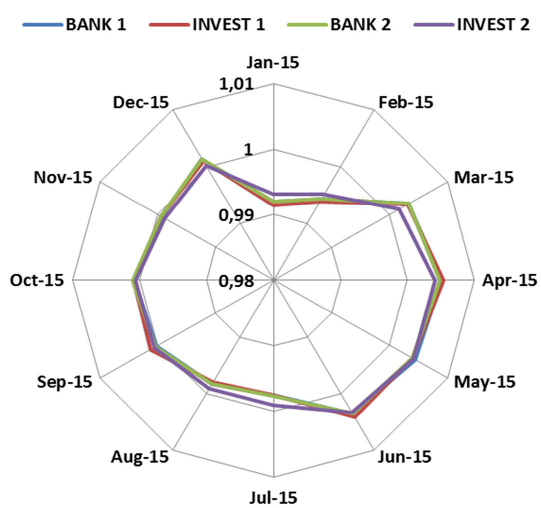


Figure 5: seasonal factors – 2015 cross actors analysis

Seasonal factors could also be used cross market:

Market participants can implement investment/arbitrage strategy according to their views on seasonality across ILB markets.

For example, the chart below presents the seasonality of 4 different CPI : the CPI in France, in the US, in the Eurozone and in Thailand.

	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
UK	0,993284	0,997418	0,997951	1,000455	1,001369	1,001927	0,999744	1,003357	1,001593	1,000185	1,000351	1,002406
Thailand	0,993523	0,995392	0,997803	0,998691	1,001107	1,002844	1,002912	1,001379	1,001610	1,004317	1,001813	0,998667
US	0,989348	0,993086	0,998374	0,999801	1,004271	1,007181	1,006621	1,004570	1,002401	1,001326	0,998611	0,994578
Eurozone	0,984780	0,990959	1,002168	1,004571	1,006627	1,006294	0,999462	0,999382	1,001442	1,002728	1,001029	1,000778

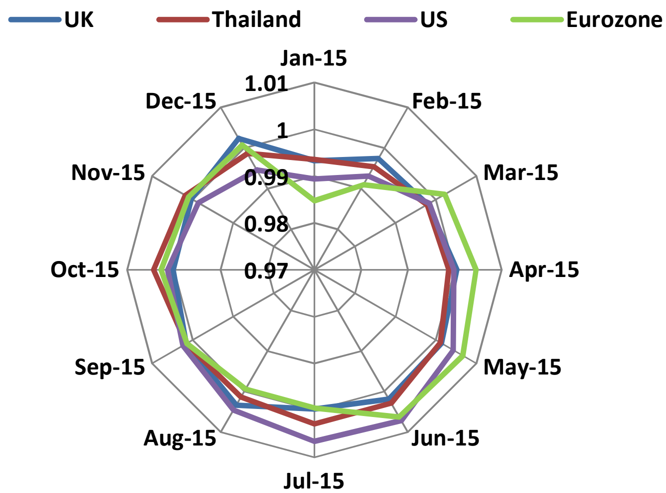


Figure 6: seasonal factors – 2015 cross market analysis

As indicated in section IV, seasonal factors are officially published in the US by the Bureau of Labor Statistics (BLS). In Appendix 2 we compared our calculations with the coefficients published by the BLS for the US consumer price index.

'Flow' Seasonality

The above has so far covered what can be described as 'statistical' seasonality, i.e. seasonality that can be inferred by studying the historic time series of inflation index prints, which in turn exhibit patterns of repeatable peaks and troughs that we can model and use as our best guess for the future pattern of inflation index fixings. What we would like to introduce here is a different kind of seasonality that has to do with market flows. In particular, this focuses on known, repeatable market flows that concentrate supply and/or demand into particular fixings in the calendar year.

The inflation swaps in many markets are composed of demand flows (whereby the investor receives inflation) which need to ultimately be offset by supply flows of inflation swaps (where the intermediate banks need to receive inflation in order to honour the demand flows just described). At the current time, the IL bond asset swap (ASW) investors are the ones who allow the completion of this market. The ASW investor buys the bonds and supplies the intermediating banks with the swap supply (often called 'synthetic' supply).

What becomes clear from the above is that there are a finite number of monthly fixings that are linked to ASW flows yet the demand side typically covers all 12 monthly fixings, with some examples of concentration due to regulatory or other requirements. Combining these supply and demand flows, one is left with unbalanced fixings whereby typically the ASW fixings are in surplus supply whereas non-ASW fixings are in surplus demand. It is this asymmetry in supply vs demand of monthly fixings that can lead to a phenomenon we call 'flow' seasonality.

Assuming the typical dealer prefers to have a flat book, it is reasonable to assume that he/she is willing to pay up to sell fixings he is long and pay up to buy fixings he is short. And since the aggregate of positions would reflect the overriding supply/demand picture, it makes sense for the ASW fixings to trade (somewhat) cheaper than they would otherwise and conversely for the non-ASW fixings to trade (somewhat) richer than they would otherwise.

The above is harder to quantify and what remains for us to say here is that it is worthwhile monitoring this effect in the market as an additive effect on top of the traditional 'statistical' seasonality.

VI) Seasonal factors' application: seasonally adjusted prices & yield for inflation-linked bonds

Based on CPI index values, available in the market, how to asses this seasonal effect?

As shown on Figure 7, seasonality can impact very significantly the Real Yield.

Seasonality will impact ILB valuation according to 3 parameters:

- Date of valuation or settlement
- Month of the Coupon date and / or Month of the date of repayment
- Coupon frequency (annual or semi-annual)

Idea is to adjust prices and yields to the settlement date. Assuming that seasonal factors stay constant over time, for a bond with an annual coupon, which is the case for OATi and OATei, the Seasonal Adjusted Clean Price[8] = SACP = CP ($\frac{\text{Ssettle}}{\text{Sm}}$)

That is the basic form taken into account the three-month lag.

Where:

- S_{settle} is the Seasonal factor at the Settlement Date
- S_{m} is the Seasonal factor at maturity date

Please note that all things being equal, S_m is constant over the life of the bond which means:

- When month of settlement date equals month of maturity date, there is a date where we have SACP = CP
- The shorter the bond tenor, the larger the seasonality impact.

An extract of the table used to draw the graph below is available in Appendix 2 as well as the average multiplicative factors based on 10 year series from 2006 to 2015 for the Eurozone HCIP Ex Tobacco used for the calculation.

[8] Alternative same methodology could be applied to Seasonal Adjusted Real Yield taking into consideration the duration of the bond.

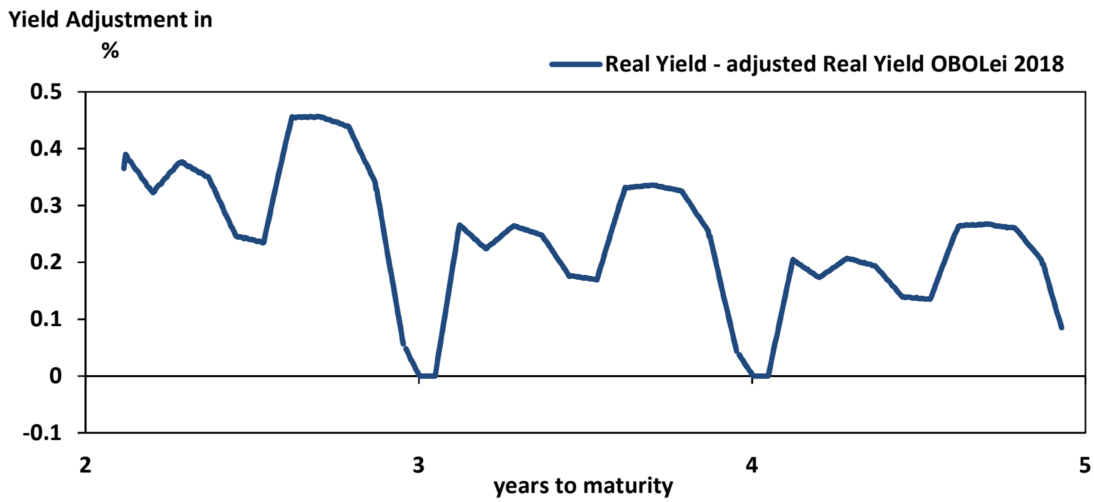


Figure 7: Spread between the OBOLei 2018 Real Yield and the OBOLei 2018 Seasonally Adjusted RY (2 Mar 2016)

Seasonal Adjusted Real yield curve: OATei on the 4th Feb 2016 considering a settlement date of the 7th Feb 2016

Linker (04-02-2016)	Real Yield	Adjusted Real Yield	% adjustment
OATei - 0,25% - 2018	-0,899	-0,755	0,14
OATei - 2,25% - 2020	-0,798	-0,716	0,08
OATei - 1,1% - 2022	-0,665	-0,609	0,06
OATei - 0,25% - 2024	-0,457	-0,414	0,04
OATei - 1,85% - 2027	-0,226	-0,19	0,04
OATei - 0,7% - 2030	-0,075	-0,049	0,03
OATei - 3,15% - 2032	-0,04	-0,014	0,03
OATei - 1,8% - 2040	0,153	0,17	0,02

Table 2: OATei Seasonal Adjusted RY on the 4th Feb 2016[9]

[9] Source of seasonally adjusted series: See Appendix 2

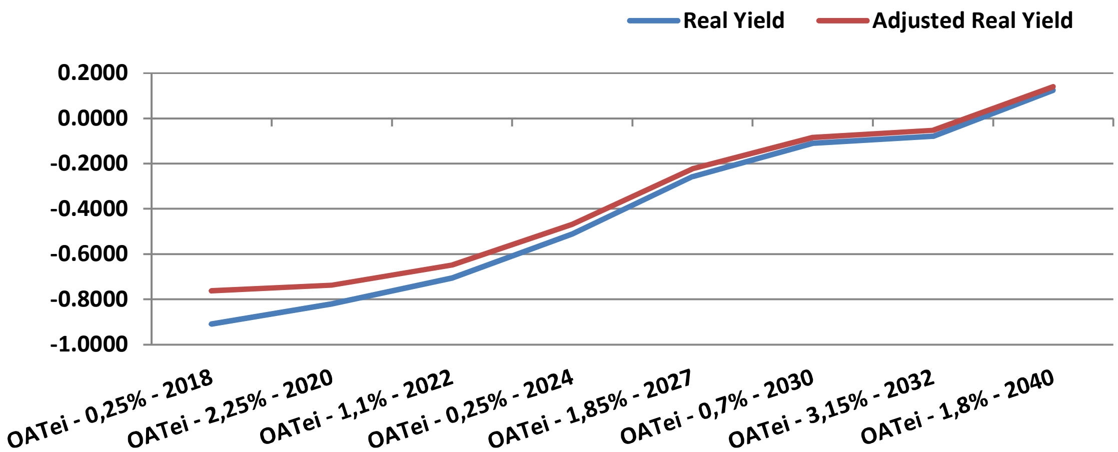


Figure 8: FR CPI OATei curve – Real Yield and Seasonally Adjusted RY (4 Feb 2016)

Cross-market spreads:

When comparing OATei and DBRei, Seasonal adjustment is clearly needed. In the below table, when we look at the frontend of the curve, it seems that Boblei 2018 real yield (-0.53 %) is 44bps wider than OATei 2018 (-0.97%).

That is a pure illusion, Seasonal Adjusted Real Yield are showing that French linker OATei July 2018 is yielding 4bps more than the BOBLei April 2018, i.e. -0.82% versus -0.86%.

Maturity	linker	Real Yield (RY)	RY Seasonally Adjusted	Adjustment in %
avr-18	BOBLei 0,750 %4-2018	-0.53	-0.86	-0.33
juil-18	OATei 0,250 %7-2018	-0.97	-0.82	0.15
avr-20	Bundei 1,750 %4-2020	-0.75	-0.93	-0.18
juil-20	OATei 2,250 %7-2020	-0.9	-0.81	0.09
juil-22	OATei 1,100 %7-2022	-0.76	-0.7	0.06
avr-23	Bundei 0,100 %4-2023	-0.71	-0.81	-0.1
juil-24	OATei 0,250 %7-2024	-0.54	-0.49	0.05
avr-26	Bundei 0,100 %4-2026	-0.52	-0.6	-0.08
juil-27	OATei 1,850 %7-2027	-0.28	-0.24	0.04
avr-30	Bundei 0,500 %4-2030	-0.3	-0.36	-0.06
juil-30	OATei 0,700 %7-2030	-0.05	-0.02	0.03
juil-32	OATei 3,150 %7-2032	0.01	0.04	0.03
juil-40	OATei 1,800 %7-2040	0.2	0.22	0.02
avr-46	Bundei 0,100 %4-2046	-0.09	-0.12	-0.03

Table 3: OATei and DBRei Seasonal Adjusted RY on the 9th Dec 2015 [10]

[10] Source of seasonally adjusted series: HSBC Fixed Income research

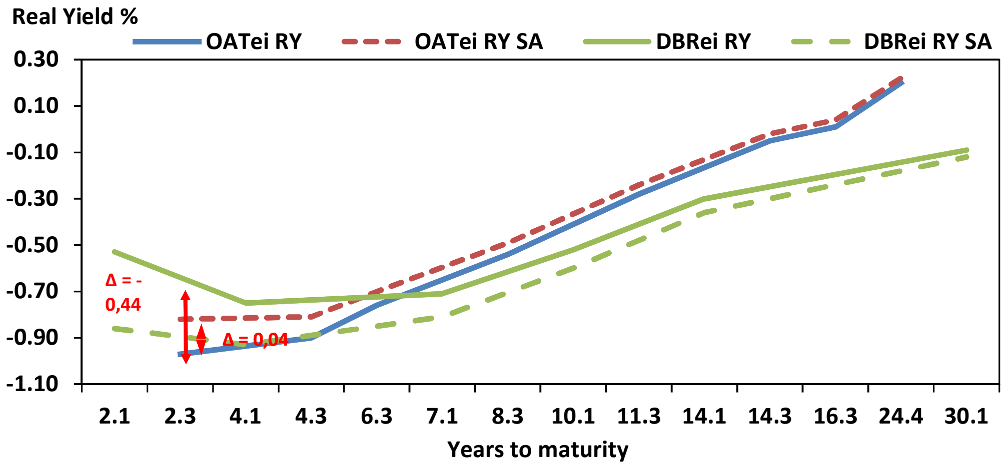


Figure 9: OATei and DBRei curves – observed Real Yield and Seasonally Adjusted Real Yield (9 Dec 2015)

Maturity	Linker	Real Yield (RY)	RY Seasonally Adjusted	Adjustment in %
sept-18	BTPei - 1,7% - 9 - 2018	0,00	0,20	0,19
avr-18	BOBLei - 0,75% - 4 - 2018	-0,53	-0,86	-0,33
sept-19	BTPei - 2,35% - 9 - 2019	0,09	0,23	0,14
avr-20	DBRei - 1,75% - 4 - 2020	-0,75	-0,93	-0,18
sept-21	BTPei - 2,1% - 9 - 2021	0,36	0,45	0,09
avr-23	DBRei - 0,1% - 4 - 2023	-0,71	-0,81	-0,10
sept-23	BTPei - 2,6% - 9 - 2023	0,62	0,69	0,07
sept-24	BTPei - 2,35% - 9 - 2024	0,80	0,86	0,06
avr-26	DBRei - 0,1% - 4 - 2026	-0,52	-0,60	-0,08
sept-26	BTPei - 3,1% - 9 - 2026	0,95	1,00	0,05
avr-30	DBRei - 0,5% - 4 - 2030	-0,30	-0,36	-0,06
sept-35	BTPei - 2,35% - 9 - 2035	1,26	1,29	0,03
sept-41	BTPei - 2,55% - 9 - 2041	1,46	1,49	0,03
avr-46	DBRei - 0,1% - 4 - 2046	-0,09	-0,12	-0,03

Table 4: BTPei and DBRei Seasonal Adjusted RY on the 26th Feb 2016[11]

[11] Source of seasonally adjusted series: See Appendix 2

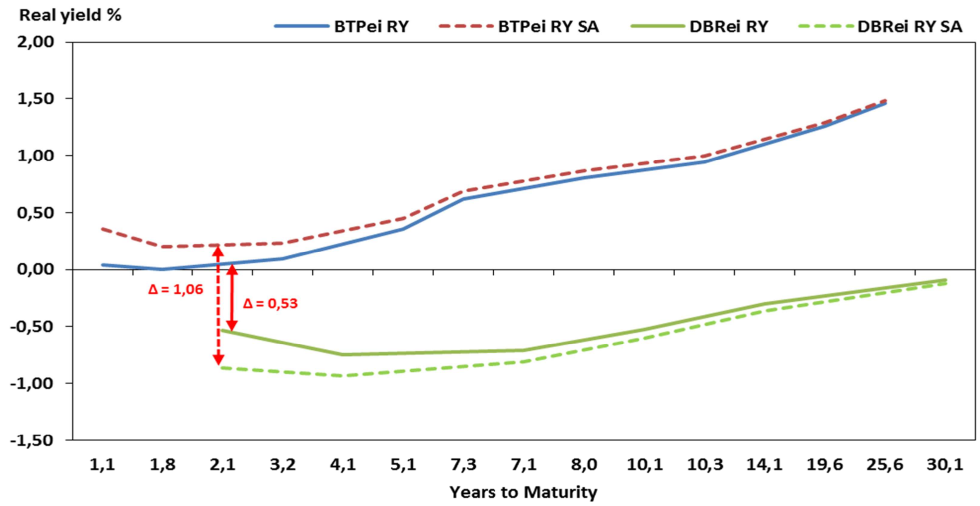
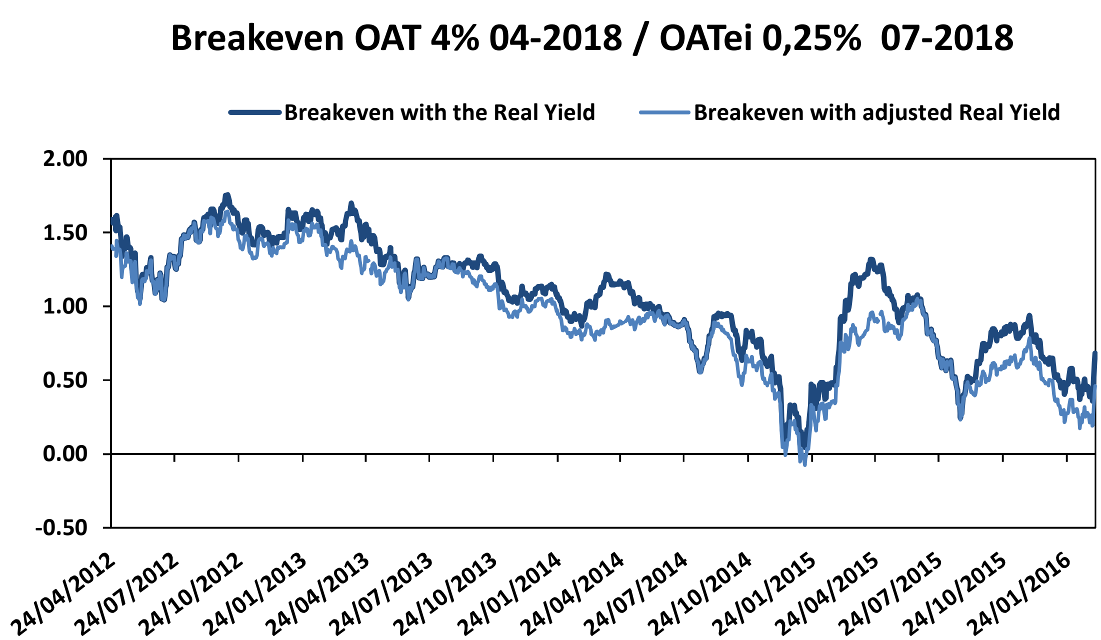


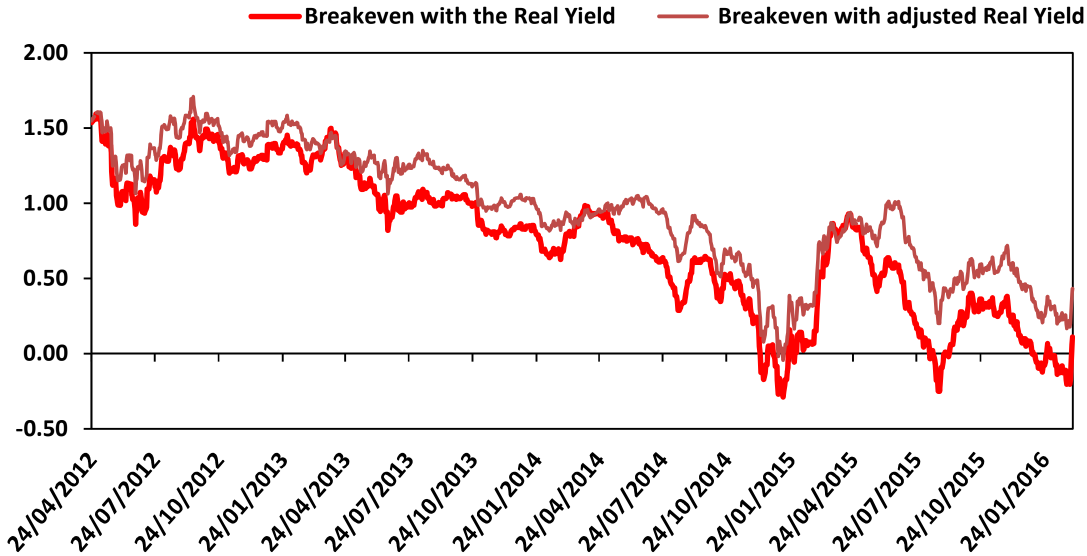
Figure 10: BTPei and DBRei curves – observed Real Yield and Seasonally Adjusted Real Yield (26 Feb 2016)

Seasonally adjusted Breakeven inflation rate

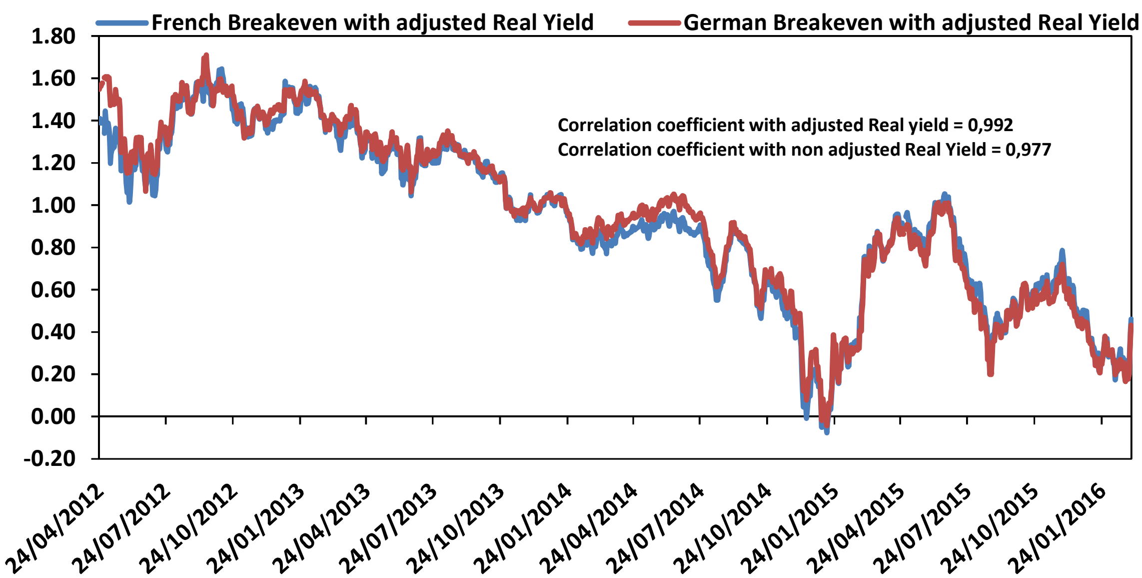
Breakeven calculation needs seasonal adjustment too. The chart below shows that after such adjustment the Breakeven calculated from OBL 2018 is extremely well correlated with the breakeven calculated from the OATei2018.



Breakeven DBR 4% 01-2018 / OBLei 0,25% 04-2018



Comparison between French and German Breakeven with adjusted Real Yield



Sources: Bloomberg, CNO

The correlation coefficients have been calculated from the 24th April 2012 to the 4th March 2016.

Series are based on OATei 0,25% 07.2018 and OBLei 0,25% 04.2018 seasonally adjusted Breakeven.

Seasonal factors are calculated according to the appendix 2 series.

VII) Appendix 1: Formulas

A) Annual coupons bonds

Paul Canty [12]'s formula to calculate as a first step the dirty price (DP):

$$DP = [\sum_{i=1}^{n} \mathrm{Ci}\left(\frac{\mathrm{Ti}}{\mathrm{Ibase}}\,\mathrm{dfi}\right)]\mathrm{Sm} \quad \textbf{(Equation 2)}$$

Where Ci is the cash flow (coupon) at date i, Sm the seasonality factor at maturity, Ti the Trend at date I, Ibase the base reference inflation index and dfi the discount factor at date i. By multiplying each cash flow by a right proportion of seasonality we will obtain a more adjusted price for the bond.

Once we have the bond's dirty price, the Seasonality Adjusted Clean Price is given by:

$$\mathrm{SACP} = \mathrm{CP}\left(\frac{\mathrm{Ssettle}}{\mathrm{Sm}}\right) \quad \textbf{(Equation 3}^{13}\textbf{)}$$

Where CP = (Ibase/Isettle) DP – RAI[14]

Please note that when settlement date equals maturity date, we have **SACP = CP**

B) Semi-annual coupons bonds

We come to the same conclusion than annual coupons bonds when dealing with global real yield curves, as shown in the below example of UK Government inflation market.

As we're now dealing with semi-annually coupons bonds, the initial stream of cash flow can be divided into two streams (stream A and stream B) to utilize the Dirty Price's formula:

$$DP = \sum_{i=1,3,5\ldots}^{n-1} \mathrm{Ci}\left(\frac{\mathrm{TiSA}}{\mathrm{Ibase}}\right)\mathrm{dfi} + \sum_{i=2,4,6\ldots}^{n} \mathrm{Ci}\left(\frac{\mathrm{TiSB}}{\mathrm{Ibase}}\right)\mathrm{dfi} \quad \textbf{(Equation 4)}$$

Still assuming constant seasonal factors over time and still according to Paul Canty's method the Seasonally Adjusted Clean Price is given by:

$$\mathrm{SACP} = \mathrm{CP}\left[\frac{\mathrm{wA}\left(\frac{\mathrm{Ssettle}}{\mathrm{S1}}\right)+\mathrm{wB}\left(\frac{\mathrm{Ssettle}}{\mathrm{S2}}\right)}{\mathrm{wA}+\mathrm{wB}}\right] \quad \textbf{(Equation 5)}$$

Where wA and wB are the present values of stream A and stream B.

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[12] "Seasonally Adjusted Prices for Inflation-Linked Bonds." Paul Canty, January 2009
[13] Please note that when settlement date equals maturity date, we have**:** SACP = CP
[14] RAI = Coupon * (number of days elapsed in coupon period / total number of days in coupon period)

C) Step by step protocol

Theologis Chapsalis formula[15]:

$$r_i = \frac{\text{CPI}}{\text{adjusted CPI}}$$

Nota bene: $r_0 = r_{12} = 1$

$$mr_i = \frac{ri}{r(i-1)}, \text{ where } 1 \leq i \leq 12$$

Residual trend:

Additive seasonal coefficients α_i	**Multiplicative seasonal coefficients Ω_i**
For additive seasonal coefficients, we multiply the mr_i ratio by Residual Trend and we substrate 1. The Residual Trend is $\frac{12}{\sum_{j=1}^{12} mrj}$ Correcting the mr_i by the residual trend provide an adjustment in order for the sum of our additional coefficients to be exactly equal to 0. Therefore, the additive coefficients are:	For the multiplicative seasonal coefficients, we do a cumulative product of the year. $s_i = \prod_{j=1}^{i}(mrj)$ By definition the $s_{12} = \prod_{j=1}^{12}(mrj) = 1$ Additive coefficients are used to obtain the multiplicative ones and a correction with Multiplicative Residual is also needed in order to have the product of all our multiplicative coefficients equals to 1. The multiplicative coefficients are obtained with the formula:
α_i = (Residual Trend x mr_i) - 1	$\Omega_i = \frac{\prod_{j=1}^{i}(\alpha j+1)}{Multiplicative\ Residual^{1/12}}$
where 1≤i≤12	where 1≤i≤12 and the Multiplicative Residual $= \prod_{j=1}^{12}(\alpha j + 1)$

[15] Theologis Chapsalis, Seasonal illusions, HSBC Global Fixed Income Strategy Special, October 2015

VIII) Appendix 2: Calculations of the Seasonality Adjusted Real Yield

Seasonal factors are calculated on a monthly basis by construction. In order to assess the coefficient relative to any specific date (either settlement **Ssett** or maturity **Sm**), we use a linear interpolation between two monthly coefficients taking into account the 3 month lag.

The vector below is a set of average seasonal factors based on 10 year series from 2006 to 2015 for the **Eurozone HCIP ex Tabacco.**

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0,99117346	0,99384212	1,00212612	1,00469210	1,00480038	1,00438088	0,99838553	0,99847773	1,00073520	1,00108865	0,99958968	1,00083485

Here are extractions of the table used to calculate the Adjusted Real Yield for the bond OBOLei 2018

settlement date	Real yield	Sm	Ssett	price last	Ssett/Sm	adjusted price	years to maturity	adjusted Real Yield	RY - adjusted RY
29/02/2016	-0,366	0,9926031	1,00075451	102,38	1,00821216	103,2207612	2,126027397	-0,74735	0,38135
28/02/2016	-0,383	0,9926031	1,00071435	102,42	1,0081717	103,2569452	2,128767123	-0,761862	0,378862
27/02/2016	-0,383	0,9926031	1,00067418	102,42	1,00813123	103,2528006	2,131506849	-0,758075	0,375075
26/02/2016	-0,383	0,9926031	1,00063401	102,42	1,00809076	103,2486561	2,134246575	-0,754297	0,371297
25/02/2016	-0,331	0,9926031	1,00059385	102,31	1,0080503	103,133626	2,136986301	-0,700401	0,369401
24/02/2016	-0,343	0,9926031	1,00055368	102,345	1,00800983	103,1647663	2,139726027	-0,712642	0,369642
23/02/2016	-0,416	0,9926031	1,00051351	102,508	1,00796937	103,3249238	2,142465753	-0,782967	0,366967
22/02/2016	-0,409	0,9926031	1,00047335	102,495	1,0079289	103,3076727	2,145205479	-0,773286	0,364286
21/02/2016	-0,396	0,9926031	1,00043318	102,47	1,00788843	103,2783279	2,147945205	-0,758196	0,362196
20/02/2016	-0,396	0,9926031	1,00039301	102,47	1,00784797	103,2741813	2,150684932	-0,754446	0,358446
19/02/2016	-0,396	0,9926031	1,00035285	102,47	1,0078075	103,2700348	2,153424658	-0,750706	0,354706
18/02/2016	-0,433	0,9926031	1,00031268	102,555	1,00776704	103,3515484	2,156164384	-0,785298	0,352298
17/02/2016	-0,407	0,9926031	1,00027251	102,508	1,00772657	103,3000353	2,15890411	-0,760371	0,353371
16/02/2016	-0,389	0,9926031	1,00023235	102,47	1,0076861	103,2575951	2,161643836	-0,739541	0,350541
15/02/2016	-0,412	0,9926031	1,00019218	102,525	1,00764564	103,3088691	2,164383562	-0,760549	0,348549
14/02/2016	-0,378	0,9926031	1,00015201	102,453	1,00760517	103,2321727	2,167123288	-0,724511	0,346511
13/02/2016	-0,378	0,9926031	1,00011185	102,453	1,00756471	103,2280269	2,169863014	-0,720835	0,342835
12/02/2016	-0,378	0,9926031	1,00007168	102,453	1,00752424	103,223881	2,17260274	-0,717168	0,339168
11/02/2016	-0,4	0,9926031	1,00003151	102,505	1,00748377	103,2721243	2,175342466	-0,736767	0,336767
10/02/2016	-0,444	0,9926031	0,99999135	102,613	1,00744331	103,3767802	2,178082192	-0,781278	0,337278
09/02/2016	-0,445	0,9926031	0,99995118	102,618	1,00740284	103,3776649	2,180821918	-0,779779	0,334779
08/02/2016	-0,462	0,9926031	0,99991101	102,66	1,00736238	103,4158216	2,183561644	-0,794732	0,332732
07/02/2016	-0,476	0,9926031	0,99987085	102,693	1,00732191	103,444909	2,18630137	-0,805646	0,329646
06/02/2016	-0,476	0,9926031	0,99983068	102,693	1,00728144	103,4407534	2,189041096	-0,801904	0,325904
05/02/2016	-0,476	0,9926031	0,99979051	102,693	1,00724098	103,4365978	2,191780822	-0,798171	0,322171
04/02/2016	-0,468	0,9926031	0,99975035	102,68	1,00720051	103,4193486	2,194520548	-0,7887	0,3207
03/02/2016	-0,487	0,9926031	0,99971018	102,733	1,00716005	103,4685731	2,197260274	-0,808392	0,321392
02/02/2016	-0,454	0,9926031	0,99967001	102,66	1,00711958	103,3908961	2,2	-0,772469	0,318469
01/02/2016	-0,467	0,9926031	0,99962985	102,693	1,00707911	103,4199755	2,202739726	-0,783331	0,316331
31/01/2016	-0,525	0,9926031	0,99958968	102,828	1,00703865	103,5517701	2,205479452	-0,83899	0,31399
30/01/2016	-0,525	0,9926031	0,99958968	102,828	1,00703865	103,5517701	2,208219178	-0,837053	0,312053
29/01/2016	-0,525	0,9926031	0,99963965	102,828	1,00708899	103,5569463	2,210958904	-0,837373	0,312373
28/01/2016	-0,518	0,9926031	0,99968961	102,815	1,00713932	103,5490296	2,21369863	-0,832003	0,314003
27/01/2016	-0,451	0,9926031	0,99973958	102,675	1,00718966	103,4131985	2,216438356	-0,771072	0,320072
26/01/2016	-0,448	0,9926031	0,99978954	102,67	1,00724	103,4133308	2,219178082	-0,769284	0,321284
25/01/2016	-0,399	0,9926031	0,99983951	102,563	1,00729034	103,3107189	2,221917808	-0,722898	0,323898
24/01/2016	-0,372	0,9926031	0,99988947	102,505	1,00734068	103,2574559	2,224657534	-0,697995	0,325995
23/01/2016	-0,372	0,9926031	0,99993944	102,505	1,00739101	103,2626158	2,22739726	-0,698482	0,326482
22/01/2016	-0,372	0,9926031	0,99998941	102,505	1,00744135	103,2677757	2,230136986	-0,698968	0,326968
21/01/2016	-0,331	0,9926031	1,00003937	102,415	1,00749169	103,1822613	2,232876712	-0,660205	0,329205
20/01/2016	-0,308	0,9926031	1,00008934	102,37	1,00754203	103,1420773	2,235616438	-0,641117	0,333117
19/01/2016	-0,336	0,9926031	1,0001393	102,438	1,00759236	103,2157467	2,238356164	-0,671276	0,335276
18/01/2016	-0,309	0,9926031	1,00018927	102,378	1,0076427	103,1604446	2,24109589	-0,645704	0,336704
17/01/2016	-0,299	0,9926031	1,00023923	102,358	1,00769304	103,1454442	2,243835616	-0,63756	0,33856
16/01/2016	-0,299	0,9926031	1,0002892	102,358	1,00774338	103,1505967	2,246575342	-0,638116	0,339116
15/01/2016	-0,299	0,9926031	1,00033916	102,358	1,00779372	103,1557492	2,249315068	-0,63867	0,33967
14/01/2016	-0,327	0,9926031	1,00038913	102,425	1,00784405	103,2284272	2,252054795	-0,668222	0,341222
13/01/2016	-0,334	0,9926031	1,00043909	102,45	1,00789439	103,2587804	2,254794521	-0,679539	0,345539
12/01/2016	-0,327	0,9926031	1,00048906	102,438	1,00794473	103,2518422	2,257534247	-0,674864	0,347864
11/01/2016	-0,353	0,9926031	1,00053903	102,5	1,00799507	103,3194944	2,260273973	-0,70208	0,34908
10/01/2016	-0,392	0,9926031	1,00058899	102,595	1,00804541	103,4204184	2,263013699	-0,743383	0,351383
09/01/2016	-0,392	0,9926031	1,00063896	102,595	1,00809574	103,4255828	2,265753425	-0,743807	0,351807
08/01/2016	-0,392	0,9926031	1,00068892	102,595	1,00814608	103,4307472	2,268493151	-0,74423	0,35223
07/01/2016	-0,399	0,9926031	1,00073889	102,613	1,00819642	103,4540591	2,271232877	-0,752353	0,353353
06/01/2016	-0,386	0,9926031	1,00078885	102,593	1,00824676	103,4390595	2,273972603	-0,744217	0,358217
05/01/2016	-0,416	0,9926031	1,00083882	102,665	1,00829709	103,5168212	2,276712329	-0,775361	0,359361
04/01/2016	-0,423	0,9926031	1,00088878	102,685	1,00834743	103,5421561	2,279452055	-0,784262	0,361262
03/01/2016	-0,433	0,9926031	1,00093875	102,713	1,00839777	103,5755602	2,282191781	-0,796542	0,363542
02/01/2016	-0,433	0,9926031	1,00098872	102,713	1,00844811	103,5807305	2,284931507	-0,796898	0,363898
01/01/2016	-0,433	0,9926031	1,00103868	102,713	1,00849845	103,5859009	2,287671233	-0,797254	0,364254

Sm corresponds to the seasonal factor of the maturity taking into account the 3 month lag, As OBOL ei 2018 maturity is 15^{th} April 2018, we assess the seasonal factor on 15^{th} January (0.9926031) using January factor (0.99117346) and February factor (0.999384212) :

Ssett corresponds to the seasonal factor of the settlement date taking into account the 3 month lag and using the same methodology described above.

IX) Appendix 3: US Seasonal factors: Comparative analysis

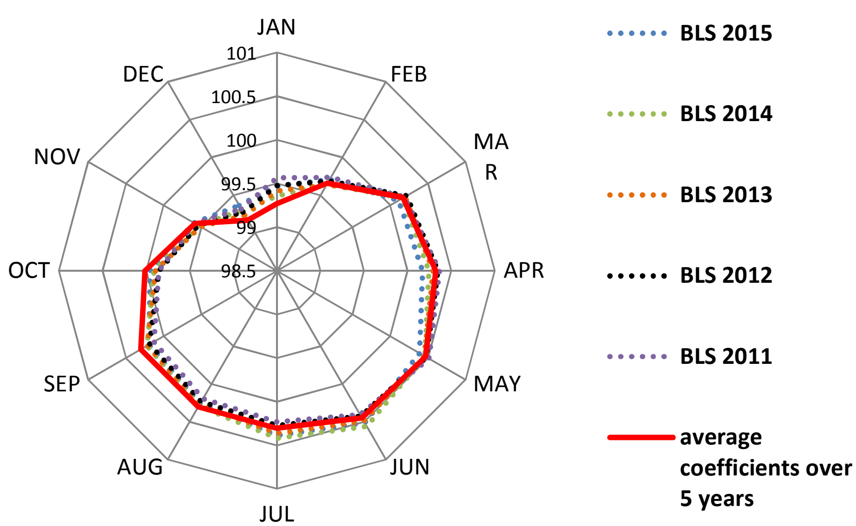
In order to verify the relevance and the accuracy of our methodology, we compared our seasonal factors with the ones published by the Bureau of Labor Statistics for the US Consumer price index.

US TIPS are linked to the US CPI Urban Consumers NSA (all items). This statistics is available on http://www.bls.gov/cpi/cpisapage.htm

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLS 2015	99,469	99,706	100,11	100,17	100,392	100,512	100,387	100,258	100,192	99,953	99,595	99,363
BLS 2014	99,354	99,643	100,168	100,244	100,463	100,56	100,418	100,291	100,219	99,908	99,532	99,301
BLS 2013	99,412	99,64	100,198	100,291	100,453	100,494	100,364	100,269	100,217	99,892	99,513	99,234
BLS 2012	99,476	99,687	100,218	100,348	100,478	100,425	100,275	100,233	100,182	99,854	99,543	99,277
BLS 2011	99,564	99,735	100,189	100,363	100,515	100,407	100,234	100,194	100,129	99,855	99,587	99,317

The graphic below is a comparison between the seasonal factors over the last five years (as published by BLS from 2011 to 2015) and the simple average of our monthly coefficients over the same 5 year period and calculated with the method described above. We can notice that the figures are quite similar with both methodologies.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2015	98,934846	99,308575	99,837415	99,980059	100,427097	100,718122	100,662145	100,456977	100,240120	100,132644	99,861055	99,457840
2014	99,153398	99,461867	100,037677	100,304647	100,589886	100,714112	100,609715	100,376697	100,389355	100,072398	99,469759	98,841800
2013	99,525772	100,225851	100,360388	100,132927	100,183924	100,301008	100,213209	100,206449	100,199786	99,814931	99,488738	99,353974
2012	99,507348	99,812532	100,422540	100,582424	100,316525	100,026718	99,716712	100,124068	100,427568	100,240753	99,623675	99,209147
2011	99,219014	99,484599	100,205259	100,608167	100,830469	100,480433	100,319757	100,346624	100,257484	99,802267	99,478441	98,986688
average coefficients over the last 5 years	99,268076	99,658685	100,172656	100,321645	100,469580	100,448079	100,304307	100,302163	100,302863	100,012598	99,584333	99,169890



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