COMPASS KALSTONE PARIS RESIDENTIAL PROPERTY INDEX (PARIS SQM)

2018 Methodology

CONTENTS

1 INTRODUCTION

The Compass Kalstone Paris Residential Property Index (the PARISSQM) has been designed to provide a benchmark for the "typical" transacted price per square meter in Paris over a reporting period of 2 weeks (the Reporting Fortnight "RF").

The Index is solely based on realised residential property transaction data reported to Paris Notaires Services (PNS) in the database BIEN. The calculation methodology used to compute the index is based on stratification, median indices and smoothing techniques.

Contrary to most of residential property indices the PARISSQM has not been primarily designed to manage changes in quality of assets and to measure the evolution of a fixed quality basket of properties evolution from one period to the other. It rather aims to represent a snapshot of the "typical" transacted price per square meter in Paris over a specific period of time. Consequently, the Index Committee has decided to use methodologies aiming to emphasise price observations.

The choice of the methodology has been dictated by the following goals:

- The PARISSQM aims to represent the "typical" transacted price of a square meter in Paris.
- Construction aims to be easily understandable by the public and particularly by real estate markets participants
- The methodology must be easily replicable to other cities to allow for Index comparison between different geographical areas.

2 DEFINITION

Data Selection Process: means the filtering process used by the Index Administrator to filter consistent transaction data and to identify outliers

Fisher price index: The geometric average of the Laspeyres price index and the Paasche price index.

HW: Holt-Winters – non- seasonal exponential smoothing used to filter the noise and capture the important patterns in times series. Computation of unknown parameters are determined by minimizing the squared prediction error using the R statistical language function HoltWinters.

Index: means the Compass Kalstone Paris Residential Property Index (PARISSQM)

Index Administrator: Compass Financial Technologies SA

Index Base Date (t_b): means 28th of May 2007

Index Calculation Agent : Compass Financial Technologies SA

Index Contributor: Paris Notaires Services (PNS)

Index Contributor Day: every Friday t of each week where the number of days between t and t0 (excluding t0 and including t) is a multiple of 14. If this day is not a business day for the Index Contributor, the Index Contributor Day is the first Index Eligible Business Day following this day on which the Index Contributor is able to provide the data contributed to the Index administrator before 12pm Paris time.

Index Disruption Event: means any event that prevents the Index Administrator from correctly calculating or publishing the Index Level on any Index Publication Day

Index Eligible Business Day: any day on which Euronext is open for trading

Index Final Dataset IFD(RF(t)): set of transactions available on date t for the Reporting Fortnight RF(t) and which have been selected after going through the Data Selection Process

Index Launch Date t0 means 27th of April 2018

Index Level or Preliminary Index Level IL(t): level of the preliminary Index published on date t

$IL_j(t)$: level of the Stratum Index computed on date t for stratum j

Index Publication Day t: every Friday t of each week where the number of days between t and t0 (excluding t0 and including t) is a multiple of 14. If this day is not an Index Eligible Business Day, the Index Publication Day is then defined as the first Index Eligible Business Day following this day.

Index Sponsors: Euronext and Kalstone

Index Supervisor: The Index Committee

Median Index M(t): A price index that tracks the change of the median property price over time. The median is the middle of a (sample) distribution: half the scores are above the median and half are below the median. The median is less sensitive to extreme scores than the mean and is often preferred to the mean as a measure of central tendency in highly skewed distributions.
$M_j(t)$: Median Index level computed on date t for stratum j

N(RF(t)): Number of total transactions available on date t for the Reporting Fortnight RF(t)

$N_{IFD}(RF(t))$: Number of transactions in the Index Final Dataset available on date t for the Reporting Fortnight RF(t)

$N_{IFD}(RF(t),S_i(t))$: Number of transactions in the Index Final Dataset related to stratum i and available on date t for the Reporting Fortnight RF(t)

$P(i)_j{}^T$: transacted price per square meter of property i in stratum j during reporting period T

Reporting Fortnight, RF(t): the 2 weeks period starting on Thursday, 8 weeks before the Thursday preceding t, and ending on Wednesday 6 weeks before the Wednesday preceding t.

$SM_j(t)$: smoothed Median Index level computed on date t for stratum j using the Holt-Winter smoothing algorithm.

Stratum $S_i(t)$: stratum i used to compute Index level published on date t

3   REAL ESTATE DATA

3.1   Source and nature of data

3.1.1   The Paris Notaire Services (PNS) database BIEN

Paris Notaires Services (PNS):

Created by the Notaries of Paris, Paris Notaires Services, PNS, is a not-for-profit association whose mission is to manage and develop the real estate database of notaries in Ile de France.
Within PNS, the department BIEN works on the exhaustive and rigorous collection of real estate transactions, data processing and the restoration of a coherent real estate repository built with unified management rules and semantics.
The team is, among others, composed of statisticians and experts in real estate.

The database BIEN (Base d'Informations Economiques Notariales)

The database is the result of an action carried out by the notaries of Paris and Ile de France for more than fifteen years, whose purpose is the collection and processing of the data of mutation recorded by all the studies of the region of Paris.

The database counts more than two million transfer files, called "references", each one informed according to more than a hundred criteria. Every year, the database is enriched with about two hundred thousand new references.

It is the most complete database of real estate transactions in Ile de France and in particular in Paris. The database is the main source of transaction data used by INSEE to compute Paris and Ile de France residential property price indicators.

3.1.2   Transaction data used to construct the index

The Index level IL(t) computed on any Index Publication Day t is based on all residential transaction prices in Paris reported in the database BIEN on date t for the reporting fortnight RF(t).

The Index Final Dataset IFD(t) used to compute the IL(t) is updated every 2 weeks according to the following process:

➢ On every Index Contributor Day, the Index Contributor send to the Index Administrator all transactions data reported in the PNS database over the last two weeks preceding the last Wednesday (included) preceding t.

➢ Then, the Index Administrator process the data to extract information which are going to be used to compute the new Index Level published on t.

For each reported transaction, the following information are theoretically available:
- Date of the transaction
- Arrondissement (district)
- Total transacted price
- Price per square meter

3.1.3   Coverage, quality, timeliness, frequency

Coverage

In France, any property sale must be recorded by a notarised deed, meaning that theoretically the collect of transactions data from notaries should represent the completeness of the real estate transactions made.

Until 2016, coverage of the database has been volatile, depending on various factors. Yet on average the coverage rate over the last 10 years exceeded 75%.

The National Assembly adopted on March 28th, 2011 the law n ° 2011-331 of modernization of the judicial or legal professions and certain regulated professions. Articles 15 and 16 of this law establish, at the expense of the notarial profession, a public service mission consisting of collecting, transmitting, centralizing and disseminating information on the transfer of real property for valuable consideration (which includes not only sales of old homes, but also sales in the future state of completion of new homes, sales of land, or those of non-residential premises). The implementing decree was published on September 3, 2013.

Hence since the first of January 2017, notaries have the obligation to report all transactions in a period of 60 calendar days following the transactions date.

Quality

Database BIEN reliability

PNS is the official organisation in charge of collecting transactions data from notaries. Apart from the fiscal authorities, PNS is the only organisation to have direct access to detailed and reliable transactions data via the privileged and unique communication process they have in place with notaries.

PNS mandate is to develop and maintain the database which is the only source of data used to create the Index.

Compass verification

Data used to construct the historical values have been statistically analysed by the Index Administrator to detect any abnormality or outliers in the data set.

Every time a new set of data is delivered to the Index administrator, the new data go through the same selection filter to detect inconsistent data.

Inconsistent data are excluded from the dataset used to calculate the Index.

Timeliness

Due to the change in law and the resulting increasing speed in transaction being recorded, a sufficient quantity and proportion of transactions allow a computation of the Index 6 weeks after the end of the reporting fortnight.

Frequency

Transactions data used by the Index Administrator are updated every 2 weeks. The observed average total number of transactions for a specific fortnight over the last 10 years is closed to 800 transactions. For that reason and keeping in mind that the main goal of our index is to give market participants a reactive and precise picture of the most recent "typical "transacted price in Paris, the PARISSQM® is calculated and published every 2 weeks.

3.1.4 Number of transactions

From April 2007 to January 2018 the data set of eligible transactions includes more 230 000 transactions.

3.2 Data Selection Process – defining the Index Final Dataset

3.2.1 Filtering uncomplete data transaction

Data received every two weeks from PNS are checked for consistency. If for a specific transaction, one of the following information is missing, the corresponding transaction is excluded from the Index Final Dataset.

- Amount of the transaction
- Price per square meter
- Arrondissement
- Date of transaction

As of 19 January 2018, the initial dataset received from PNS for transactions dated from April 2007 to January 2018 includes 248 277 observations.

15 980 observations have been excluded from the original data deliveries due to uncomplete and erroneous information. As of 19January 2018, the Index Final Dataset included 232 297 transactions.

3.2.2 Managing outliers

For a specific time period, if transactions meet the following criteria they are considered as outliers and are excluded from the data set used for the index calculation:

The price per square meter of the property is below the 1st centile or above the 99th centile of the recorded price transactions signed over the specific fortnight.

4 METHODOLOGY

The PARISSQM is based on the computation of median prices observed over the reporting period (the Reporting Fortnight RF(t)). Data used to compute the Index are included in the Index Final Dataset (IFD) and result from the process described above.

To mitigate potential bias linked to the changes in the proportion of properties sold in higher and lower priced arrondissement from one period to the other, stratification method (or mix-adjustment) is used according to the following steps:

1. Strata aiming to group transactions by geographical location (in our case by arrondissement) and long-term price levels are defined every year in March based on previous calendar year transactions data

2. For each stratum j, a median price index $M(t)_j$ is computed on the Index Final Dataset filtered for the corresponding stratum j (IFD$_j$). Then a smoothed price index $SM(t)_j$ based on HW algorithm is computed for the corresponding stratum.

3. The aggregated Index Level, IL(t), is computed using a Fisher Formula Index FI(t) and the number of selected transactions for each stratum

The resulting index is the PARISSQM.

4.1 Stratification

The Index Committee has decided to use stratification method for the 2 following reasons:
- The ability to provide real estate actors with sub-market defined by level of prices and geographical location
- Mitigate the noise linked to sample selection bias

Strata have been defined based on geographical area (arrondissement) and level of observed median prices. To maintain sufficient data in each stratum, it has been decided to keep 3 strata.

Stratum definition process

In March of each year, for each arrondissement, median prices for transactions realised during the previous calendar year are computed and sorted in ascending order. A first stratum is defined with arrondissement where the median price is inferior or equal to the 33th percentile. A second stratum is defined for arrondissement where the median price is between the 33th percentile and the 66th percentile. The remaining stratum is defined by the arrondissements where the median price is superior or equal to the 66th percentile.

The stratification process is reviewed annually in March and is implemented on the first Index Publication Day of April.

4.2 Calculation methodology

On every Index Publication Day, Index Levels are computed for each stratum j as the smoothed median of the prices per square meter of the eligible transaction.

$$SM(t)_j = HW \ ((Median_{i \in IFDj(RF(s))}(P(i)_j^{RF(s)}))_{s \in (t_b, \dots t)})$$

Where RF(t) is the reporting period considered on date t

Then two aggregated indices are computed according to the following formula:

A Paasche Index:

$$P_P \ (t) = \frac{\sum_{j=1}^{j=NbStratum} SM(t)_j \times N_{IFD}(RF(t), j)}{\sum_{j=1}^{j=NbStratum} SM(t-1)_j \times N_{IFD}(RF(t), j)}$$

Where $N_{IFD}(RF(t), j)$ is the number of eligible transaction in stratum j available on date t and signed during the reporting period RF(t)

And a Laspeyres Index:

$$P_L \ (t) = \frac{\sum_{j=1}^{j=NbStratum} SM(t)_j \times N_{IFD}(RF(t-1), j)}{\sum_{j=1}^{j=NbStratum} SM(t-1)_j \times N_{IFD}(RF(t-1), j)}$$

Those 2 indices aim to measure the price change between the Reporting period RF(t-1) and the current Reporting Fortnight RF(t).

Then a Fisher Index is computed:

$$FI\ (t) = \sqrt{P_P\ (t) \times P_L\ (t)}$$

The Index Level published on date t is then computed through the following formula

$$IL(t) = IL(t-1) \times FI(t)$$

$$IL(t_b)\ = Median_{i \in IFD\left(RF\left(t_b\right)\right)}\left(P(i)^{RF\left(t_b\right)}\right)$$

4.3 Historical data

Based on transaction data from the database BIEN, the Index Administrator has been able to compute Index Levels from April 2007.

Due to the lack of reliable information regarding the date on which transactions were available in the database and because the new French law applied to notaries since January 2017 changes significantly the transactions reporting delay the Index Administrator provides only historical figures based on the exhaustive set of transactions realised since April 2007 and available in the database BIEN as of the 26 May 2017.

Historical data are available under request to the Index Administrator. Back tested data are solely provided for illustrative purpose and does not guarantee future performance.

4.4 Rounding rules

Index levels are computed using all available decimals and are published with 2 decimals.
Prices and surfaces data related to transactions are used with the number of decimals provided by the Index Contributor.

5 INDEX DISRUPTION EVENTS, EXTRAORDINARY EVENTS– DEFINITION AND REMEDIES

5.1 Index disruption events

"Index Disruption Event" means, in the determination of the Index Administrator, the occurrence of any of the following events affecting the Index:

- Temporary loss of sufficient data

Definition: If for any Index Publication Day t, the number of eligible transaction for the Reporting Fortnight, $N_{IFD}(RF(t))$, is below 100, the Index will be considered as disrupted.

Remedy: Then its level will be equal to the last value published.
Historically, this happen only once over the last 10 years.

- **Index Contributor default to provide the dataset on time**
  Definition: If for any reason, the Index Administrator does not receive the dataset before noon on each Index Contributor Day, the Index will be considered as disrupted. In case Friday would be a holiday for the Index Contributor, this definition will apply.

  Remedy: The Index publication will be postponed to the Index Eligible Business Day following the Index Business Day on which the Index Administrator received the required dataset before noon (i.e. following the last Index Contributor Day).

5.2 Extraordinary events

Change of the Index Contributor
Definition: The Index Administrator considers that the Index Contributor cannot pursue its role as Index Contributor

Remedy: Then the Index Administrator can take any appropriate action to replace the Index Contributor. The Index Administrator shall suspend the Index computation and publication until a satisfactory solution is found to replace the Index Administrator.

6 INDEX GOVERNANCE AND MAINTENANCE

6.1 Administrator

Compass Financial Technologies is the Administrator of the index (" the Index Administrator"). The Index Administrator is responsible for the day-to-day management of the Index and is also responsible for decisions regarding the interpretation of these rules.

6.2 Index Committees – Supervisor

COMPASS agrees that only a highly transparent and independently monitored financial index can be recognised as a benchmark.
Compass has consequently established governance functions to review and provide challenges on all aspects of the Index determination process. Governance functions are managed by the Compass Oversight Committee and by the PARISSQM Steering Committee.

a) the Compass Oversight Committee oversees all areas of the benchmark determination processes.

It is responsible for supervising and controlling the index operations team on all Compass Indices. It is also responsible for:

i. periodic review of incidents
ii. making final decisions in case index operation team are not capable or allowed to take decisions
iii. defining and implementing organisation procedures for the index operations team
iv. defining and overseeing measures that allow for mitigation of operational risks.
v. supervising internal or external audit results.

The committee is comprised of senior representatives of COMPASS Financial Technologies and external industry experts.

b) The PARISSQM Steering Committee is responsible for:

i. determining the calculation methodology and the rules governing the publication of Index levels
ii. making periodic reviews of the Index to validate the robustness of the methodology and to analyse the impact of methodology changes
iii. organising consultation with Index stakeholders if necessary
iv. ensuring that the Index offers a reliable and representative view of the market.

The PARISSQM Steering Committee is composed of members of COMPASS Financial Technologies, Euronext and Kalstone. The committee may include individuals or representatives of companies such academics, external counsels or market participants

The PARISSQM Steering Committee assembles once a year in March. However, at the request a member of the committee, the Index Committee may meet on any other day of the year to discuss potential "market emergency" and "force majeure" events or any other situation, which makes an extraordinary meeting necessary.

All Index Committee decisions will be published without delay following the Index Committee decision. A representative of COMPASS Financial Technologies chairs the Index Committee.

Index committee members as of March 2018:

- Guillaume Le Fur, CEO, Compass Financial Technologies
- Edouard Mouton, Head of Research Compass Financial Technologies
- Michael Benhamou, Partner, Kalstone
- Stéphane Mesguiche, CEO, Kalstone
- Fabrice Rahmouni, Head of Index Team, Euronext

As of the 14 of May 2018, Mr. Guillaume Le Fur chairs the Index Committee.

6.3 Cases not covered in rules

In cases which are not expressly covered in these rules, operational adjustments will take place along the lines of the aim of the index. Operational adjustments may also take place if, in the opinion of the Index Administrator, it is desirable to do so to maintain a fair and orderly market in derivatives on this index and/or this is in the best interests of the investors in products based on the Index and/or the proper functioning of the markets. The Index Administrator will report to the Supervisor if it took a decision about a case which is not specifically covered in the rules for comments and review.

6.4   Methodology changes - Maintenance

This methodology may be supplemented, amended in whole or in part, revised or withdrawn at any time. Supplements, amendments, revisions and withdrawals may also lead to changes in the way the Index is compiled or calculated or affect the Index in another way.

In the absence of exceptional circumstances affecting the Index calculation or methodology, the Index is reviewed annually in March. The review includes re-testing model parameters and particularly re-defining the new stratums for the coming period.
Changes in Index methodology or computation parameters decided during the annual review are published on the last Index Eligible Business day of March and implemented on the first Index Publication Day of April.

The results of the Steering Index Committee will be published in a press release on COMPASS, Kalstone and Euronext websites and distributed timely to data vendors and major news sources.

6.5   Liability

The Index Administrator and the Supervisor are not liable for any losses resulting from supplementing, amending, revising or withdrawing the rules for the index.

The Administrator will do everything within its power to ensure the accuracy of the composition, calculation, publication and adjustment of the Index in accordance with relevant rules. However, neither the Index Administrator, nor the Supervisor are liable for any inaccuracy in index composition, calculation and the publication of the Index, the information used for making adjustments to the Index and the actual adjustments. Furthermore, the Index Administrator and the Supervisor do not guarantee the continuity of the composition of the Index, the continuity of the method of calculation of the Index, the continuity of the dissemination of the index levels, and the continuity of the calculation of the Index.

7   PUBLICATION AND DISSEMINATION

The Index Level is published on every Index Publication Day.
Publication and broadcasting of Index Levels are under embargo until 5:30 pm Paris time on every Index Publication Day.
From that time, information regarding Index will be published and distributed according to the following rules:
➢   To the medias by Euronext
➢   To the attention of the public by Compass FT and Euronext: Index Levels will be published on the Index Administrator website and available through any other information channels considered as relevant by the Index Administrator.

8   CONTACT INFORMATION

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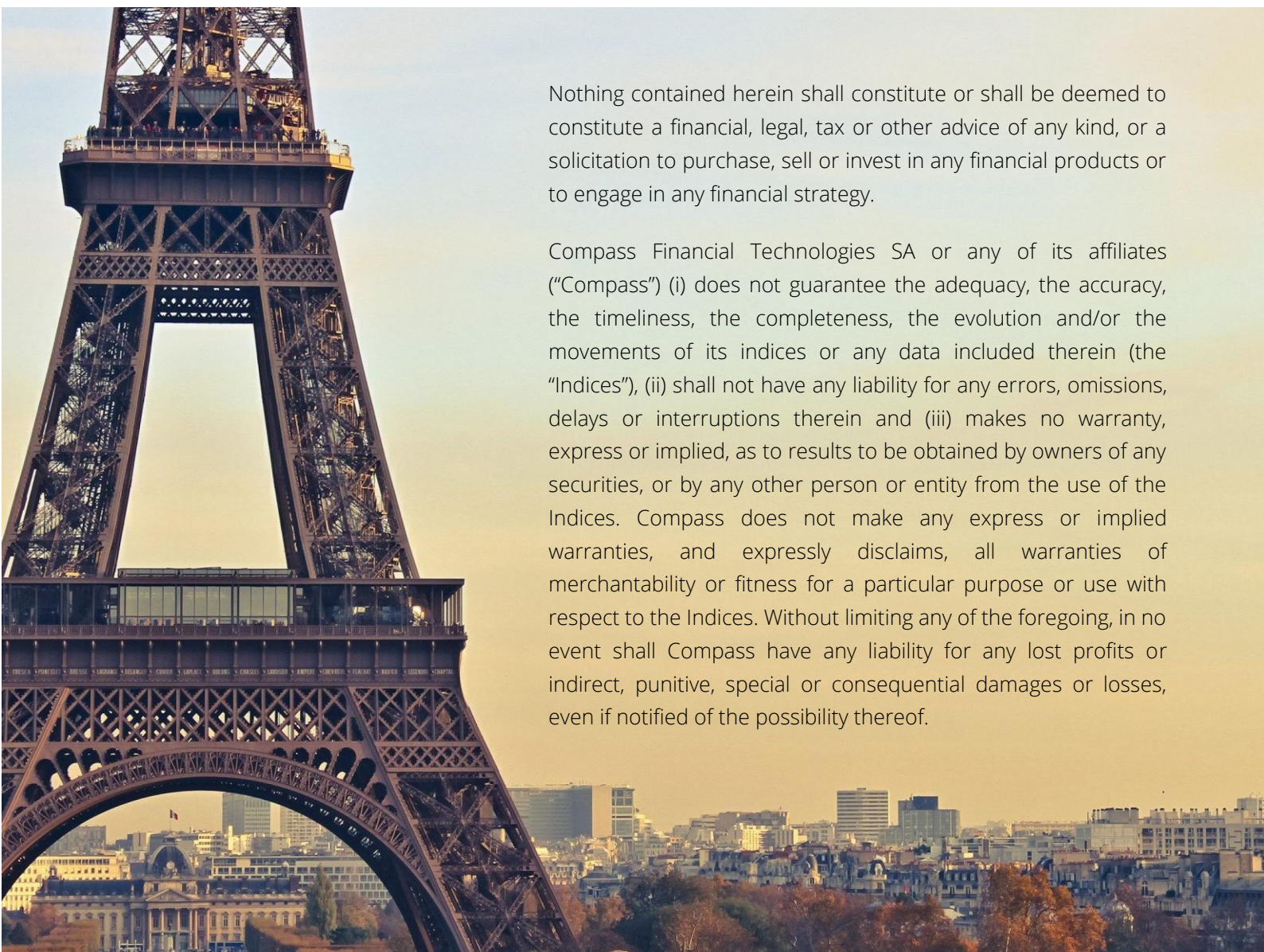e-mail : guillaume.lefur@compass-ft.com.

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