CHAPTER II
THEORETICAL REVIEW

2.1 ATTRIBUTION

Attribution is an effort to trace what contributed or caused a certain result or performance. In financial portfolio management terms, attribution means the effort to trace what contributed or caused a certain return. Combining Tim Lord and David Spaulding (Spaulding, 2003) definitions, the purpose of performance attribution is to measure total return performance of a portfolio relative to a benchmark and to explain that performance in terms of investment strategy and changes in market conditions.

The difference between the return of a portfolio and the return of the benchmark is the excess return. Basically there two ways to calculate excess return:

2.1.1. Arithmetic Excess Return

\[ ER_A = R_P - R_B \]

where

\[ ER_A = \text{arithmetic excess return} \]
\[ R_P = \text{portfolio return} \]
\[ R_B = \text{benchmark return} \]

2.1.2. Geometric Excess Return

\[ ER_G = \frac{1 + R_P}{1 + R_B} - 1 \]

where

\[ ER_G = \text{geometric excess return} \]

Here we will be using the arithmetic excess return formula.
Attribution analysis is still considered an evolving discipline. There is yet a one-size-fit-all model. Therefore there are various studies and papers written proposing different models for different needs. Nevertheless, there are laws in which have been generally accepted and must be fulfilled by every model.

2.1.3 First law of Performance Attribution:

*The attribution model should represent the active investment decisions of the portfolio manager*

The first law emphasizes the need to look at the manager’s intended actions when we try to figure out what caused the excess return.

2.1.4 Second Law of Performance Attribution

*The sum of the attribution effects must equal the excess return*

Mathematically, this law equates to:

$$\sum_{i=1}^{n} AE_i = R_P - R_B$$

where

- $AE = \text{attribution effect}$
- $R_P = \text{portfolio return}$
- $R_B = \text{benchmark return}$
- $i = \text{the individual effect}$
- $n = \text{the number of effects in the model}$

As mentioned earlier there are many different models for different needs. If one would like to do an attribution analysis on the performance of a security portfolio the model used would be different from a model used to analyze a
bond portfolio. We could consider the various models as tools in a toolbox. Different jobs require different tools.

Here we would be focusing on Bond Portfolio performance attribution analyses. In the realm of bond portfolio performance attribution there are two most widely used models which are the Campisi model and Tim Lord’s model. The purpose of this study is not to compare between models but to use a model and interpret the results, thus choosing any of the two will do. The Campisi model has been chosen solely on the fact that the theory on the model was easier to achieve.

2.2 BOND REVIEW

In order to better understand and interpret the results of the Campisi model, it would be preferable to review the theories on bonds especially in relation to their returns. A bond’s return could be illustrated as follow:

**Figure II-1 Diagram of Return Process**

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<table>
<thead>
<tr>
<th>Total Return</th>
</tr>
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<tbody>
<tr>
<td></td>
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The diagram above shows that the total return of a bond is the sum of its income and its price change over the measurement period. Mathematically expressed as follow:

\[
\text{Total Return} = \text{Income Return} + \text{Price Change}
\]

where:
• Income Return = Annual Coupon Rate ÷ Beginning Market Price
• Price Change = Effect of Yield Changes

The income return is quite straightforward since the beginning price remains constant throughout the lifetime of the bond. Annual coupon rate also is often constant, and if not there is always a benchmark to which the coupon is calculated.

Unfortunately the same cannot be said about Price Change and the Effect of Yield Changes. Therefore we would go a bit deeper on this.

2.2.1 BOND YIELD
According to Campisi (2000) Bond yields have two components:

2.2.1.1 An underlying Treasury Interest Rate, more familiar known as the T-Bond Rate.
2.2.1.2 A premium for risk which is given to compensate for both payment of principals and interest uncertainties.

Generally there are four types of risk embedded in bonds that require premium, which are:

• Interest Rate Risk – In accordance to the T-Bond rate, each change in the T-Bond rate will change the present value of the bond. An increase in the T-Bond rate will cause a drop in the bond’s present value while on the other hand a decrease in the T-Bond rate will cause an increase in the bond’s present value.

• Credit Risk – This is usually known as default risk, which is the risk where the bond issuer will fail to fulfill their obligations which are coupon payments and/or principal payments. There are certain institutions that evaluate the possibility of default risk/creditworthiness of companies that issue bonds. In Indonesia there are two that are most widely used which are Pefindo and PT Moody (formerly PT Kasnic). According to Campisi (2000) the ratings differ between AAA to BBB. The less creditworthy the
company the lower is their rating thus the higher the premium requested by investors.

- **Prepayment Risk** – This is a risk where the bond issuer has the option to repurchase the bonds at a predetermined price or rate. When the T-Bond rate drops below the coupon rate of the bond the issuer would have an incentive to borrow at a lower rate. Thus when the T-Bond rate drops below a certain level, it would be more profitable for a company to repurchase their bonds, pay the premium promised and borrow or issue a new bond with a lower coupon rate leaving the former investors to reinvest at lower yields.

- **Equity-type Risk** – This type of risk is mainly associated with “junk bonds”. These type of bonds are also known as speculative grade bonds which have a grading rate between BB-D (defaulted). Compared to investment grade bonds, “junk-bonds” definitely reflect a higher degree of default risk and a much greater than average selection effect.

### 2.2.2 CONNECTION BETWEEN PRICE AND YIELD: DURATION

As mentioned earlier bonds face credit risk. This is caused by the relationship between yield and the price of a bond which is theoretically calculated as the present value of its future cash flow. According to Ross (2005) the present value of a bond is calculated as follow:

\[
PV = C \left[ \frac{1}{r} - \frac{1}{r \times (1 + r)^T} \right] + \frac{F}{(1 + r)^T}
\]

where

- \( PV \) = Present Value
- \( C \) = Bond Coupon Amount per period
- \( r \) = yield
- \( T \) = remaining periods
\[ F \] = face/beginning value of the bond

From this formula we can see that an increase in yield would cause a decrease in present value and vice versa. The extent of the change in present value due to a change in yield depends on the bond's sensitivity. This price sensitivity is called duration. Fabozzi (2000) used the Macaulay duration formula to calculate duration. The Macaulay Duration is as follow:

\[
Macaulay \text{ Duration} = \frac{\sum_{t=1}^{n} \frac{tC}{(1 + Y)^t} + \frac{nM}{(1 + Y)^n}}{P}
\]

where

- \( C \) = Coupon Amount per period
- \( t \) = individual period
- \( n \) = period at maturity
- \( Y \) = yield
- \( M \) = maturity value
- \( P \) = current market price

This duration is usually modified as follow:

\[
Modified \text{ Duration} = - \frac{Macaulay \text{ Duration}}{1 + y}
\]

According to Fabozzi (2000) the above equation is related to the approximate percentage change in price for a given change in yield. The change in yield could be due to changes in interest rates and/or risk premiums.

Campisi (2000) presented the general model for bond price change is:

\[
Change \text{ in Bond Price} = -\text{Modified Duration} \times \text{Change in Yield}
\]
The negative sign preceding modified duration preserves the inverse relationship between yield change and bond price change. Duration generally increases with longer bond maturities and decreases with higher coupon rates.

Like Beta’s for stocks, duration is the systematic risk measure for bonds. Betas are used to measure the sensitivity of stock against the overall stock market, meanwhile durations measures the sensitivity of a bond to changes in yields caused by changes in treasury rate and/or risk premium. Just as market risk cannot be diversified away in a stock portfolio, the risk of price declines resulting from rising yields cannot be diversified away. By incorporating the systematic risk of bonds, a true risk-adjusted attribution process begins to emerge. Thus far, this attribution process identified the income component of return, along with the price change from systematic risk. The remaining component is a small selection effect. Calculating the selection effect involves comparing the portfolio’s average spread change with the spread change for an identically allocated index, after controlling for any differences in price sensitivity. By adjusting for differences in duration, this process eliminates the error of assigning a selection effect to differences in systematic risk or style.

This concludes the basics of about bonds needed to understand and interpret the results of the Campisi model.

2.3 CAMPISI’S MODEL

The following data is needed for the investment and the benchmark:

- Duration
- Coupon
- Beginning Market Price
- Allocation to sectors
- Total Return
- Interest Rate Change
The Campisi Fixed Income Performance Attribution Model measures the performance of return of a fixed income portfolio relative to a benchmark by decomposing the return to its derivatives. But before any decomposing is done we must first neutralize the effect of risk of the portfolio and the benchmark by separating the bonds that form them in groups according to each bond’s risk level. After this is done, then we can continue the decomposition process. Both the portfolio’s and the benchmark’s returns are decomposed into:

2.3.1 Income Effect

The income effect is the proportion of income which is derived from the promised coupons of bonds that build the portfolio. The formula for Income Effect is:
2.3.2 Treasury Effect

According to Campisi (2000), this is the component of our price change that results from the change in treasury rates and the sensitivity of the investment to the change in rates. We calculate Treasury Effect with the following formula:

\[ \text{Treasury Effect} = (-\text{Duration}) \times \text{Treasury Change} \]

The Treasury Change component is derived from the measurement of the sensitivity of T-Bonds towards yield change and difference in duration.

2.3.3 Spread Change Effect

This measures the portion of price return attributable to changes in the yield spread between a bond and its “duration-matched Treasury Bond” (DMT). DMT is a synthetic (noncallable) Treasury Bond, constructed from the Treasury yield curve. The formula for spread effect is:

\[ \text{Spread Change} = Y_{\text{Bond}} - Y_{\text{DMT}} \]

2.3.4 Spread Effect

The spread effect is the percentage price change due to a widening or tightening of the yield spread. This is the product of spread change effect and the bond’s duration formulated as follow:

\[ \text{Spread Effect} = (-\text{Duration}) \times \text{Average Spread Change} \]

2.3.5 Selection Effect

Selection effect for fixed income is similar with selection effect for securities. It is the effect of selecting certain bonds against others including shifts in weight. Campisi (2000) also considers this as usually relatively small for portfolios and even zero for indexes. Here Campisi formulates...
Selection effect as the residual return after adjusting for all systematic effects as follow:

\[
\text{Selection Effect} = \text{Total Return} - \text{Income Effect} - \text{Treasury Effect} - \text{Spread Effect}
\]

Concluding the Campisi’s Fixed Income Performance Attribution Model after decomposing total return of the benchmark and the evaluated portfolio we could further analyze the evaluated portfolios performance relative to the benchmark and trace the causes of differences. To conclude, here is the formula of the decomposition:

\[
\text{Total Return} = \text{Income Effect} + \text{Treasury Effect} + \text{Spread Effect} + \text{Selection Effect}
\]

2.4 PREVIOUS EMPIRICAL RESEARCH

As mentioned earlier, the fixed-income performance attribution is still a developing subject. Some studies breakdown performance into more detail factors, some propose that performance attribution must follow the approach which was intended by the manager and some even argue that returns should be time weighted. Here we will present some empirical studies that relate to this study.

2.4.1 Nabil Khoury, Marc Veilleux and Robert Viau (Fall 2003)

Khoury et.al in their article entitled “A Performance Attribution Model for Fixed-Income Portfolios – Eleven Factors to Consider When Evaluation Bonds agreed that in general ex-post performance attribution can be broken down into four broad components, which are:

- Passage of time
- Yield curve movements
- Changes in spread
- Security selection

Khoury et.al then proposed a more detailed breakdown which consists of 11 factors. The eleven factors mentioned are as follow:

- Passage of Time
The coupon factor
The cash factor
The curve factor
The spread factor
The options factor
The exchange factor
The arbitrage factor
The derivatives factor
The selectivity factor
The residual factor

There is one specific factor mentioned above which is quite different from that of Campisi which is the residual factor. Even though this study is not meant to compare between models, Khouri’s model may possibly shed some light on why the results of this study show a considerable selection effect and whether or not the selection effect should be broken down even further.

2.4.2 Damien Laker

Damien Laker wrote an article entitled “Fundamentals of Performance Attribution: Implementation Consideration”. This article focuses on time intervals for performance attribution, how to get appropriate data and the reasons for attribution analysis. In this article it is mentioned that the whole purpose of performance attribution is to explain a portfolio’s return in a systematic way. Ideally, the assumptions behind the performance attribution will be congruent with the investment process that a portfolio professes to use. Here Damien shuts down the possibility that consensus may be achieved in the field of performance attribution. There will never be a one size fits all method. Knowing the strengths and weaknesses of each model would help a person to determine which model best fit their needs.