Product Guide

CreditManager: Risk Attribution Module

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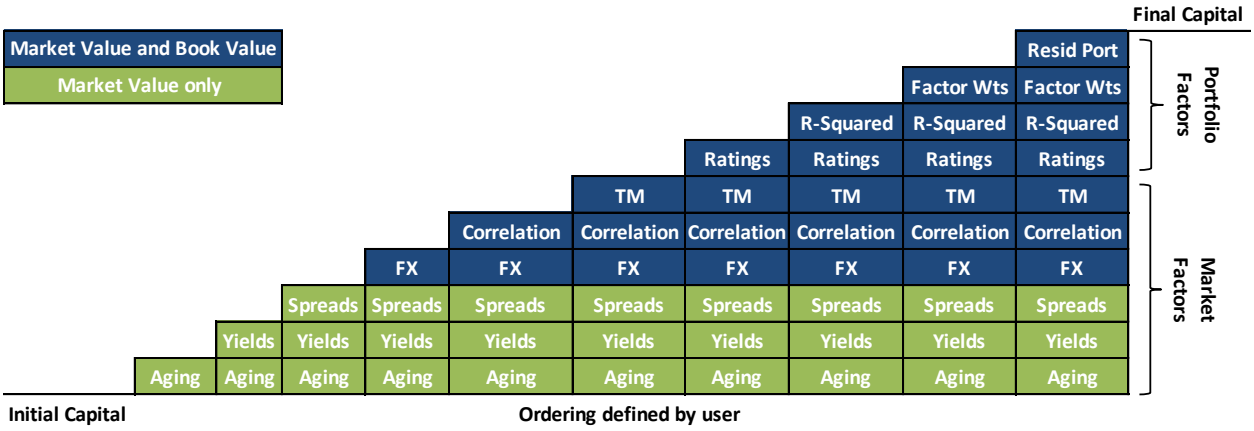
Introduction

Credit risk statistics in CreditManager are produced by a simulation-based model. Changes in these statistics between two dates are driven by various factors such as portfolio composition changes, the passage of time and changes in market data such as yields, credit spreads, correlation market factors and transition matrices (TM). Understanding and attributing these changes across time is an important part of the capital allocation process.

This paper highlights CreditManager's Attribution Module that is designed to systematically address changes in simulated statistics such as VaR and Expected Shortfall (hereafter called capital), as well as non-simulated statistics such as current value and mean horizon value, across two points in time. The top level change in the statistics is broken down via a cumulative, sequential changing of the individual factors (Figure 1). This can be further attributed across portfolio drilldowns defined via tags. In the following sections, we present a practical overview of the methodology before moving to a case study showing the module in use. We conclude with examples of the CreditManager work flow.

Figure 1: Schematic of attribution analysis methodology



Notes: A) Graphic above for illustration only; individual factors such as correlation may not always increase capital. B) If position is set to mature before risk horizon (typically 1yr), after moving to final attribution analysis date, 'Aging' can factor in Book Value also.

Methodology – Step by step

Within CreditManager, Credit Value at Risk (CVaR) can be defined as a percentile of a profit and loss (PnL) distribution, produced from many simulation trials. Each PnL is defined as the difference between a value for the exposure, due to a simulated rating at the risk horizon (horizon value), and the current value. In book value mode, this PnL is driven primarily by default. In market value mode, PnL is further driven by rating migrations, since valuation comes into play. Both modes are referenced in Figure 1.

CreditManager's Attribution Module runs sequential simulations to isolate changes in Capital across time (initial and final) to factors. Apart from Capital, this module can also be used for a variety of other statistics, such as current value or mean horizon value. The general steps are explained below:

Step 1 – 'Starting': Credit risk simulation using all 'initial' market data and correlation settings.

Step 2 – 'Aging': Step 1 parameters remain unchanged except for instrument pricing date (from Report Settings), which is moved to 'final' date; the simulation is then re-run. 'Aging' is attributed to the difference in Step 2 and Step 1 capital figures.

Step 3 – 'Yields': Step 2 parameters remain unchanged except for government and swap curve levels, which are moved to values corresponding to the 'final' date; the simulation is then re-run. 'Yields' is attributed to the difference in Step 3 and Step 2 capital figures.

Step 4 – 'Spreads': Step 3 parameters remain unchanged except for spread levels, which are moved to values corresponding to the 'final' date; the simulation is then re-run. 'Spreads' is attributed to the difference in Step 4 and Step 3 capital figures.

Step 5 – 'FX': Step 4 parameters remain unchanged except for FX levels, which are moved to values corresponding to the 'final' date; the simulation is re-run. 'FX' is attributed to the difference in Step 5 and Step 4 capital figures.

Step 6 – 'Correlation': Step 5 parameters remain unchanged except for the 'Market Factor Indices' date (from Report Settings), which is moved for 'final' date; the simulation is then re-run. 'Correlation' is attributed to the difference in Step 6 and Step 5 capital figures.

Step 7 – 'Transition Matrices': Step 6 parameters remain unchanged except for 'Transition Matrices'. Here, the transition matrices associated with obligors from the 'final' date snapshot are used; the simulation is then re-run. 'Transition Matrices' are attributed to the difference in Step 7 and Step 6 capital figures.

Step 8 – 'Portfolio Factors': Step 7 parameters remain unchanged, and the portfolio (obligors and exposures) corresponding to the 'initial' date is exchanged for the portfolio corresponding to the 'final' date; the simulation is then re-run. As suggested by Figure 1, these changes can be further decomposed into changes in assigned credit ratings, obligor R-squared, relative factor weights as well as the portfolio positions themselves, which are included in the 'residual portfolio changes' category.

The steps presented above can be generated when row groups are presented. This is the case in the example that follows.

Case Study

To help highlight the functionality, we present a case study. For our portfolio, we use a single government bond portfolio, with our time endpoints being 1 January 2013 and 15 April 2013. The

composition is entirely investment grade, with roughly a third of notional in each of EUR, GBP and JPY currencies.

During this period, we exchange roughly EUR1bn of United States government bonds for Italian government bonds (Table 1). This exchange can be seen in ratings and currency composition. For example, at 15 April 2013, the BBB allocation has increased to 15% from 9%, while the AAA allocation has been reduced accordingly. A similar change is seen in the currency composition; EUR allocation has increased and USD has decreased. We will conduct this study in CreditManager's 'market value mode' and therefore market data changes will also be meaningful in the attribution analysis.

Table 1: Portfolio notional at beginning and end of measurement period

	1 January 2013	15 April 2013
Rating Composition (%)		
AAA	26	20
AA	60	60
A	5	5
BBB	9	15
Currency Composition (%)		
EUR	30	36
GBP	5	5
JPY	29	29
USD	26	20
Other	10	10

Attribution Analysis Report

We begin our case study with an example from the CreditManager VaR Attribution report itself, which shows an attribution analysis report on VaR contribution (defined hereafter as capital), by Country (Figure 2). For each of the columns in this report, only one factor is changed, and a 'new' simulation is run. This report output will be referred to throughout this document.

Top level capital during this time period rose from approximately EUR212mm to EUR300mm. In what follows, we show the results of the attribution report and specifically look at the factor behavior over a time period, to help understand the drivers for change during the period.

Figure 2: Example output of attribution analysis report

VaR Contribution (99%) *

	VaR Contribution (99%) *											
	Levels	Differences										Levels
	Starting	Aging	Yields	Spreads	FX	Correlations	Transition Matrices	Credit Ratings	R-Squared	Relative Factor Weights	Residual Portfolio Effects	Ending
Total	212,792,849	-7,360,938	2,593,427	-9,105,416	-4,085,628	304,470	0	0	0	0	104,780,603	299,919,367
AT	665,882	-26,488	-583	-96,974	67,692	-134,176	0	0	0	0	110,928	586,282
AU	734,111	-33,275	-31,721	95,085	-105,343	30,505	0	0	0	0	-263,876	425,485
BE	2,426,757	-76,195	29,209	-581,181	249,452	1,195,726	0	0	0	0	-2,223,998	1,019,772
CA	4,377,872	-175,347	-71,761	211,856	-97,116	-1,248,569	0	0	0	0	-1,035,858	1,961,077
CH	594,700	-24,919	-2,097	25,616	-22,579	-80,025	0	0	0	0	-157,471	333,225
DE	13,175,428	-471,833	-325,343	2,133,132	-45,222	347,221	0	0	0	0	-3,945,025	10,868,357
DK	665,119	-5,161	-10,856	95,854	-39,017	374,221	0	0	0	0	-456,784	623,376
ES	12,512,436	-474,266	-107,165	-1,585,907	174,893	896,194	0	0	0	0	-3,027,774	8,388,412
FI	747,964	-28,362	-43,389	1,625	7,887	-249,041	0	0	0	0	-149,538	287,147
FR	7,364,548	-242,659	333,407	-1,984,623	52,651	-1,399,965	0	0	0	0	-659,309	3,464,049
GB	15,086,515	-219,290	150,583	2,074,430	-1,377,350	-830,655	0	0	0	0	1,456,873	16,341,106
IT	86,478,919	-2,135,955	-1,296,492	5,155,039	3,687,516	3,759,953	0	0	0	0	133,185,494	228,834,474
JP	42,075,480	-1,304,521	4,023,176	-10,800,651	-7,145,605	-2,086,951	0	0	0	0	-6,831,895	17,929,033
MX	235,655	-8,293	-38,324	-45,862	130,059	30,124	0	0	0	0	-318,436	-15,077
MY	145,661	-12,386	992	-5,192	4,299	-121,964	0	0	0	0	-7,054	4,357
NL	4,649,855	-177,547	-297,803	836,741	-52,977	-260,568	0	0	0	0	-981,575	3,716,127
NO	124,754	-6,789	1,290	5,791	-4,188	15,794	0	0	0	0	-48,114	88,537
PL	568,171	-25,924	-24,757	26,769	86,381	-333,237	0	0	0	0	-113,655	183,748
SE	612,171	-26,905	-25,500	12,767	25,194	-65,857	0	0	0	0	-308,048	223,822
SG	124,613	-5,936	-249	5,053	-5,566	-54,549	0	0	0	0	-18,559	44,807
US	19,426,237	-1,878,886	330,809	-4,684,784	323,310	520,289	0	0	0	0	-9,425,724	4,611,250

* denotes baseline for loss distribution is Mean Horizon Value

Aging

As noted previously, we have enabled CreditManager's market value mode in this study. This option allows for Hull White valuation to take place, and hence duration is accounted for. The report shows that aging reduces capital by about EUR7.4mm, and suggests that aging has made the portfolio marginally less sensitive to other market factor changes, as the age and duration have been reduced. In other words, when the simulation that corresponds to the incremental aging change is run, the portfolio PnL is less sensitive to rating migrations due to its lower duration.

Yields

This risk factor group includes government curves across currencies. The output in Figure 2 shows an attribution of about EUR2.6mm during our measurement period, with a significant portion of that coming from Japan and the US, which account for about two thirds of notional.

Figure 3: Yield curve levels at beginning and end of measurement period

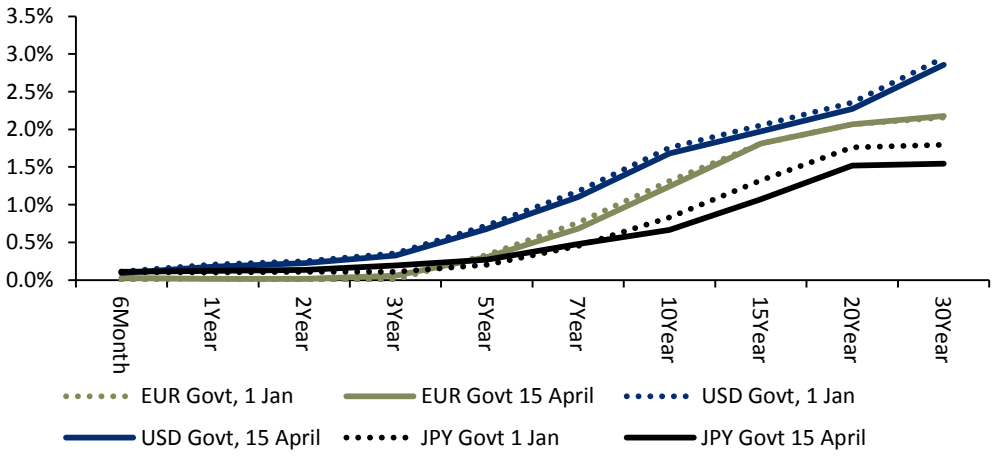
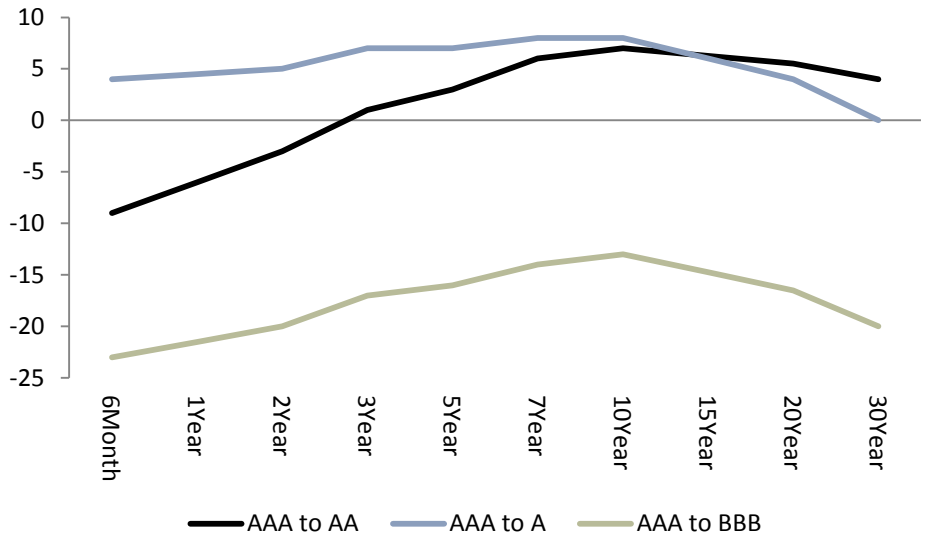


Figure 3 shows the movement of USD and JPY curves, as well as the EUR government yield curves which are used for EUR denominated bonds. For each currency, the dotted line denotes the 1 January level, while the solid line shows the 15 April level. The movements here are intuitive, for example, the EUR curve shows essentially no change while we see both USD and especially JPY tightening during the period. The tightening works to increase the value of the USD and JPY portions of the portfolio, which acts as a larger base from which capital is accounted for. Accordingly, within the 'Yield' factor of attribution, JPY and USD bonds contribute the majority of the capital change allocation while the EUR denominated bond contributions are more mixed.

Spreads

Top level capital attributable to spreads decreased by about EUR9mn. While general spread levels tightened during our measurement period, the spread differences between ratings varied. For example, Figure 4 shows that during our measurement period, the spread change due to a migration from AAA to AA at the 6mo tenor decreased nearly 10bps, and the spread change due to migration from AAA to single-A at the 6mo tenor increased nearly 5bps. PnL due to rating migration in CreditManager is driven by the differences between spread levels, while attribution is driven by the relative changes of these differences during the measurement period.

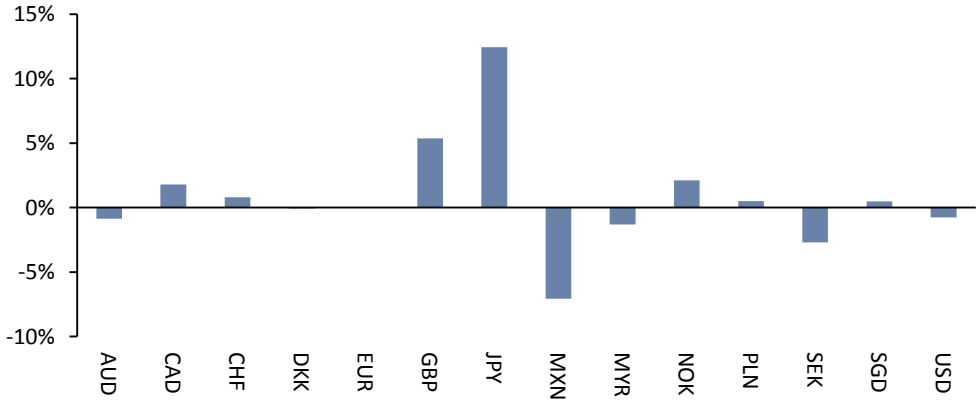
Figure 4: Change in spread between ratings during period (15 Apr minus 1 Jan, bps)



FX

Foreign exchange movements of EUR-4.1mm were driven largely by JPY exposures, which account for about a third of the holdings. The significant weakening of the Yen relative to the EUR reporting currency was the primary driver, with a –EUR7.1mm contribution over the period. A smaller relative weight to the JPY positions following the FX move is the reason for this reduction. We observe a similar story for GBP as well.

Figure 5: Euro currency returns (reporting currency) during measurement period



Correlation

Our government bond portfolio references various equity index factors, which were chosen to be the respective country financials index. A one year lookback period for these indices was used for correlation. For example, the first period looks back a year from 1 January, while the end period looks back a year from 15 April. The respective charts for factor returns used to derive asset return correlation are shown in Figure 6 and Figure 7. Going a step further and running the Obligor Correlation Diagnostics report in CreditManager, we find that the average pairwise correlation among obligors remained relatively stable, having moved from about 29% to 31% over our measurement period. This Attribution Report confirms this stability with only a change of EUR0.3mm over the measurement period.

Figure 6: One year historical cumulative factor returns, at 1 January 2013

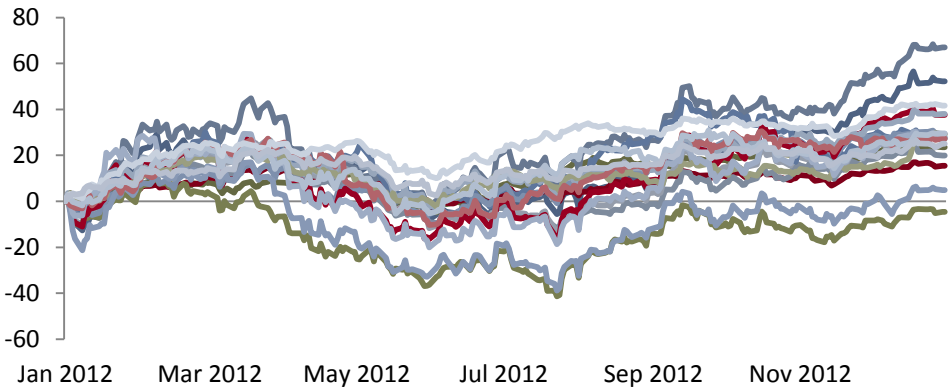
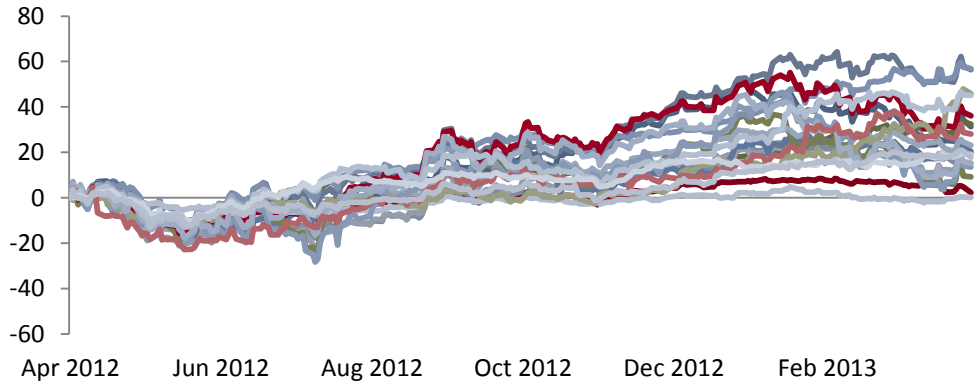


Figure 7: One year historical cumulative factor returns, at 15 April 2013



Transition Matrices

In some cases, factors may not change during the measurement period. For example, the same rating transition matrix might be used at both measurement endpoints. This is the case in our study; the 2012 cohort was used on both periods. Should the analysis period start and end points fall in different years, where different cohorts of matrices are used, this would be accounted for in the attribution analysis.

Portfolio Changes

Finally, we consider the portfolio changes during our measurement period. In this case, attribution is driven by changes in assigned credit ratings, obligor R-squared, relative factor weights and the portfolio positions themselves (residual portfolio changes).

Within our case study, recall that the rating composition changed due to the United States and Italian government bond exchange, which was the only portfolio change during our measurement period (Table 1). This can clearly be seen as the single largest driver of VaR contribution during this period at EUR 104mm; all other components are zero. From a ratings perspective, riskier bonds replaced less risky bonds. Put another way, we see that the one-for-one exchange of bonds was not reflective by a one-for-one exchange in capital. For example, removing the United States component reduced its VaR contribution by about EUR9mm while the Italian component increased by about EUR 133mm.

Application in CreditManager

The Attribution Module is optional in CreditManager and is available via an additional tab in the application. The sub components within this tab are ‘Market Data’, ‘Portfolio’ and ‘Automation’.

Market Data Snapshots

To mark the start and end points of the attribution analysis, corresponding market data snapshots are defined. The components governed by the market data snapshot are:

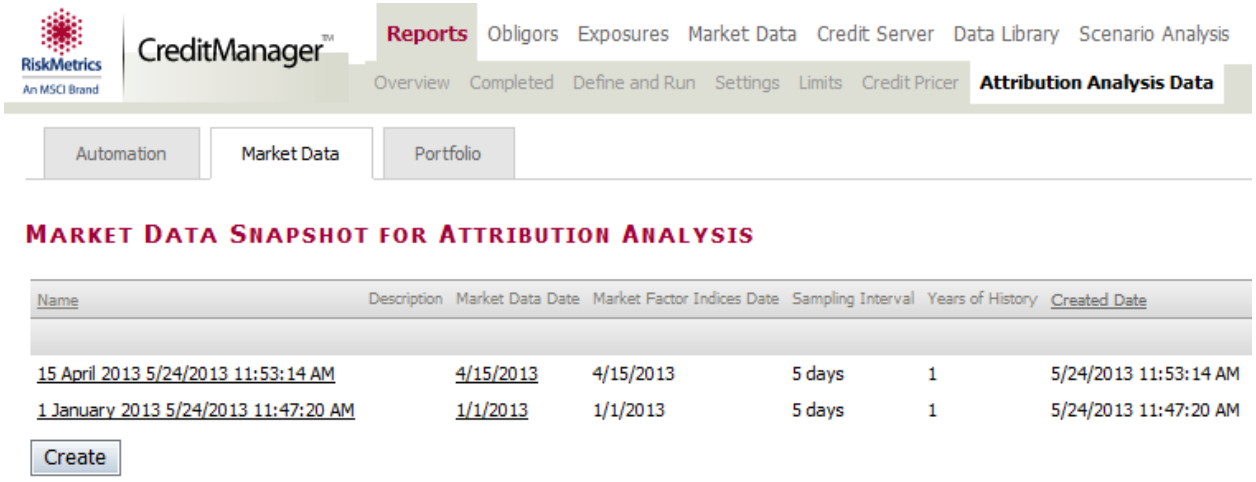
Market Data Date: As the name suggests, the date at which market data is snapped for the analysis.

Market Factor Indices Date: The end date for the correlation market factor indices.

Sampling Interval: The return sampling frequency for correlation market factor indices.

Years of History: The number of years of history to use for correlation market factor indices.

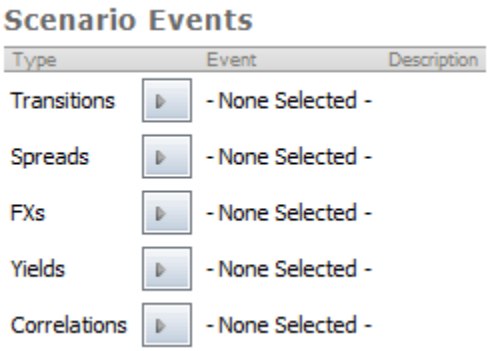
Figure 8: Market data snapshot tab in CreditManager attribution analysis module



Scenarios

When creating market data snapshots, the user may also incorporate scenarios (Figure 9). In addition to allowing for custom data to be used, Scenarios can integrate stress tests in the overall attribution analysis.

Figure 9: Portfolio snapshot tab in CreditManager attribution analysis

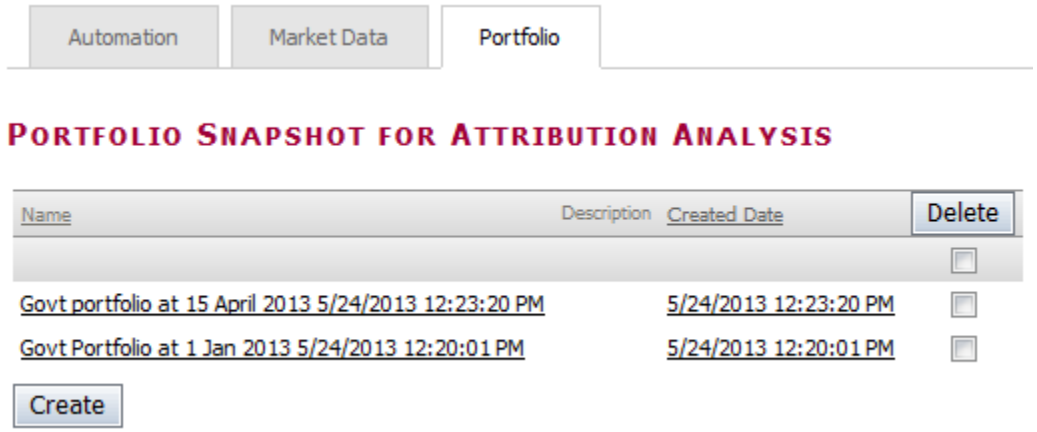


Portfolio Snapshots

Within CreditManager, creating a portfolio snapshot is quite simple; the user need only specify a date for the snapshot. However, behind the scenes, a larger process takes place. That is, a copy of all obligors and exposures, and therefore all portfolios, in the user's realm is created and stored with the name of the snapshot. This copy is time stamped, and can be accessed later in the attribution report by

specifying the portfolio snapshot, and corresponding portfolio. Importantly, this snapshot can be accessed even if all the obligors and exposures have since been deleted by the user.

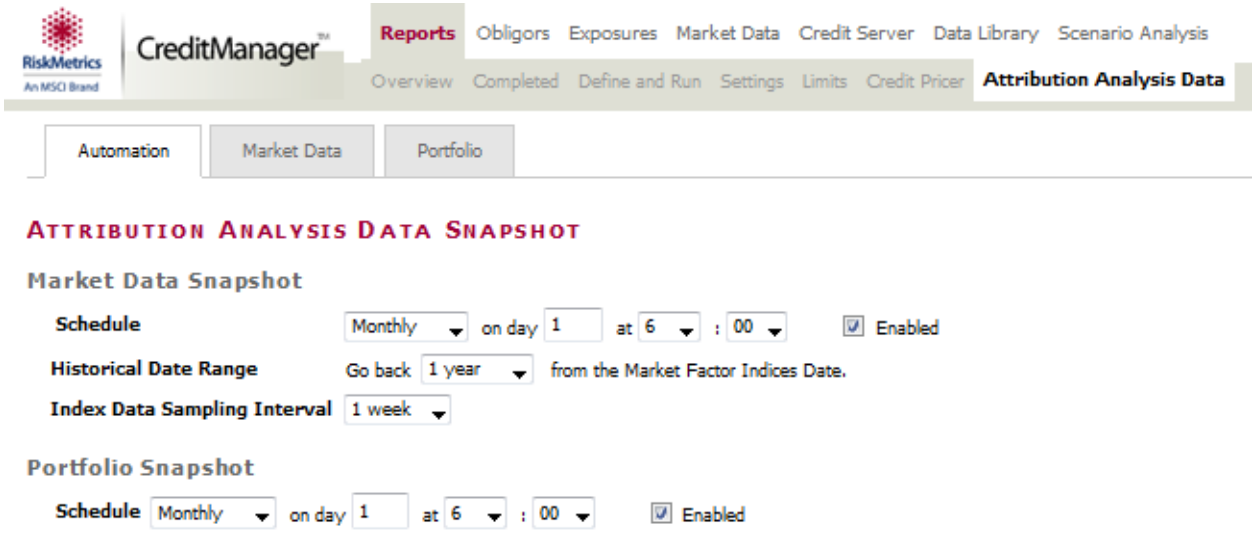
Figure 10: Portfolio snapshot tab in CreditManager attribution analysis module



Automation

To help integrate attribution analysis as part of a larger workflow, the Automation tab can be used to schedule automatic market data and portfolio snapshots to take place. Such functionality is intended to increase efficiency and also help in historical analysis, where the user may wish to call up various historical instances of a particular portfolio.

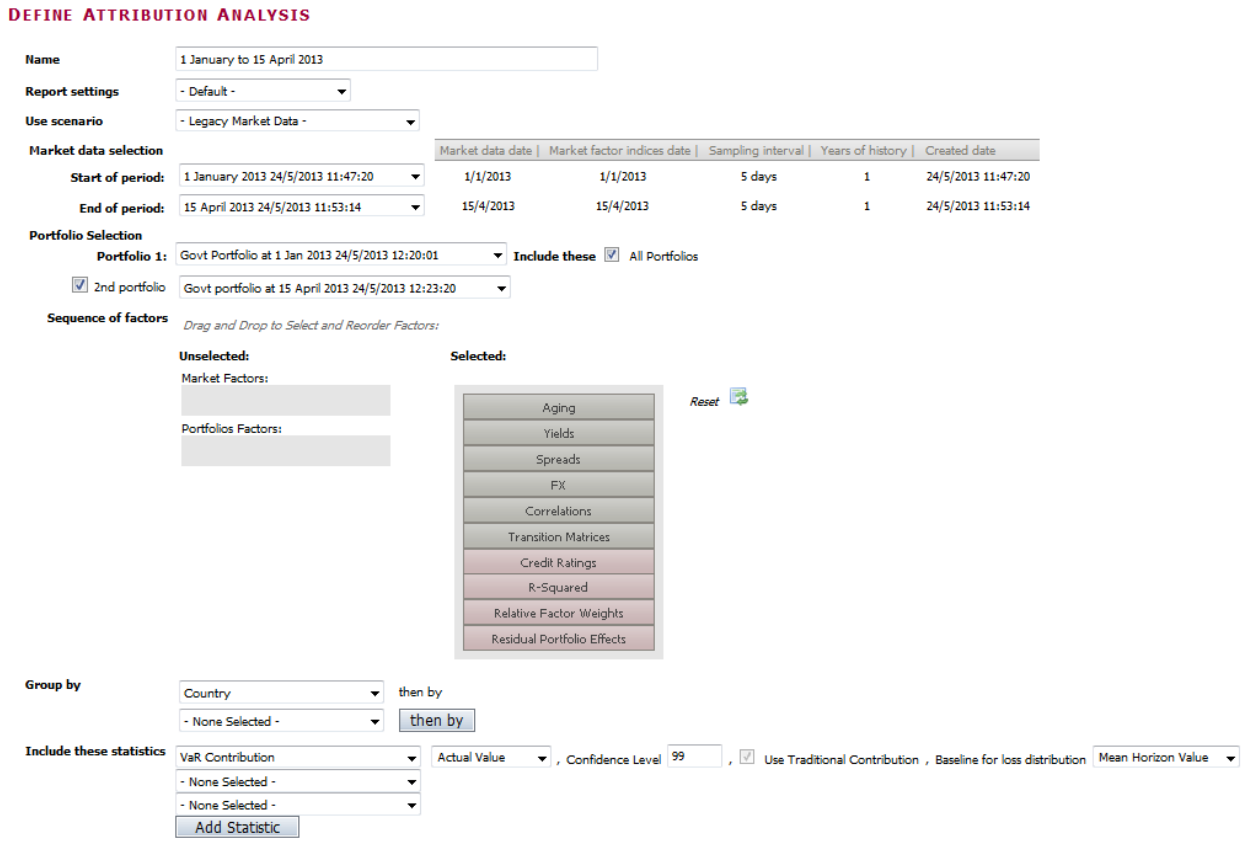
Figure 11: Snapshot automation tab in CreditManager attribution analysis module



Report Creation

Once the above components have been defined, the remaining step is a report definition. This is similar to creating most other reports in CreditManager, with the addition of referencing the portfolio and market data snapshot to use.

Figure 12: Report definition template for CreditManager attribution analysis module



Conclusion

Storage of multiple portfolio instances coupled with the attribution functionality can be valuable for CreditManager users. The intuitive and rigorous methodology paired with the easy to use interface provides CreditManager users with a platform to quickly and accurately understand changes in capital, as part of the credit risk management process.

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[1] *As of June 30, 2011, based on eVestment, Lipper and Bloomberg data.*