

HiddenLevers Stress Testing Model Performance Review



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KEY FINDINGS

1. **HiddenLevers'** model accurately projected equity and fund performance in 84% of cases studied across four different historical scenarios.
2. In the 2014 oil price decline, the model correctly projected the direction and magnitude of returns for all 11 securities studied, including oil producers, large caps, ETFs, and mutual funds.
3. Bond spreads are now a new lever, improving projections in divergent scenarios where the S&P rises as bond spreads widen.

HiddenLevers' Model Performance: HiddenLevers tested its model using a range of stocks, ETFs, and mutual funds across four different scenarios. In 21 of 25 directly comparable cases, the model produced projections within 5% of actual historical returns. The model also correctly projected the direction and magnitude of returns in 100% of the cases studied.

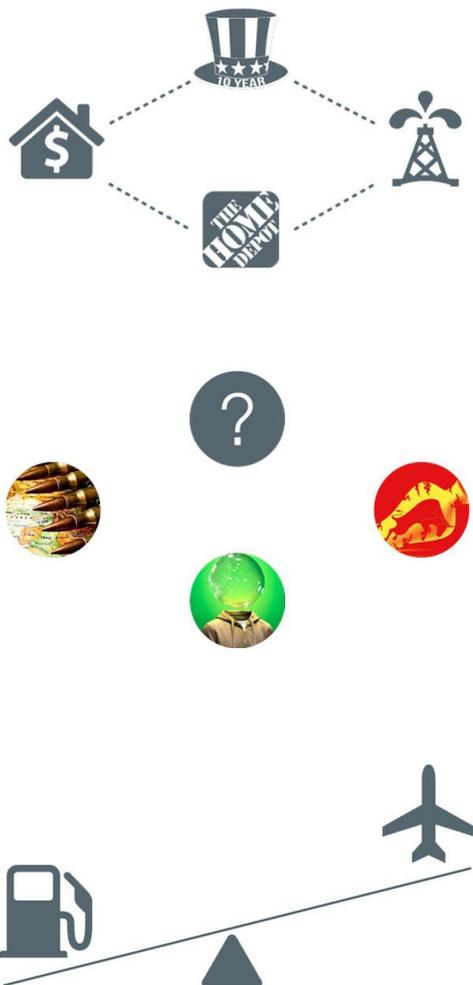
HL vs. traditional models – **What's the difference?** Monte Carlo and Value at-Risk are two widely used models, yet neither accounts for tail risk or scenarios in which traditional relationships in the economy break down. HiddenLevers provides scenario-based portfolio stress testing, which can account for a wider range of risk factors than traditional models.

2014 Oil price decline – HL model shines in divergent scenario: Starting in June 2014, oil prices began to fall and bond spreads started to rise even as the S&P 500 continued its bull run. Monte Carlo and **VaR models don't measure the impact of oil prices or other economic indicators**, rendering them incapable of making meaningful projections in this kind of economic environment. **HiddenLevers' model performed well in this instance**, projecting direction and magnitude correctly for a range of securities including oil producer stocks and high yield bond funds.

1. MODEL COMPARISON

HiddenLevers uses a scenario-based approach which relies on correlations between dozens of levers (economic indicators) and assets, while competing models like Monte Carlo and VaR often rely only on expected return and standard deviation for different asset classes. A brief overview of the HiddenLevers model and a comparison to traditional models is provided below.

1.1 HiddenLevers Model Overview



1. Find the Connections

HiddenLevers uses big data to measure millions of relationships between the economy and investments. Interest rates affect home sales and oil prices, which impact the price of Home Depot stock. We uncover these links for 35,000+ investments.

2. Ask the Big What-ifs

HiddenLevers creates scenarios to model recessions, crises, and other economic events, using historical research and analysis on how economic indicators are correlated. A scenario is defined from this research as a series of up-or-down movements in the levers.

3. Model the Impacts

In a stress test, investment performance is projected using the relationships measured in step 1, applied to the scenario assumptions in step 2. If a scenario forecasts oil to rise, and Exxon is correlated with oil, then Exxon will rise in that scenario.



1.2 Comparison to Monte Carlo and VaR

Since the HiddenLevers model measures the relationship between a wide range of levers and each individual asset, it is capable of projecting the potential impact of these forces on a portfolio.

Monte Carlo: Monte Carlo-style models generally use the expected return and standard deviation of an asset class to engage in a large number of probabilistic **projections of an asset's returns**. The advantage of this simple approach is that it relies on very few inputs, and can be used to quickly create a range of projected **"paths" that an asset's returns might take over time**. The disadvantage of this approach is that Monte Carlo has no concept of oil prices or any other lever, and cannot take economic shocks into account in any meaningful way. Monte Carlo models will tend to produce results showing a 95% confidence interval around projected returns, but will fail to take into account macro-economic tail risks entirely.

Value at Risk: Value at risk models attempt to estimate the potential downside risk to a portfolio **by calculating each individual asset's potential loss range over a** specified timeframe. Most value at risk models calculate the potential losses for a particular asset in a probabilistic manner similar to Monte Carlo, with no macro-economic input, and with a fixed view of potential downside from a standard deviation perspective. The advantage of VaR models is that they can be used to generate a single potential loss number for a portfolio (hence the name). The disadvantages were seen in 2008, when a tail-risk event like the financial crisis shocked individual securities beyond a traditional 2 or 3 standard deviation cutoff.

Conditional VaR models help to quantify tail-risk in a portfolio, but generally do not attempt to account for differences in various economic outcomes. For instance, falling interest rates and oil prices may be beneficial to certain portfolio holdings, and harmful to others – but which ones? HiddenLevers attempts to answer these questions, while most traditional models do not.

2. HISTORICAL SCENARIO RESULTS

HIDDENLEVERS MEASURED MODEL PROJECTIONS AGAINST REAL HISTORICAL RESULTS – THE MODEL ACCURATELY PROJECTED RESULTS IN 21 OF 25 COMPARISONS.

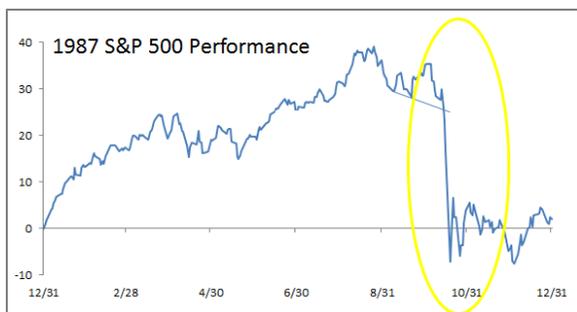
2.1 Historical Comparison Approach

HiddenLevers has back-tested its model against historical scenarios in order to assess and improve model accuracy. HiddenLevers uses the real-life percentage change in the economic levers over a past time period in order to create a historical scenario. The historical scenario can then be executed against a portfolio of investments, with the actual performance of each investment over the historical time period compared against the model projection.

HiddenLevers historical scenarios essentially simulate what would happen if a historical event were to replay **again today, with today's relationships between each security and lever**. **When comparing actual and model results, it's important to note that the business of certain companies may have changed significantly over time, and the compositions of funds may have changed as well.** Nonetheless, this form of backtesting is valuable as it **enables us to gauge the model's performance against real-life events**.

2.1 Definitions of Historical Scenarios

Four historical scenarios were studied, using the timeframes specified below:



1987 Market Crash:

Covers early October to late October 1987, including the 20%+ one-day crash on October 19th, 1987.



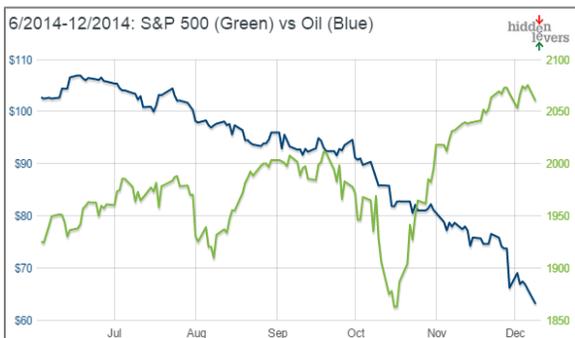
1998 Russia Default:

Covers May 1998 – October 1998, a timeframe in which both the Russian sovereign default and LTCM hedge fund failure occurred.



2008-2009 Financial Crisis:

Covers the core period of the financial crisis from just prior to Lehman Brothers' collapse to the market lows (September 1st 2008 – March 9th 2009).



2014 Oil Price Decline:

Covers the six months from June 1st to December 1st 2014, a period in which oil prices dropped nearly 50% while the S&P 500 rose 8%.



2.2 Model vs. Historical Results Comparison

The following table shows the performance of 6 representative securities, comparing HiddenLevers model projections versus actual returns for the first three historical scenarios. Section 3 describes the comparative results for the final scenario (2014 Oil Price Decline) in greater detail.

Table 1: HiddenLevers model vs. historical performance for three scenarios

Symbol	Financial Crisis		1987 Market Crash		Russia Default / LTCM	
	HL	Actual	HL	Actual	HL	Actual
IBM	-38.1%	-45.10%	-18%	-15%	-9.80%	-13%
BAC	-90%	-93.10%	-40.50%	-69.30%	-33.80%	-35%
AGG	3%	2.20%	-6.25%	N/A	1.30%	N/A
IWM	-50.40%	-51.10%	-32.10%	N/A	-16.60%	N/A
FCNTX	-36.80%	-37.70%	-28.60%	-27.70%	-13.70%	-12.10%
PTTRX	1.50%	2.40%	-3.30%	-2.60%	3%	2.40%

(Green highlighting indicates that model projection was within 5% of actual result; blue highlighting indicates the projection fell outside of this range)

The results above include two large cap US equities (IBM, BAC), one broad-based bond ETF (AGG), a small cap ETF (IWM), a large cap mutual fund (FCNTX), and an actively managed bond fund (PTTRX). The diversity of securities and scenarios selected helps to **validate whether HiddenLevers' model can cope with a wide range of securities and macro-economic environments**. In 14 of 18 cases above a direct comparison is available between the HL model projection and actual results. In the remaining 4 cases no direct historical comparison is available, owing to the shorter history of ETFs in the market.

In 12 (85%) of 14 comparable cases, **HiddenLevers' model produced a result within five percentage points of the actual result. HiddenLevers' model produced a result with double digit error percentage in only a single case – Bank of America declined by roughly 69% during the 1987 crash, versus a -40.5% projection by the HL model. Even in this case the HiddenLevers model did provide warning of significant downside risk exposure.**

Section 3 details HiddenLevers' performance in the 2014 oil price decline, with 5 additional securities added to the 6 detailed above. In total, HiddenLevers produced results within 5% of historical results in 21 of 25 directly comparable cases.

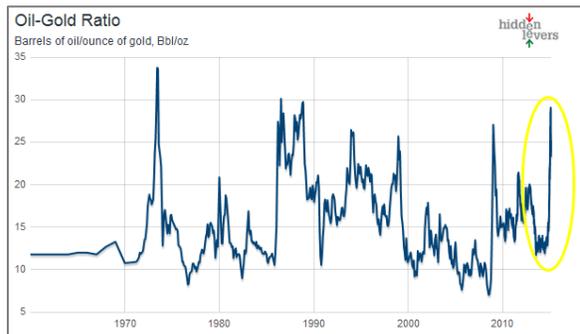
3. 2014 OIL PRICE DECLINE SCENARIO

HIDDENLEVERS SUCCESSFULLY MODELED THE 2014 OIL PRICE DECLINE, PRODUCING MEANINGFUL RESULTS FOR ALL ELEVEN SECURITIES STUDIED DESPITE A BREAKDOWN IN MARKET CORRELATIONS

3.1 Oil Price Decline Scenario Background



The decline in oil prices beginning mid-June 2014 poses a number of challenges for stress testing models. The general correlation between the S&P and oil over the previous five years broke down rapidly, and relationships between other commodities broke down as well. Copper did not fall as fast as oil, while steel and uranium prices rose, and gold was volatile but almost flat over the period.



Traditional multiple regression models attempt to measure the impact of all variables simultaneously. This approach could provide inaccurate projections when the historical correlation between variables breaks down. It might even project a RISE in oil stocks in this scenario (due to the impact of the S&P and other variables), when in fact virtually all fell.

Meanwhile, Monte Carlo and VaR **models usually don't** include oil prices in their models at all. Because of this, they might project a happy ending for all equities, given the 8% rise in the S&P over the timeframe.



3.2 How the Model Copes with Correlation Breakdown

Since HiddenLevers separates the impact of each variable in its model, it is more robust to unexpected environments in which variables move in opposing directions.

The HiddenLevers model has taken a novel approach to solve problems frequently found in multivariate regression models, resulting in a model that can better handle unexpected divergences like that occurring between oil and equities today.

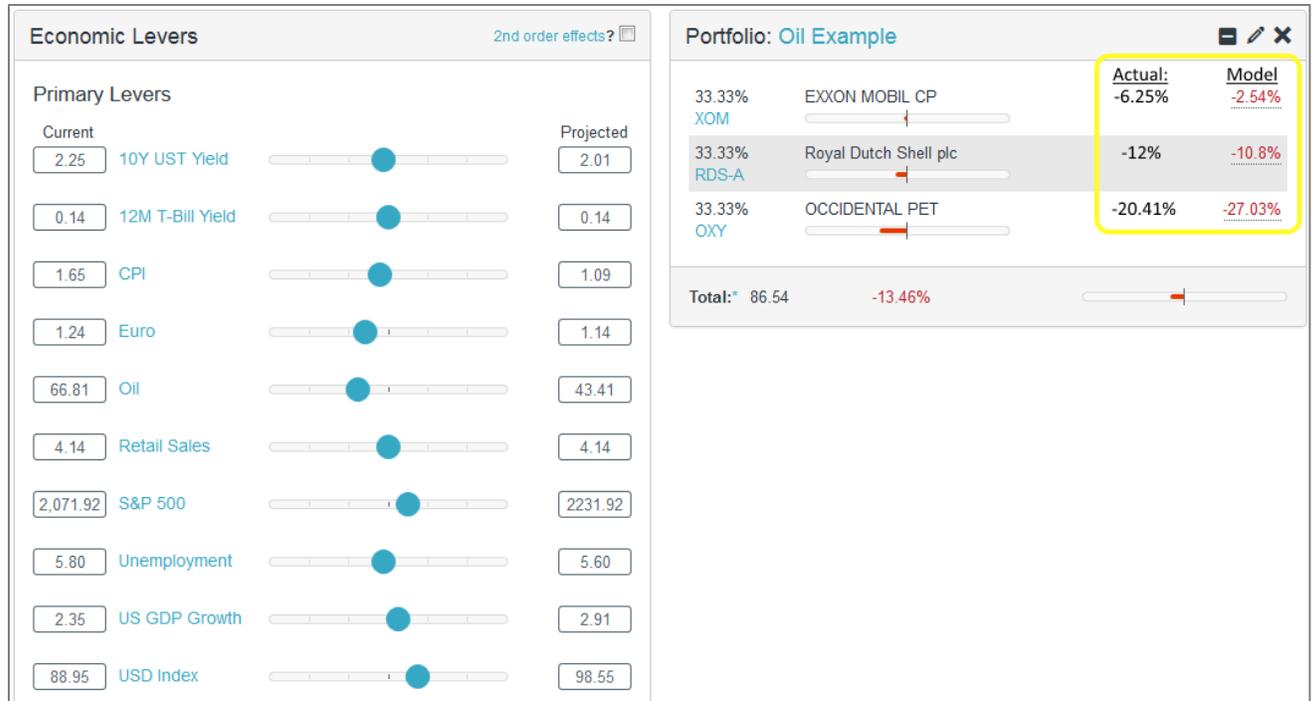
Coefficient results (e.g. oil beta, retail sales beta) from initial regressions are combined in an estimation model that uses the correlation between the independent variables to scale their relative impacts. This model approach is particular to HiddenLevers, and the approach has met with considerable success in real life conditions. By breaking apart the estimation of the variables, and recombining and scaling the results in the estimation process, HiddenLevers has created a model that is more robust to unexpected economic environments that are dissimilar to the historical data used for the regressions.

3.3 Results for Major Oil Producers

Here are examples of the performance of three different oil companies (XOM, RDS-A, OXY) during the recent environment, compared with actual performance over the 6 months ending Dec. 1st 2014.



Hidden Levers



In the HiddenLevers screenshot above, the economic levers at left have been set to represent the same percentage moves for each indicator as occurred in the actual economy over the six months ending 12/1/14. Since the model is forward looking, the projections end at a different point, but the percentage changes are identical to that which occurred over the historical time period, enabling a comparison of model performance and actual performance.

As shown above, the HiddenLevers model provides a very close estimate for the performance of Royal Dutch Shell, and produces an error of less than 4% for Exxon Mobil, and around 6.5% for Occidental Petroleum. The model is correct in order of magnitude and direction for all three oil companies.

3.3 Results for Large Caps, ETFs, and Mutual Funds

The screenshot below shows model projections for the set of securities used in the previous set of historical scenarios, with actual results provided for comparison. Two additional bond funds were added in this analysis as well:



Hidden Levers

		<u>Model:</u>	<u>Actual:</u>
12.50%	INTL BUSINESS MACH	-13.21%	-13%
IBM			
12.50%	BK OF AMERICA CP	3.9%	+10.9%
BAC			
12.50%	iShares Barclays Aggregate Bond ETF	1.42%	+1.3%
AGG			
12.50%	iShares Russell 2000 Index ETF	8.96%	+4%
IWM			
12.50%	Fidelity Contrafund	5.87%	+6.8%
FCNTX			
12.50%	PIMCO Total Return Instl	1.84%	+1.3%
PTRX			
12.50%	SPDR Barclays Capital High Yield Bond ...	-6.23%	-5.4%
JNK			
12.50%	iShares JPMorgan USD Emerg Markets ...	-4.08%	-2.6%
EMB			

In 6 of 8 of the comparisons above, HiddenLevers provided results within 5% of the actual performance, and the direction and magnitude of the model projections was accurate in 100% of these cases. How did HiddenLevers nail the projection on IBM? One economic headwind that IBM faced in 2014 was a strong rise in the value of the dollar (IBM does a significant percentage of business overseas). While this was not the **only factor in IBM's decline**, the HiddenLevers model was able to use this inverse correlation to project weakness in IBM despite the rising S&P 500, and as a result **provided an accurate model of IBM's actual results**.

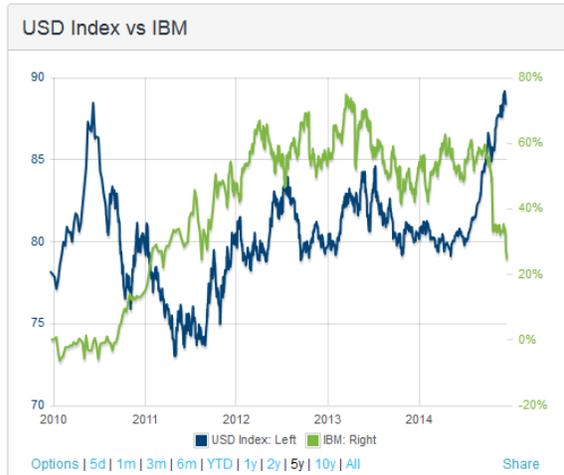


Chart: IBM vs. USD, 5 year timeframe showing inverse correlation, and collapse of IBM in concert with spike in USD value

3.4 Results for High Yield and other Bond Funds

HiddenLevers recently improved its model further by adding US high yield bond spreads **(to treasuries) as a new economic lever. This improves the model's ability to account for** rising credit risk in bond markets. The oil price decline in 2014 resulted in a substantial spike in credit spreads, and since HiddenLevers measures the correlation between bond funds and spreads, it was able to project the negative impact to high yield bond funds like JNK and emerging market bond funds like EMB. HiddenLevers continues to improve its model and assesses new levers for their potential benefit on an ongoing basis.



4. CONCLUSION

HiddenLevers periodically assesses the accuracy of its model against historical scenarios, and has published herein results affirming the accuracy of the model across a wide range of scenarios, including the 2008 financial crisis and recent 2014 oil price decline. **HiddenLevers' model projections fell within 5% of realized returns in 21 of 25** directly comparable cases studied.

When assessing different **stress testing methodologies**, it's important to ask, **"But what happens to this model when its assumptions break down?"** Precisely this sort of test arose in late 2014, as oil prices diverged from equities prices. The HiddenLevers model proved capable of making accurate projections for this kind of scenario, and accurately projected returns for both oil-related and general investments.

Users of HiddenLevers' model also continue to benefit from ongoing advancements in the model – high yield bond spreads were recently added to the model, enabling accurate projections for less creditworthy bond funds in the oil price decline scenario.

THANK YOU.

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