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Are precious metals a hedge against exchange-rate movements? An empirical exploration using bayesian additive regression trees

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ABSTRACT

We use Bayesian additive regression trees to reexamine whether investments in precious metals are a hedge against exchange-rate movements. We quantify the relative importance of several major exchange rates, and we study how the marginal effects differ across times of appreciations/depreciations and across times of small/large exchange-rate fluctuations. Results show that investments in gold and silver are strong hedges against depreciations of major exchange rates. The hedging properties of palladium and platinum are mainly confined to the Australian dollar and Canadian dollar. We also study whether precious metals investments are a safe-haven in times of large exchange-rate movements.

1. Introduction

In recent years, significant research has been done to study whether investments in precious metals act as a hedge against exchange-rate movements. An investor can use, for example, a gold investment as a hedge against exchange-rate movements if the dollar-denominated gold price increases in times of a dollar depreciation, that is, if the correlation between gold returns and exchange-rate movements is positive. Beckers and Soenen (1984) argue that a positive correlation between gold returns and exchange-rate movements can be hypothesized on theoretical grounds because low U.S. interest rates should make a dollar investment less attractive while, at the same time, a zero-yield gold investment becomes more attractive. Recent empirical evidence lending support to the hedging hypothesis has been documented by Ciner, Gurdgiev, and Lucey (2013), Joy (2011) and Reboredo (2013a).[1]

We use a machine learning algorithm known as Bayesian additive regression trees (BART, see Chipman, George, & McCulloch, 1998) to reexamine the hedging hypothesis. The BART algorithm renders it possible to build flexible empirical models that help to explore how precious metals returns are linked to movements in several major exchange rates. Model building with BART uses Bayesian techniques to compute and additively combine regression trees. Regression trees use recursive binary splits to subdivide the range of exchange-rate movements into non-overlapping regions. Within every region, the response of precious metals returns is then set to some region-specific constant (on regression trees, see

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[1] For an analysis of the interplay between gold returns and ther returns of various exchange rates, see also the recent study by Pukthuanthong and Roll (2011). For further empirical evidence, see also Capie, Mills, and Wood (2005). See also Beckmann, Berger, and Czudaj (2015a), who use daily data to study the role of the U.S. dollar and exchange-rate volatility.

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Breiman, Friedman, Oshen, & Stone, 1983). Precious metals returns of granular size can be modeled by implementing several splits, and by combining several regression trees. Regression trees lend themselves to study the hedging property of precious metals investments because regression trees capture in a natural way even complex nonlinearities in the link between returns and exchange-rate movements. In addition, special techniques like partial dependence plots and measures of variable importance have been developed for the analysis of regression trees that make it straightforward to visualize the hedging properties of precious metals and to quantify the relative importance of predictor variables (on the advantages of regression trees, see Hastie, Tibshirani, & Friedman (2009), page 351). The latter property is important because we study several exchange rates, and because we control for the impact of variables like oil-price movements and stock returns commonly studied in earlier research (Baur & McDermott, 2010, Beckmann & Czudaj, 2013a & Ciner et al., 2013, among others). While regression trees have several interesting advantages, applications of regression trees in economics are relatively scarce (for a useful introduction with a focus on economic applications, see Varian (2014)). In recent research, Malliaris and Malliaris (2015) use regression trees to study gold returns. However, they derive their empirical results using single regression trees. A drawback of single regression trees is that their hierarchical structure makes them high-variance predictors. The BART algorithm overcomes this drawback by using Bayesian techniques to combine several trees.

We study the hedging properties of four precious metals: gold, silver, platinum, and palladium. Studying these four precious metals is interesting because earlier researchers have shown that they cannot be considered as a single asset class. Batten, Ciner, and Lucey (2010) report that different macroeconomic factors are relevant for the modeling of the four precious metals. Based on an analysis of spillover effects, Batten, Ciner, and Lucey (2015) argue that the markets for the four precious metals are only weakly integrated. Moreover, Lucey and Sile (2015) find that the three precious metals silver, platinum, and palladium are safe-haven assets during some periods of time when gold is not a safe haven. Findings by Agyei-Ampomah, Gounopoulos, and Mazouz (2014) suggest that, while gold acts as a hedge for losses in sovereign bonds issued by countries with serious debt problems, other metals may provide better protection against losses in sovereign bond markets in times of market jitters.

Adopting the standard definition of hedges and safe-haven investments proposed in earlier literature (see, e.g., Baur & McDermott, 2010), we find that gold and silver investments are a strong hedge against exchange rate movements of the dollar vis-á-vis the yen, the euro, the pound, the Canadian dollar, and the Australian dollar. Specifically, gold and silver returns exhibit a positive correlation with exchange-rate movements in times of U.S. dollar depreciations. We also find that the positive correlation continues to hold and in some cases strengthens in times of large dollar depreciations. This finding shows that gold and silver investments act as safe-haven investments in times of large depreciations. It also confirms recent results documented by Wang and Lee (2011), who report that gold investments are an effective exchange-rate hedge in times of large depreciations of the yen. The exchange-rate-hedging property of palladium and platinum is confined to movements in the Canadian dollar and the Australian dollar. In quantitative terms, both the Canadian dollar and Australian dollar, two classic "commodity currencies", tend to have a higher explanatory power for precious metals returns than other exchange rates (on commodity exchange rates, see Chen, Rogoff, & Rossi (2010)).

We further find that an investment in gold acts as a strong hedge against U.S. stock-market downturns (see also Baur & McDermott, 2010). Silver returns, in contrast, show no systematic response to stock-market movements, indicating that silver investments are only a hedge against stock-market movements. Further, gold returns exhibit a positive comovement with oil-price increases, which is in line with results reported by Reboredo (2013b). Platinum and in particular palladium, in turn, tend to react procyclically to stock-market movements, possibly reflecting fluctuations in industrial demand at business-cycle frequencies. Price dynamics, thus, substantially differ across precious metals, lending support to the view that they cannot be considered as a single asset class (Batten et al., 2010, 2015). All four precious metals react in a procyclical but nonlinear way to commodity-market movements as represented by returns on the widely-studied Standard & Poors Goldman Sachs Commodity Index (GSCI).

We proceed as follows. In Section 2, we lay out the BART algorithm. In Section 3, we describe our data. In Section 4, we summarize our empirical results. In Section 5, we conclude.

2. Bayesian additive regression trees

A regression tree uses binary recursive splits to partition the space of the predictors into non-overlapping regions. The binary splits imply that a regression tree consists of a root, interior nodes, and terminal nodes. The depth of a tree, d, represents the distance from the root to the terminal nodes (the "leaves"). We further define $M = (\mu_1, \ldots \mu_b)$ as leaf parameters with b denoting the number of terminal nodes. Every leaf parameter is the best prediction of precious metals returns given that the predictors settle in one of the non-overlapping regions resulting from the binary splits. In order to find these non-overlapping regions, each interior node of a regression tree involves a splitting rule. Such a splitting rule implies, for example, that leaf parameter μ_1 predicts returns when $x_i < c$ and leaf parameter μ_2 predicts returns when $x_i \geqslant c$, where x_i is one of n predictors and c denotes a split point.

The recursive hierarchical ordering of splits implies that an individual regression tree is a high-variance predictor as slight changes at an upper-level split propagate down the entire remaining tree. To overcome the resulting data-sensitivity, a BART model computes predictions of precious metals returns using the sum of individual tree predictions. In terms of notation, we let T_j denote a single regression tree, and an ensemble of trees consists of $j = 1, \ldots, m$ trees. The basic idea underlying BART