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Measures of global uncertainty and carry-trade excess returns

Kimberly A. Berg [a], Nelson C. Mark [b,*]

[a] Department of Economics, Miami University, United States
[b] Department of Economics, University of Notre Dame and NBER, United States

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ABSTRACT

Asset market participants generally do not like uncertainty. In studying the cross-section of carry-trade-generated currency excess returns and their exposure to macroeconomic uncertainty, we find it also to be true for those participating in this market. A global, news-based measure of macroeconomic uncertainty is negatively and robustly priced into these excess returns, which is consistent with the existence of a global uncertainty factor.

1. Introduction

During times of heightened economic uncertainty, precautionary saving should increase, real investment should decline, and portfolios should be rebalanced away from risky assets towards safe assets. This paper studies how such responses to variations in uncertainty play out in global asset markets. We investigate the way uncertainty is or is not priced into carry-trade-generated currency excess returns and seek answers to the following questions. First, how do return dynamics on risky currencies differ from those of safe currencies in the face of variations in economic uncertainty? Second, do mean currency excess returns vary in proportion to their exposure to uncertainty? Third, which measures or characterizations of uncertainty are useful for understanding systematic differences in these currency excess returns?

The measures of economic uncertainty we use are not our own. Instead, we defer to an active area of research that is working to quantify macroeconomic uncertainty. This body of research proposes a variety of alternative measures of economic uncertainty and shows how economic activity becomes depressed following upward spikes in measured uncertainty. We draw upon several measures of uncertainty, proposed recently in the literature, and ask if they encapsulate those phenomena international investors and traders pay attention to when evaluating portfolio investments on carry-trade assets.

Our candidate risk factors can be dichotomized into measures of US versus global uncertainty, into macroeconomic versus financial uncertainty, and trichotomized into news-based versus data-based versus subjective measures. The news-based measures include those proposed by Baker et al. (2016), Husted et al. (forthcoming), and Caldara and Iacoviello (2016). They are based on the frequency with which certain words or phrases relating to uncertainty are mentioned in major newspapers.

* Corresponding author at: Department of Economics, University of Notre Dame, Notre Dame, IN 46556, United States.
E-mail address: nmark@nd.edu (N.C. Mark).

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We also analyze econometrically constructed measures of uncertainty proposed by Jurado et al. (2015), Ozturk and Sheng (2016), Scotti (2013), and Rossi et al. (2016). The uncertainty indices proposed by these researchers aggregate the variances of econometric or professional forecast errors over a large set of macroeconomic or financial variables. Overall, a variety of strategies have been employed to produce indices capturing different aspects of uncertainty, and several of them were presented at the conference represented by this special issue.[1] The focal point of this collection of uncertainty measures is on general macroeconomic uncertainty, however, HRS (Husted et al., forthcoming) focuses on monetary policy uncertainty and CI (Caldara and Iacoviello, 2016) focuses on geopolitical tension. In addition to macroeconomic uncertainty, BBD (Baker et al, 2016) and JLN (Jurado et al., 2015) generate indices focused on financial market uncertainty.

The assets we study are six interest-rate ranked portfolios of currency excess returns. Excess returns are formed relative to the US and are related to the carry trade, which instructs you to borrow the low interest rate currency and lend the high interest rate currency. The robust uncertainty factor priced into currency excess returns is a global version of the BBD (2016) measure. This uncertainty factor has three salient characteristics. First, it is a global measure as opposed to being US centric. In a globally integrated financial market, investors should respond to global economic uncertainty, and our results are consistent with this view. US specific measures, it turns out, are not sufficient statistics for pricing currency excess returns, although they do show some importance for developed country currency returns. Second, the factor is news-based as opposed to being an econometric construction from macro time series or from subjective professional forecasts. News-based indices measure the attentiveness of editors and reporters to various concepts of economic, financial, or security uncertainty which presumably proxies for the interest level of the reading public. These indices are found to do a better job in capturing an uncertainty factor to which global investors respond. Third, the factor is focused on macroeconomic as opposed to financial uncertainty. However, our results do not generally rule out financial uncertainty measures, as the financial measures available to us are not global measures but are focused on the US.

We study currency returns at the one-month horizon. High interest currencies are the risky ones that pay the largest premium. Their returns tend to fall during times of high economic uncertainty whereas the returns of the lowest interest currencies tend to rise. In terms of their exposure to risk, high-interest portfolios have negative betas and low-interest portfolios have positive betas. The uncertainty factor itself looks like risk. It increases in bad times and declines in good times. The high interest-rate portfolios pay a large excess return in good times as compensation for poor performance in bad times.

The economic mechanism at work is that international investors pay attention to a global factor, in the sense that their stochastic discount factors depend on the factor. It is unlikely that they actually monitor the BBD Global index. More likely, BBD Global is a reasonably accurate estimator of the true underlying uncertainty factor. As an illustration of the mechanism, we draw on Lustig et al.'s (2011) two-factor no arbitrage affine asset pricing model as an organizing framework for the interpretation of the empirical results. The model features two state variables–a global uncertainty factor and a country-specific uncertainty factor. Excess return variation over time and across currencies will emerge if there is heterogeneity in cross-country loadings of global uncertainty in the log stochastic discount factor (SDF). The model heterogeneity implied by the data is that the log SDFs of risky currencies–those with high interest rates and high excess returns–load more heavily on the global uncertainty factor.

Our paper is part of an active literature that studies portfolios of currency excess returns in the context of asset pricing models. The absolute asset pricing strand of the literature examines currency returns in terms of their direct exposure to basic macroeconomic fundamental risk factors. Burnside et al. (2011), Lustig and Verdelhan (2007), Menkhoff et al. (2013), Berg and Mark (2016) consider frameworks where stochastic discount factors are built from macroeconomic measures of risk, such as consumption or GDP growth. Della Corte et al. (2016) focus on countries' external balances, Hassan (2013) discusses a country-size factor in that large country debt, being more desirable to investors, has lower yields, while Ready et al. (2015) analyze differences across countries in the diversification of their production technologies.[2] In the relative asset pricing strand of the literature, risk factors are excess returns on traded assets. In Lustig et al. (2011), the two factors are level and slope of carry trade excess returns while Ang and Chen (2010) focus on factors derived from country yield curves.

Our paper is more closely aligned with a strand of the literature that connects notions of uncertainty to currency excess returns. Here, Menkhoff et al. (2012) price returns to global foreign exchange volatility, Della Corte et al. (2015) price currency returns in relation to sovereign risk, and Della Corte and Krecetovs (2015) build uncertainty indices from the dispersion of professional forecast errors on major macroeconomic indicators. As with these papers, the uncertainty indices we employ attempt to capture variations in macroeconomic uncertainty by aggregating primitive information on a large number of economic and/or financial variables.

Our paper does not claim to present a new solution to the carry-trade excess return anomaly. Research cited above, has already shown that there are risk factors that price carry-trade currency returns. Instead, our objective is to study the information content of newly proposed uncertainty measures and to compare their usefulness in understanding currency returns. From a macroeconomic perspective, an improved understanding of currency excess returns can help inform future developments in modeling uncovered interest rate parity shocks. Frequently, macro models impose exogenous dynamics into deviations from uncovered interest rate parity (UIP) for the models to generate realistic exchange rate dynamics

[1] "Impact of Uncertainty Shocks on the Global Economy," the 2nd Workshop on Macroeconomic Uncertainty, London, 12–13 May 2016.

[2] Jordà and Taylor (2012) and Daniel et al. (2014) study augmenting strategies beyond the carry (comparing interest rates) to improve return performance. In another strand of the literature, Brunnermeier et al. (2008), Jurek (2014), Lettau et al. (2014) employ the rare-disaster framework, while Clarida et al. (2009) and Christiansen et al. (2011) focus on regime switches.

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(Kollmann, 2002; Devereux and Engel, 2003; Engel, 2015; Itskhoki and Mukhin, 2016). Empirical analyses, such as ours, may aid in developing models with endogenous deviations from UIP.

The organization of the paper is as follows. The next section discusses the construction of portfolios of currency excess returns. Section 3 describes the data. Section 4 describes the uncertainty measures and implements the main empirical work. Section 5 discusses the empirical results. Section 6 provides a further examination of the BBD Global uncertainty factor. Section 7 presents the affine asset pricing model, and Section 8 concludes.

2. Portfolios of currency excess returns

The availability of currency excess returns, implied by violations of uncovered interest parity, has been recognized as an empirical regularity since Hansen and Hodrick (1980), Bilson (1981), and Fama (1984). Because the interest rate differential between two countries is not offset by subsequent short-horizon movements in exchange rates, systematically positive excess returns can be generated by shorting one country's currency and using the proceeds to take a long position in the other country's currency. An extensive literature is devoted to understanding why these currency excess returns exist and how they behave. Hodrick (1987), Engel (1996), and Lewis (1995) survey this earlier literature. One strand of this work was aimed at understanding the excess returns as risk premia, with an emphasis on the time-series behavior of individual currency excess returns–that is, the observational unit was the bilateral excess US dollar return against a single currency. This research struggled to identify systematic risk in currency returns.

A useful innovation of recent methodology, introduced by Lustig and Verdelhan (2007), was to change the observational unit from individual returns to portfolios of currency excess returns. This is useful because organizing the data into portfolios of returns averages out noisy idiosyncratic and non-systematic variation in the returns, which helps improve one's ability to uncover systematic risk. A second break from the older literature has been to switch the emphasis from the time-series to the cross section of returns and to focus on understanding why some excess returns are systematically high and positive while others are less so. As we are following the current literature, our units of analysis are interest rate ranked portfolios of currency returns in excess of the US interest rate. By analogy to the carry trade, which shorts the low interest rate currency and goes long the high interest rate currency, we call these carry-trade-generated portfolios of currency excess returns.

In each time period, we rank countries by their interest rates from low to high. As in Lustig et al. (2011), we form six such portfolios, $P_1, \ldots, P_6$ where P_6 is the equally weighted average return from those countries in the highest quantile of interest rates and P_1 is the equally weighted average return from the lowest quantile. Bilateral excess returns are stated relative to the US.[3] At time t, there are $n_t + 1$ currencies available. The US will always be country '0.' The nominal interest rate of country j is $r_{j,t}$ for $j = 0, \ldots, n_t$. The exchange rate, $S_{j,t}$, is expressed as USD per foreign currency unit so that a higher exchange rate means the dollar has *fallen* in value relative to the foreign currency. In the carry trade, one uses the USD as the funding currency if the average of portfolio P_i interest rates are higher than the US rate and vice versa. The exact excess return for portfolio P_i ($re^p_{i,t}$) is,

$$re^p_{i,t} = \frac{1}{n_{i,t}} \sum_{j \in P_i} (1 + r_{j,t}) \frac{S_{j,t+1}}{S_{j,t}} - (1 + r_{0,t}), \tag{1}$$

and the log-approximate excess return is

$$re^p_{i,t} \simeq \underbrace{\frac{1}{n_{i,t}} \sum\nolimits_{j \in P_i} (r_{j,t} - r_{0,t})}_{\text{Interest Differential}} + \underbrace{\frac{1}{n_{i,t}} \sum\nolimits_{j \in P_i} (\ln S_{j,t+1} - \ln S_{j,t})}_{\text{Exchange Return}} \tag{2}$$

The next section describes the data we use to construct the portfolios of currency excess returns as well as some properties of the excess return data.

3. The returns data

We study monthly currency excess returns and the maximal span is 1973.04 to 2014.12.[4] Cross-country data availability varies over time. At the beginning of the sample, observations are available for 11 countries. The sample expands to include additional countries as their data becomes available, and contracts when data vanishes (as when countries join the euro). Our encompassing sample is for 41 countries plus the euro area. The countries are Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Malaysia, Mexico, the Netherlands, New Zealand, Norway, the Philippines, Poland, Portugal, Romania,

[3] An alternative, but equivalent approach would be to short any of the $n_t + 1$ currencies and to go long in the remaining n_t currencies. Excess returns would be constructed by 'differencing' the portfolio return, as in Lustig et al. (2011) and Menkhoff et al. (2013), by subtracting the P_1 return from P_2 through P_6. It does not matter, however, whether excess returns are formed by the 'difference' method or by subtracting the US interest rate because portfolios formed by one method are linear combinations of portfolios formed by the other.

[4] For robustness, we also study quarterly currency excess returns which have a maximal span of 1973Q1 to 2014Q2. Cross-country data availability varies over time. At the beginning of the sample, observations are available for 10 countries. To save on space, we do not report quarterly results in the paper.

Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, the United Kingdom, and the United States.[5] Observations for European countries that join the euro area are dropped at the time they adopt the common currency.

Interest rates are either Eurocurrency or interbank rates. We employ interest rates on interbank or Eurocurrency loans because we want returns on assets that are tradable and for which investors can take both long and short positions. Rates in different currencies are quoted by the same bank, so Eurocurrency/interbank rates net out cross-country differences in default risk. Since the global financial crisis began in 2007, covered interest parity no longer holds (Pinnington and Shamloo, 2016; Du et al., 2016). Hence, using the foreign exchange rate forward premium to substitute for the interest rate differential is not advised.

One-month yields are from *Global Financial Data* and exchange rates are from *Bloomberg*. Observations are end-of-month and point-sampled. From 1973 to 1996, availability of exchange rates and interest rates from the aforementioned sources are spotty. To augment the time-series dimensions, exchange rates and interest rates for Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States are from the Harris Bank *Weekly Review*. These are quotations from the last Friday of the month from 1973.03 to 1996.01.

The other data we employ are quantitative measures of uncertainty developed by various researchers. We describe these data in Section 4. We next provide some summary statistics of the returns data described above.

Table 1 shows the mean portfolio currency excess returns $\left(\overline{re}_i^p = \frac{1}{T}\sum_{t=1}^{T} re_{i,t}^p\right)$ in log-units, their Sharpe ratios, and the decomposition of the mean excess returns into contributions from the mean interest rate differentials $\left(\frac{1}{T}\sum_{t=1}^{T}\left(r_t^{P_j} - r_{0,t}\right)\right)$ where $r_t^{P_j} \equiv \frac{1}{n_{j,t}}\sum_{i\in P_j} r_{j,t}$, and the mean exchange rate returns $\left(\frac{1}{T}\sum_{t=1}^{T}\left(\frac{1}{n_{i,t}}\sum_{j\in P_i}\Delta\ln(S_{j,t+1})\right)\right)$ in log-units. These form the cross-section of returns that we analyze below.

P_6 excess returns are large and P_1 excess returns are low (negative, actually). Non-monotonicity of the monthly excess returns is due to P_3. There is a large jump in the average excess return from P_5 to P_6. Looking at the interest rate differential and exchange rate components, on average, there is no forward premium anomaly in P_4, P_5, and P_6 portfolio excess returns. The forward premium anomaly says higher foreign interest rates relative to the US are associated with a strengthening of their currencies. Instead, for these portfolios, the average exchange rate movements go in the direction of uncovered interest parity.[6]

Fig. 1 plots cumulated monthly excess returns from shorting the dollar and going long in the foreign currency portfolios. A carry trade based on portfolio P_6 performs poorly before the mid 1980s, but its profitability takes off around 1985. The observations available in the 1970s are mostly for European countries, who held a loose peg against the deutsche mark, initially through the 'Snake in the Tunnel,' and then in 1979 through the European Monetary System. During this period, there is not much cross-sectional variation across countries, especially in their exchange rate movements against the USD. The US nominal interest rate was also relatively high during this time period.

The global financial crisis was a time of high economic uncertainty. The decline in returns of the higher interest rate currencies in 2009, which can be seen from Fig. 1 underscores the riskiness in those portfolios, and suggests that they may be driven by an uncertainty factor. In contrast to the other portfolio excess returns, P_1 cumulated returns continue to rise during the period. These would be considered the safe-haven currencies.

4. Uncertainty measures

This section describes the uncertainty measures, proposed in the literature, that we employ in our analysis.

4.1. Newspaper based measures

The first group of uncertainty indices are based on the frequency of newspaper articles that mention certain words or phrases. These indices are not directly based on macroeconomic fundamentals. They measure the extent to which newspaper editors and reporters are paying attention to various concepts of economic, financial, or security uncertainty. Presumably, the frequency of newspaper coverage for these topics proxies for the interest level in these topics of the reading public.

- BBD US and BBD Global: These are indices from Baker et al. (2016). They construct economic policy uncertainty indices for Australia, China, Europe, France, Germany, India, Italy, Japan, Korea, Russia, Spain, United Kingdom, and the US. To build the index for the US, they search in major newspapers and tally up terms related to economic and policy uncertainty–terms such as 'uncertainty' or 'uncertain,' 'economic' or 'economy,' and 'congress,' 'legislation,' 'white house,' 'regulation,' 'federal reserve,' or 'deficit.' The same approach is followed in constructing indices for the other countries. We form a BBD Global uncertainty measure by taking the cross-sectional average of the individual country uncertainty indices. The cross-sectional average is known to approximate the first principal component. These indices were downloaded from their website, http://www.policyuncertainty.com/index.html.

[5] The selection of countries in our sample was based on the availability of rates on interbank or Eurocurrency loans.

[6] The long-run relationship between the interest rate differential and the exchange rate return for P_4, P_5, and P_6 portfolios is consistent with long-horizon uncovered interest parity as reported in Chinn and Merideth (2004).

Table 1
Monthly currency excess return summary statistics (1973.04–2014.12).

	P_1	P_2	P_3	P_4	P_5	P_6
Mean Currency Excess Return	−1.385	−0.238	1.622	0.600	1.823	7.966
Sharpe Ratio	−0.053	−0.008	0.061	0.021	0.059	0.232
Mean Interest Rate Differential	−2.838	−1.023	0.535	2.297	4.755	17.336
Mean Exchange Rate Return	1.453	0.785	1.087	−1.697	−2.932	−9.370

Notes: To form the portfolio returns, we sort by the nominal interest rate for each country from low to high. The rank ordering is divided into six categories, into which the currency returns are assigned. P_6 is the portfolio of returns associated with the highest interest rate quantile and P_1 is the portfolio of returns associated with the lowest interest rate quantile. The excess returns are the mean of the USD returns in each category minus the US nominal interest rate and are stated in percent per annum. These are log-approximated excess returns and exchange rate returns. The mean currency excess return is $\overline{re}_i^p = \frac{1}{T}\sum_{t=1}^T re_{i,t}^p$. The mean interest rate differential is $\frac{1}{T}\sum_{t=1}^T \left(r_t^{P_j} - r_{0,t}\right)$, where $r_t^{P_j} \equiv \frac{1}{n_{j,t}}\sum_{i\in P_j} r_{j,t}$. The mean exchange rate return is $\frac{1}{T}\sum_{t=1}^T \left(\frac{1}{n_{i,t}}\sum_{j\in P_i}\Delta\ln(S_{j,t+1})\right)$ and is positive when the dollar falls in value.

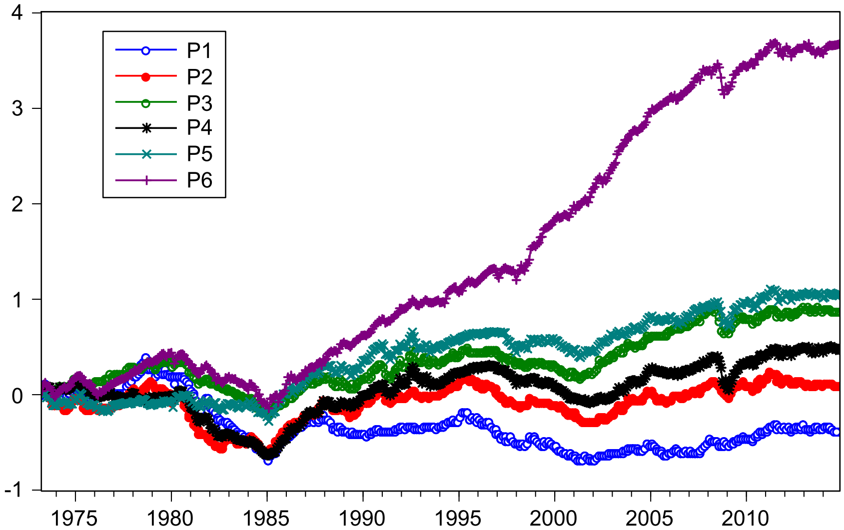

Fig. 1. Cumulated excess return in each of the six carry portfolios. The figure shows cumulated excess return (as raw numbers) of six interest-sorted portfolios over the US interest rate. Rolling over a USD 1 long position in P_6 minus rolling over a USD 1 short position in the USD beginning in April 1973 results in a net value of 3.32 in December 2014.

- BBD US Equity: This is Baker, Bloom, and Davis's index built from analyses of news articles containing terms related to US equity market uncertainty. Starting in January 1985, they tally searches of terms such as 'uncertainty' or 'uncertain,' 'economic' or 'economy,' and 'equity market,' 'equity price,' 'stock market,' or 'stock price.' They only do this for the US. This index was downloaded from their website, http://www.policyuncertainty.com/index.html.
- CI GeoPol: This is a global index of geopolitical risk proposed by Caldara and Iacoviello (2016). They draw on the Baker, Bloom, and Davis newspaper analysis by counting occurrence of words related to geopolitical tensions in leading newspapers to create a monthly index of geopolitical risk. Their index spikes around events such as the Gulf War, 9/11, the 2003 Iraq invasion, the 2014 Russia-Ukraine crisis, and the Paris terrorist attacks. Their index is found to lead declines in real activity, moves with the VIX and corporate credit spreads, and moves inversely with oil prices.
- HRS MPU: This is a news-based monetary policy uncertainty index for the US proposed by Husted et al. (forthcoming). They construct their index using the newspaper approach similar to Baker, Bloom, and Davis, but with a focus on US monetary policy. Their index begins in 1985.

4.2. Econometric measures

The next set of uncertainty indices are based on econometric analyses of macroeconomic time-series data and analyses of professional forecasts.

- JLD Macro and JLD Fin: These are the macroeconomic uncertainty and financial market uncertainty indices for the US, proposed and analyzed by Jurado et al. (2015). They begin by computing individual uncertainty, which is the conditional volatility of the forecasting error of an individual macroeconomic or financial time series. They compute them at 1-, 3-, and 12-month ahead forecast-error horizons. The macro uncertainty index is an aggregate of the individual macro uncertainty measures and the financial uncertainty index is an aggregate of the individual financial time-series uncertainty measures. Their macro (financial) data set consists of hundreds of macroeconomic (financial) time-series. We employ the 1-month horizon indices in analysis of monthly currency excess returns.

- S-RTA Global: Scotti (2013) constructs a daily, real-time uncertainty measure using surprises to macroeconomic data releases. She constructs indices for Canada, the euro area, Japan, United Kingdom, and the US. Individual surprises are deviations between the data release and the median Bloomberg forecast of industrial production, employment, retail sales, purchasing manager's index, and the unemployment rate. Squaring the surprise gives the uncertainty measure. The individual uncertainty is aggregated using weights obtained from a dynamic factor model for a latent uncertainty index estimated with the individual macro time series. We employ the cross-sectional average of her country indices as a global measure of uncertainty. We note that she constructs her indices beginning in 2003.05, so the time-span of measurement is relatively short.
- OZ Global: Ozturk and Sheng (2016) create an index similar to Scotti (2013) in that their measure is based on forecasts of market participants. Using the Consensus Forecasts from 1989 to 2014 on 8 variables for 46 countries, they construct a global uncertainty measure by aggregating the mean-square professional forecast errors across variables, countries, and forecasters.
- RSS-U, RSS Ex Ante, and RSS Knight: Knight (1921) distinguishes between risk (assessing probabilities associated with a known distribution) and uncertainty (problems faced when the distribution is unknown). Rossi et al. (2016) (RSS) is unique and innovative, in the sense that they attempt to model Knightian uncertainty. Using the Survey of Professional Forecasters, they trace the probability forecast of any outcome by an individual forecaster and call the mean-square prediction error (MSPE) of this probability forecast (i.e., the MSPE applied to the forecast distribution) the individual forecaster's uncertainty. Aggregating over individuals, then integrating over the domain of the distribution gives an overall measure of uncertainty. This overall measure can be decomposed in various ways. One decomposition gives a measure of Knightian uncertainty. An alternative decomposition breaks overall uncertainty into ex ante and ex post components. We employ the overall measure (RSS-U), the ex ante measure (RSS Ex Ante) and the Knightian uncertainty (RSS Knight) in our analysis. We note that RSS compute their uncertainty measures only for the US.

4.3. Estimation

We are considering a variety of uncertainty measures in our analysis. Each measures a different feature of the macroeconomy. The newspaper based indices measure the public's interest in a particular topic (policy uncertainty, financial market uncertainty, geopolitical tensions). The second group of measures come from direct and indirect (of professional forecasts) analyses of the macroeconomic data.

BBD, CI, Scotti and OZ's work give uncertainty measures that are global in nature. The others are strictly US based. One might ask if it makes any sense to entertain US based uncertainty measures as a potential factor for currency excess returns. For motivation that a US measure may be a sufficient statistic, we cite studies by Lustig and Verdelhan (2007), who reported success in pricing currency excess returns via the consumption CAPM using only US consumption growth, Andersen et al. (2007), who find US macroeconomic news moves equity, bond, and foreign exchange markets, and Andersen et al. (2003), who find that the USD/GDM reacts to US data releases but not to releases of German data.

We employ the two-pass regression method used in finance to estimate how the cross-section of carry-trade excess returns are priced by the potential uncertainty factors described above.

Two-pass regressions. Let $\left\{re^p_{i,t}\right\}$, for $i = 1, \ldots N$, $t = 1, \ldots, T$, be our collection of $N = 6$ carry-trade excess returns. Let $\left\{f^U_{k,t}\right\}$, $k = 1, .., K$, be the collection of potential uncertainty factors. In the first pass, we run $N = 6$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas' (the slope coefficients on the risk factors),

$$re^p_{i,t} = a_i + \sum_{k=1}^{K} \beta_{i,k} f^U_{k,t} + \epsilon_{i,t}. \tag{3}$$

Covariance is risk, and the betas measure the extent to which the excess return is exposed to, or covaries with, the $k-th$ uncertainty factor (holding everything else constant). If this uncertainty factor is systematic and undiversifiable, investors should be compensated for bearing it. The uncertainty factor should explain why some excess returns are high while others are low. This implication is tested in the second pass, which is the single cross-sectional regression of the (time-series) mean excess returns on the estimated betas,

$$\overline{re}^p_i = \gamma + \sum_{k=1}^{K} \lambda_k \beta_{i,k} + \alpha_i, \tag{4}$$

where $\overline{re}^p_i = (1/T)\sum_{t=1}^{T} re^p_{i,t}$ and the slope coefficient λ_k is the risk premia associated with the $k-th$ uncertainty factor.

In other contexts, the excess return is constructed relative to what the investor considers to be the risk-free interest rate. If the model is properly specified, the intercept γ should be zero. In the current setting, the carry trades are available to global investors. When the trade matures, the payoff needs to be repatriated to the investor's home currency, which entails some foreign exchange risk. Hence, the excess returns we consider are not necessarily relative to 'the' risk-free rate, and there is no presumption that the intercept γ is zero.

To draw inference about the λs, we recognize that the betas in Eq. (4) are not data themselves, but are estimated from the data. To do this, we compute the GMM (generalized method of moments) standard errors, described in Cochrane (2005) and Burnside (2011a, 2011b), that account for the generated regressors problem and for heteroskedasticity in the errors. Cochrane (2005) sets up a GMM estimation problem using a constant as the instrument, which produces the identical point estimates for $\beta_{i,k}$ and λ_k as in the two-pass regression. The GMM procedure automatically takes into account that the $\beta_{i,k}$ are not data, per se, but are estimated and are functions of the data. It is also robust to heteroskedasticity and autocorrelation in the errors. Also available is the covariance matrix of the residuals α_i, which we use to test that they are jointly zero. The α_i are referred to as the 'pricing errors,' and should be zero if the model adequately describes the data. We get our point estimates by doing the two-pass regressions with least squares and get the standard errors by 'plugging in' the point estimates into the GMM formulae.[7]

The objective is to see if there is a systematic (proportional) relationship between average currency excess returns and their exposure (betas) to uncertainty. The point is not to get a high R^2 in the time-series regression or to statistically reject the hypothesis that the betas are zero. The GMM standard errors automatically take into account the sampling variation in the estimated betas.

5. Empirical results

This section addresses the central issue of the paper. Does the cross-section of carry-trade-generated currency excess returns vary according to their exposure to uncertainty measures? Is there evidence that an uncertainty factor drives currency excess returns?

5.1. Currency excess return analysis

We begin by estimating a single-factor model for monthly returns with the two-pass procedure. Table 2 shows the second stage estimation results for the single-factor model.

Evidence in Table 2 is potentially favorable to several uncertainty indices as a possible uncertainty factor in monthly currency excess returns. All three of the BBD measures, CI's geopolitical index, JLN Macro, and RSS Ex Ante are significantly priced in currency excess returns (the t-ratios on λ estimates are significant). These results suggest that carry trade investors, although they may not necessarily pay attention to these indices per se, are influenced by the same underlying factors that cause variation in the indices over time. The uncertainty indices are inversely related to what normally would be considered risk, in that their betas and the price of risk (λ) are negative. Upward spikes in uncertainty is bad news for global investors as higher values of the indices are associated with declines in the high interest portfolio excess returns. High values of the indices must be associated with the bad state of nature. The exception is CI GeoPol, which has a positive estimated λ.

Among the alternative uncertainty measures, an informal examination suggests that the BBD Global measure dominates. It has the highest t-ratio on the λ estimate and the highest R^2. But is BBD Global robust to the alternatives? To address this question, we estimate a two-factor model with BBD Global as the maintained first factor, and we consider each of the alternative indices as a potential second factor. As an additional robustness check, we build an additional factor that aggregates information from all the uncertainty measures but excluding BBD Global. This is the first principal component of 11 uncertainty measures, which we label as 'First PC.' Table 3 shows the estimation results.

Here, BBD Global is significant at the 5% level in every case except when S-RTA Global is included, but even there it is significant at the 10% level. None of the alternative uncertainty measures are significantly priced, even at the 10% level. BBD Global appears to be a robust uncertainty factor for carry-trade-generated currency excess returns.

What do the BBD Global betas look like? Fig. 2 is a scatter plot of each portfolio's average excess return against its BBD Global beta. The figure gives a visual representation of the regression results that average currency excess returns are characterized as varying in proportion to their beta. High interest portfolio (P_6) currency excess returns have a negative beta. These excess returns tend to be low during periods of high global uncertainty. Beta on the low interest (P_1) portfolio currency excess returns is positive, which is consistent with the idea that those in P_1 are safe-haven currencies.

What are the interest and exchange rate component exposures to the BBD Global factor? If UIP held, the beta on $re^p_{i,t}$ would be zero. The interest rate beta and exchange rate return beta would be equal in magnitude and opposite in sign. Earlier, we saw in Table 1 that a portion of the interest rate differential is offset by the exchange rate return in the direction of UIP but is not fully offset. Table 4 reports portfolio betas on the interest rate differentials and exchange rate returns separately.[8] The interest rate differential component of the beta is from a regression of $\frac{1}{n_{i,t}}\sum_{j\in P_i}(r_{j,t-1} - r_{0,t-1})$ on the BBD Global factor f^U_t. The exchange rate return component of the beta comes from regressing $\frac{1}{n_{i,t}}\sum_{j\in P_i}\Delta\ln(S_{j,t})$ on f^U_t.

[7] The details of the GMM procedure are written up in an unpublished appendix, available upon request from the authors.

[8] The table also shows Newey-West t-ratios on the betas, but statistical significance of the betas is not key in the analysis. The focus is on whether BBD Global is a significantly priced factor, or whether λ is significant. The standard errors for the λ estimate takes into account the sampling variability of the estimated betas.

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Table 2
Two-pass estimation of the single-factor beta-risk model on monthly carry excess returns.

Single-Factor Model								
Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
BBD US Equity	−2.032	**−1.964**	7.695	1.512	0.774	5.524	0.355	85.01–14.12
BBD US EPU	−0.570	**−2.484**	2.216	0.785	0.820	3.821	0.575	73.05–14.10
BBD Global	−0.423	**−3.300**	0.184	0.096	0.919	4.112	0.533	73.05–14.12
CI GeoPol	1.479	**2.084**	−3.198	−0.739	0.465	3.252	0.661	85.01–14.12
HRS MPU	−1.634	−1.400	8.445	1.360	0.351	3.341	0.648	85.01–14.12
JLN Macro	−0.139	**−1.993**	−2.291	−0.850	0.245	12.812	0.025	73.05–14.12
JLN Fin	−0.205	−0.894	0.924	0.472	0.073	11.558	0.041	73.05–14.12
S-RTA Global	−0.003	−0.799	−0.491	−0.151	0.711	3.001	0.700	03.05–14.12
OZ Global	−0.397	−0.979	1.295	0.194	0.632	2.889	0.717	89.11–14.07
RSS-U	−0.822	−1.407	0.767	0.281	0.108	13.358	0.020	82.09–14.06
RSS Ex Ante	−0.198	**−2.735**	4.388	1.951*	0.250	22.714	0.000	82.09–14.06
RSS Knightian	−0.621	−1.329	−0.172	−0.066	0.241	9.184	0.102	82.09–14.06

Notes: The raw data are monthly and are end-of-month and point-sampled. To form the portfolio returns, we sort by the nominal interest rate (carry) for each country from low to high. The rank ordering is divided into six portfolios, into which the currency returns are assigned. P_6 is the portfolio of returns associated with the highest nominal interest rate countries and P_1 is the portfolio of returns associated with the lowest nominal interest rate countries. This table reports the two-pass procedure estimation results from a one-factor model. In the first pass, we run $N = 6$ individual time-series regressions of the excess returns on the K factors to estimate the factor 'betas,' $re^p_{i,t} = a_i + \sum_{k=1}^{K} \beta_{i,k} f^U_{k,t} + \epsilon_{i,t}$, where $re^p_{i,t}$ is the excess return, $\beta_{i,k}$ is the factor beta, and $f^U_{k,t}$ is the uncertainty factor. The factors considered include BBD US Equity, BBD US EPU, BBD Global, CI GeoPol, HRS MPU, JLN Macro, JLN Fin, S-RTA Global, OZ Global, RSS-U, RSS Ex Ante, and RSS Knightian. In the second pass, we run a single cross-sectional regression of the (time-series) mean excess returns on the estimated betas, $\overline{re}^p_i = \gamma + \sum_{k=1}^{K} \lambda_k \beta_{i,k} + \alpha_i$, where $\overline{re}^p_i$ is the average excess return, γ is the intercept, λ_k is the risk premia, and α_i is the pricing error. The table reports the price of risk (λ) and its associated t-ratio (using GMM standard errors), the estimated intercept (γ) and its associate t-ratio, R^2 and the Wald test on the pricing errors (Test-stat), and its associated p-value (p-val.).
'*' indicates significance at the 10% level. Bold indicates significance at the 5% level.

Table 3
Two-pass estimation of two-factor beta-risk model on monthly carry excess returns.

Two-Factor Model (First Factor is BBD Global)										
λ_1	t-ratio	2^{nd} Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
−0.467	**−3.093**	BBD US Equity	−0.570	−1.004	2.870	0.945	0.941	1.277	0.937	85.01–14.12
−0.446	**−3.807**	BBD US EPU	−0.228	−0.787	−0.852	−0.281	0.934	2.895	0.716	73.05–14.10
−0.518	**−2.178**	CI GeoPol	−0.182	−0.472	2.106	0.674	0.936	2.275	0.810	85.01–14.12
−0.482	**−2.348**	HRS MPU	0.073	0.141	1.186	0.335	0.940	2.135	0.830	85.01–14.12
−0.442	**−3.695**	JLN Macro	0.023	0.444	1.489	0.640	0.936	3.067	0.690	73.05–14.12
−0.405	**−3.577**	JLN Fin	0.118	0.782	1.109	0.593	0.959	2.010	0.848	73.05–14.12
−0.326	−1.836*	S-RTA Global	−0.001	−0.441	−0.153	−0.081	0.837	3.600	0.608	03.05–14.12
−0.538	**−3.453**	OZ Global	0.040	0.292	0.666	0.304	0.909	3.859	0.570	89.11–14.07
−0.486	**−3.395**	RSS-U	0.119	0.371	2.179	0.994	0.966	0.876	0.972	82.09–14.06
−0.450	**−2.806**	RSS Ex Ante	−0.054	−0.693	1.963	0.916	0.979	0.784	0.978	82.09–14.06
−0.515	**−3.841**	RSS Knightian	0.161	0.744	2.530	1.152	0.974	0.718	0.982	82.09–14.06
−0.378	**−2.530**	First PC	−0.852	−1.044	−0.429	−0.163	0.936	2.380	0.795	73.05–14.12

Notes: See notes to Table 2. First PC is the first principal component of all of the uncertainty measures excluding BBD Global.

We see that the interest rate differential beta declines monotonically across portfolios P_1 through P_6. Only the betas for the P_5 and P_6 interest rate differentials are negative. These interest rates tend to fall relative to the US rate in times of high global uncertainty. In $P_1 - P_4$, yields tend to increase relative to the US in times of high global uncertainty.

Except for the positive beta on P_1 exchange rate returns, the other betas are negative. In times of uncertainty, P_2 through P_6 portfolio's currencies depreciate relative to the USD when BBD Global uncertainty increases. The pattern is consistent with the idea that the US is viewed as a safe haven relative to these currencies, whereas the P_1 currencies seem to be safe relative to the US.

5.2. Robustness analysis

In the previous analysis, the BBD Global factor is seen to be negatively priced into the carry-trade-generated currency excess returns. Is this result robust to alternative subsample analyses? To address this, we first restrict our sample to developed countries. We then consider only emerging market countries. Lastly, we restrict our sample to two common time-span samples.

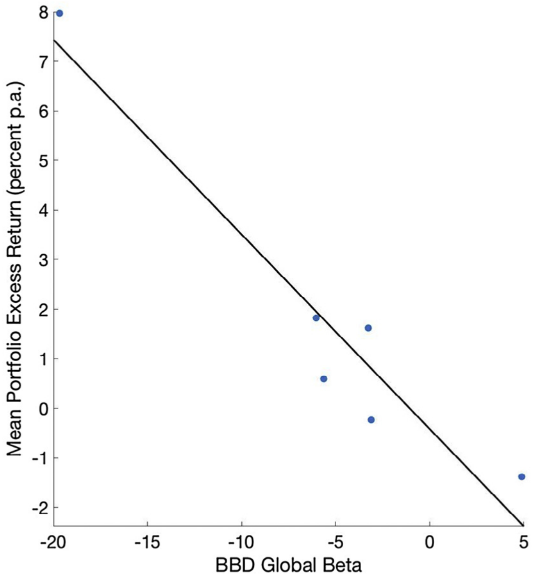

Fig. 2. Mean monthly excess returns and BBD global betas. Mean excess returns of interest-rate sorted portfolios plotted against their BBD-global betas.

Table 4
Beta decomposition on monthly currency excess returns.

	P_1	P_2	P_3	P_4	P_5	P_6
Total Excess Return Beta	4.900	−3.114	−3.278	−5.617	−6.032	−19.684
t-ratio	1.840*	−0.915	−0.735	−1.053	−1.239	**−3.146**
Interest Rate Differential Beta	2.104	1.477	1.511	1.042	−0.034	−12.926
t-ratio	**5.781**	**5.747**	**6.744**	**3.583**	−0.068	**−4.586**
Exchange Rate Beta	2.795	−4.591	−4.789	−6.659	−5.998	−6.758
t-ratio	1.046	−1.353	−1.068	−1.234	−1.191	−1.001

Notes: These are log-approximated excess returns and exchange rate returns. The excess return beta is from regressing $re^p_{i,t}$ on the BBD Global factor f^U_t. The interest rate differential beta is from regressing $\frac{1}{n_{i,t}}\sum_{j\in P_i}(r_{j,t-1} - r_{0,t-1})$ on f^U_t. The exchange rate return beta is from regressing $\frac{1}{n_{i,t}}\sum_{j\in P_i}\Delta\ln(S_{j,t})$ on f^U_t. t-ratios are computed by Newey and West (1987).
'*' indicates significance at the 10% level. Bold indicates significance at the 5% level.

5.2.1. Developed countries analysis

Table 5 shows the mean portfolio currency excess returns $\left(\overline{re}^p_i = \frac{1}{T}\sum_{t=1}^{T} re^p_{i,t}\right)$ in log-units for developed countries, their Sharpe ratios, and the decomposition of the mean excess returns into contributions from the mean interest rate differentials $\left(\frac{1}{T}\sum_{t=1}^{T}\left(r^{P_j}_t - r_{0,t}\right)\right)$ and the mean exchange rate returns $\left(\frac{1}{T}\sum_{t=1}^{T}\left(\frac{1}{n_{i,t}}\sum_{j\in P_i}\Delta\ln(S_{j,t+1})\right)\right)$ in log-units. The developed country subsample includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, and United States.

Similar to the full sample, P_6 excess returns are large (positive), on average, P_1 excess returns are low (negative), on average, and non-monotonicity of the excess returns is due to P_3. However, there is less variation in the data for the developed countries and there is not a large jump in the average excess return from P_5 to P_6.

Table 6 shows the second stage estimation results for the single-factor model. While there remains evidence that the BBD Global is priced into the excess returns (t-ratio = -1.96, $R^2 = 0.91$), the results are weakened relative to the full sample results (Table 2) on account of the smaller sample size and smaller variation across mean excess returns.

Table 7 shows the second stage estimation results for the two-factor model with BBD Global as the maintained first factor. In most cases, the t-ratio on the second uncertainty factor is smaller in magnitude than that on the BBD Global factor. The exception is BBD US EPU. These results suggest that there is potentially a difference in risk exposure for developed countries versus emerging market countries. Developed country currency returns appear to be more sensitive to US uncertainty and less impacted by global risks than emerging market countries.

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Table 5
Monthly currency excess return summary statistics (1973.04–2014.12): developed countries.

	P_1	P_2	P_3	P_4	P_5	P_6
Mean Currency Excess Return	−1.188	−0.482	1.311	0.828	3.263	3.849
Sharpe Ratio	−0.041	−0.018	0.043	0.028	0.107	0.109
Mean Interest Rate Differential	−2.904	−1.297	0.024	1.144	2.590	6.736
Mean Exchange Rate Return	1.716	0.816	1.287	−0.316	0.674	−2.886

Notes: See notes to Table 1. Developed countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, and United States.

Table 6
Two-pass estimation of the single-factor beta-risk model on monthly carry excess returns: developed countries.

	Single-Factor Model							
Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
BBD US Equity	−1.447	−1.448	8.033	1.442	0.606	2.116	0.833	85.01–14.12
BBD US EPU	−0.412	−1.742*	2.627	0.970	0.896	2.045	0.843	73.05–14.10
BBD Global	−0.330	−1.955*	1.182	0.642	0.908	2.797	0.731	73.05–14.12
CI GeoPol	1.252	1.356	−3.567	−0.726	0.801	1.435	0.920	85.01–14.12
HRS MPU	−0.200	−1.260	4.209	**2.630**	0.042	11.054	0.050	85.01–14.12
JLN Macro	−0.127	−1.100	−2.236	−0.721	0.497	1.856	0.869	73.05–14.12
JLN Fin	−0.261	−1.194	0.345	0.134	0.896	1.006	0.962	73.05–14.12
S-RTA Global	−0.001	−0.524	2.036	1.035	0.199	2.154	0.827	03.05–14.12
OZ Global	−0.132	−1.147	1.566	0.509	0.668	3.834	0.574	89.11–14.07
RSS-U	−0.678	−1.116	−0.050	−0.023	0.296	3.768	0.583	82.09–14.06
RSS Ex Ante	0.128	1.747*	1.885	1.117	0.096	8.556	0.128	82.09–14.06
RSS Knightian	−0.536	−1.123	−0.885	−0.371	0.745	2.866	0.721	82.09–14.06

Notes: See notes to Table 2. Developed countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, and United States.

Table 7
Two-pass estimation of two-factor beta-risk model on monthly carry excess returns: developed countries.

		Two-Factor Model (First Factor is BBD Global)								
λ_1	t-ratio	2^{nd} Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
−0.332	−1.539	BBD US Equity	0.531	−0.883	4.128	1.226	0.909	2.029	0.845	85.01–14.12
−0.302	−1.636	BBD US EPU	−0.341	−1.785*	1.770	0.810	0.917	2.260	0.812	73.05–14.10
−0.277	−0.833	CI GeoPol	0.111	0.131	1.784	0.407	0.890	2.700	0.746	85.01–14.12
−0.394	−1.837*	HRS MPU	−0.295	−1.355	3.481	1.555	0.922	1.532	0.909	85.01–14.12
−0.407	**−2.479**	JLN Macro	0.049	0.735	3.222	1.150	0.951	0.945	0.967	73.05–14.12
−0.233	−1.180	JLN Fin	−0.143	−0.836	0.771	0.350	0.934	1.335	0.931	73.05–14.12
−0.301	−1.543	S-RTA Global	0.001	1.187	1.376	0.592	0.864	0.780	0.978	03.05–14.12
−0.324	−1.292	OZ Global	0.010	0.126	1.569	0.778	0.804	4.148	0.528	89.11–14.07
−0.476	**−2.288**	RSS-U	0.574	1.624	4.718	1.642	0.968	0.436	0.994	82.09–14.06
−0.343	−1.680*	RSS Ex Ante	0.023	0.259	2.204	0.931	0.874	3.411	0.637	82.09–14.06
−0.546	−1.300	RSS Knightian	0.339	0.514	4.458	1.092	0.894	1.449	0.919	82.09–14.06
−0.316	−1.690*	First PC	−0.822	−1.408	4.039	1.195	0.953	0.944	0.967	73.05–14.12

Notes: See notes to Table 2. First PC is the first principal component of all of the uncertainty measures excluding BBD Global. Developed countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, and United States.

5.2.2. Emerging market countries analysis

Table 8 shows the mean portfolio currency excess returns $\left(\overline{re}_i^p = \frac{1}{T}\sum_{t=1}^{T} re_{i,t}^p\right)$ in log-units for emerging market countries, their Sharpe ratios, and the decomposition of the mean excess returns into contributions from the mean interest rate differentials $\left(\frac{1}{T}\sum_{t=1}^{T}\left(r_t^{P_j} - r_{0,t}\right)\right)$ and the mean exchange rate returns $\left(\frac{1}{T}\sum_{t=1}^{T}\left(\frac{1}{n_{i,t}}\sum_{j\in P_i}\Delta \ln(S_{j,t+1})\right)\right)$ in log-units. The emerging market country subsample includes Brazil, Chile, Colombia, Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Philippines, Romania, South Africa, Thailand, and Turkey.

Similar to the full sample and developed country sample, P_6 excess returns are large (positive), on average, and P_1 excess returns are low (negative), on average. Also, there is substantially more cross-sectional variation in mean currency excess returns for the emerging market countries. Here, non-monotonicity of the excess returns is due to P_2 and there is a large jump in the average excess return from P_5 to P_6.

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Table 8
Monthly currency excess return summary statistics (1973.04–2014.12): emerging market countries.

	P_1	P_2	P_3	P_4	P_5	P_6
Mean Currency Excess Return	−0.978	2.017	0.923	1.671	6.155	16.869
Sharpe Ratio	−0.062	0.085	0.039	0.051	0.136	0.334
Mean Interest Rate Differential	−0.958	0.758	3.314	6.794	14.805	38.779
Mean Exchange Rate Return	−0.020	1.260	−2.391	−5.124	−8.649	−21.910

Notes: See notes to Table 1. Emerging market countries include Brazil, Chile, Colombia, Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Philippines, Romania, South Africa, Thailand, and Turkey.

Table 9
Two-pass estimation of the single-factor beta-risk model on monthly carry excess returns: emerging market countries.

Single-Factor Model								
Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
BBD US Equity	−2.170	−0.974	0.937	0.221	0.071	3.626	0.604	86.09–14.12
BBD US EPU	−1.007	**−2.476**	−1.864	−0.585	0.908	2.032	0.845	86.09–14.10
BBD Global	−0.775	**−3.168**	−1.964	−0.733	0.932	2.731	0.741	86.09–14.12
CI GeoPol	0.266	1.090	3.931	**2.682**	0.030	20.264	0.001	86.09–14.12
HRS MPU	−6.061	−0.342	3.452	0.240	0.451	0.228	0.999	86.09–14.12
JLN Macro	−0.116	**−2.685**	3.185	0.721	0.228	22.620	0.000	86.09–14.12
JLN Fin	−0.046	−0.392	4.583	**2.278**	0.003	25.045	0.000	86.09–14.12
S-RTA Global	−0.002	−1.662*	0.897	0.181	0.556	2.378	0.795	03.05–14.10
OZ Global	−0.094	−0.882	4.317	1.598	0.026	22.613	0.000	89.12–14.05
RSS-U	−0.185	−0.584	4.786	**2.401**	0.008	24.793	0.000	86.09–14.06
RSS Ex Ante	−0.156	−0.959	6.837	**3.584**	0.038	17.469	0.004	86.09–14.06
RSS Knightian	−0.815	−1.146	−2.040	−0.310	0.234	6.350	0.274	86.09–14.06

Notes: See notes to Table 2. Emerging market countries include Brazil, Chile, Colombia, Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Philippines, Romania, South Africa, Thailand, and Turkey.

Table 10
Two-pass estimation of two-factor beta-risk model on monthly carry excess returns: emerging market countries.

Two-Factor Model (First Factor is BBD Global)										
λ_1	t-ratio	2^{nd} Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
−0.725	**−2.912**	BBD US Equity	0.423	0.299	−0.706	−0.177	0.941	1.678	0.892	86.09–14.12
−0.907	**−2.073**	BBD US EPU	−0.188	−0.206	−1.959	−0.512	0.945	0.774	0.979	86.09–14.10
−0.830	**−2.768**	CI GeoPol	−0.406	−0.951	−1.496	−0.560	0.945	2.395	0.792	86.09–14.12
−0.306	**−0.136**	HRS MPU	2.719	0.202	−3.167	−0.294	0.971	0.094	1.000	86.09–14.12
−0.760	**−3.029**	JLN Macro	−0.046	−0.706	−2.023	−0.691	0.938	2.665	0.751	86.09–14.12
−0.814	**−2.598**	JLN Fin	−0.161	−0.705	−2.845	−0.715	0.947	1.840	0.871	86.09–14.12
−0.421	**−2.038**	S-RTA Global	−0.001	−1.139	−1.689	−0.732	0.864	1.999	0.849	03.05–14.10
−0.750	**−2.449**	OZ Global	−0.062	−0.357	−2.792	−0.726	0.925	2.726	0.742	89.12–14.05
−0.800	**−2.802**	RSS-U	−0.416	−0.701	−2.404	−0.642	0.954	1.779	0.879	86.09–14.06
−0.773	**−3.011**	RSS Ex Ante	−0.181	−0.902	0.267	0.105	0.986	0.539	0.991	86.09–14.06
−0.737	**−2.584**	RSS Knightian	−0.328	−0.738	−4.024	−0.869	0.959	0.926	0.968	86.09–14.06
−0.732	**−2.810**	First PC	−0.349	−0.259	−1.897	−0.695	0.935	2.894	0.716	86.09–14.12

Notes: See notes to Table 2. First PC is the first principal component of all of the uncertainty measures excluding BBD Global. Emerging market countries include Brazil, Chile, Colombia, Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Philippines, Romania, South Africa, Thailand, and Turkey.

Table 9 shows the second stage estimation results for the single-factor model. These results are stronger than the developed country sample results (Table 6). Table 10 shows the second stage estimation results for the two-factor model. In all cases, the BBD Global factor is significant at the 5% level and the second uncertainty factor is never significant.

5.2.3. Analysis on common time-span samples

We next address the concern that the BBD Global factor may dominate the other uncertainty factors because we have a longer time-series for the BBD Global factor than for most of the other factors. In this subsection, estimation is done on a common time-span sample across the alternative uncertainty factors.

We first consider the relatively short time period from May 2003 to June 2014 where we have data available for all uncertainty factors. Call this 'common sample 1.' Table 11 shows the second stage estimation results for the single-factor model. These results are weaker, but there remains evidence that the BBD Global factor is priced into the carry-trade-generated currency excess returns (t-ratio = −1.77).

Table 11
Two-pass estimation of the single-factor beta-risk model on monthly carry excess returns: all countries, common sample 1.

	Single-Factor Model							
Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
BBD US Equity	−0.169	−1.310	1.188	0.574	0.561	7.567	0.182	03.05–14.06
BBD US EPU	−0.294	−1.539	1.348	0.629	0.654	6.596	0.252	03.05–14.06
BBD Global	−0.324	−1.774*	0.516	0.251	0.838	3.869	0.568	03.05–14.06
CI GeoPol	0.235	1.516	2.049	0.736	0.682	5.879	0.318	03.05–14.06
HRS MPU	−0.660	−1.754*	4.260	1.093	0.631	2.759	0.737	03.05–14.06
JLN Macro	−0.074	−0.741	1.744	0.809	0.327	7.923	0.161	03.05–14.06
JLN Fin	−0.143	−0.930	1.348	0.565	0.459	6.452	0.265	03.05–14.06
S-RTA Global	−0.003	−0.799	−0.538	−0.167	0.710	2.986	0.702	03.05–14.06
OZ Global	−0.163	−0.752	3.053	0.781	0.375	6.433	0.266	03.05–14.06
RSS-U	−0.693	−0.690	3.340	0.857	0.180	6.180	0.289	03.05–14.06
RSS Ex Ante	0.081	1.211	3.899	1.605	0.061	7.656	0.176	03.05–14.06
RSS Knightian	−0.244	−0.903	1.138	0.599	0.308	6.541	0.257	03.05–14.06

Notes: See notes to Table 2.

Table 12
Two-pass estimation of two-factor beta-risk model on monthly carry excess returns: all countries, common sample 1.

			Two-Factor Model (First Factor is BBD Global)							
λ_1	t-ratio	2^{nd} Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
−0.415	**−3.120**	BBD US Equity	−0.068	−0.768	0.789	0.390	0.877	3.249	0.662	03.05–14.06
−0.437	**−2.604**	BBD US EPU	−0.177	−0.970	0.030	0.012	0.978	0.642	0.986	03.05–14.06
−0.574	−1.714*	CI GeoPol	−0.231	−0.755	−1.660	−0.471	0.962	0.873	0.972	03.05–14.06
−0.292	−1.913*	HRS MPU	−0.234	−1.347	1.207	0.589	0.864	2.566	0.766	03.05–14.06
−0.398	**−2.996**	JLN Macro	0.036	0.933	1.026	0.519	0.871	3.080	0.688	03.05–14.06
−0.382	**−2.970**	JLN Fin	0.022	0.299	1.021	0.551	0.895	3.108	0.683	03.05–14.06
−0.320	−1.728*	S-RTA Global	−0.001	−0.459	0.296	0.150	0.840	3.388	0.640	03.05–14.06
−0.417	**−2.939**	OZ Global	0.085	0.894	0.312	0.160	0.865	3.105	0.684	03.05–14.06
−0.350	**−2.502**	RSS-U	0.257	0.738	0.648	0.344	0.861	3.853	0.571	03.05–14.06
−0.308	−1.838*	RSS Ex Ante	0.012	0.227	0.301	0.152	0.844	3.727	0.589	03.05–14.06
−0.410	**−3.028**	RSS Knightian	0.125	0.867	1.675	0.759	0.898	2.561	0.767	03.05–14.06
−0.422	**−3.181**	First PC	−0.070	−0.496	0.826	0.418	0.890	3.056	0.691	03.05–14.06

Notes: See notes to Table 2. First PC is the first principal component of all of the uncertainty measures excluding BBD Global.

Second-stage estimation results for the two-factor model, reported in Table 12, are favorable to the maintained BBD Global first factor. BBD Global is significant at the 5% level in eight cases and significant at the 10% level in four cases. In all cases, the second uncertainty factor is never significant.

We next consider the common time span extending from November 1989 to June 2014. Call this 'common sample 2.' Here, we need to exclude the S-RTA Global uncertainty factor. Table 13 shows the second stage estimation results for the single-factor model. These results are not as strong as the full sample results (Table 2), but there remains evidence that the BBD Global factor is priced into the excess returns (It has the largest t-ratio and R^2.). Table 14 shows the second stage estimation results for the two-factor model with BBD Global as the maintained first factor. In all cases, the BBD Global factor is significant at the 5% level and the second uncertainty factor is never significant.

In sum, while the results from the subsample analysis are not as strong as in the full sample, our main result is maintained. We take this as further evidence that BBD Global is a robust uncertainty factor for carry-trade-generated currency excess returns.

6. Country-level exposure to uncertainty

In the preceding analysis, we sorted countries by interest rates and formed portfolios. Average portfolio excess returns varied in proportion to their betas on the BBD Global measure of uncertainty. Additional evidence that BBD Global is an uncertainty factor would come in the form of seeing average excess returns vary with beta. In this section, we look for this additional evidence by first estimating BBD Global betas for individual country excess returns (relative to the US) and then sort by betas.

Table 15 shows these results for monthly excess returns. We show individual currency results for the top and bottom beta quartiles. A mix of emerging and developed countries appear in the low and high beta quartiles. Low (negative) beta currencies have high average excess returns and large positive beta currencies have low average excess returns. Fig. 3 plots the individual average currency excess return against its BBD Global beta.

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Table 13
Two-pass estimation of the single-factor beta-risk model on monthly carry excess returns: all countries, common sample 2.

	Single-Factor Model							
Factor	λ	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
BBD US Equity	−0.938	−1.392	1.879	0.656	0.353	9.791	0.081	89.11–14.06
BBD US EPU	−0.566	**−2.453**	1.893	0.692	0.712	8.585	0.127	89.11–14.06
BBD Global	−0.518	**−2.935**	0.634	0.272	0.909	4.156	0.527	89.11–14.06
CI GeoPol	1.479	**2.027**	−6.113	−1.369	0.460	3.316	0.651	89.11–14.06
HRS MPU	−1.657	−1.298	7.931	1.158	0.290	3.995	0.550	89.11–14.06
JLN Macro	−0.115	−0.840	1.284	0.534	0.179	10.500	0.062	89.11–14.06
JLN Fin	0.109	1.906*	5.399	**3.498**	0.067	18.894	0.002	89.11–14.06
OZ Global	−0.391	−1.008	1.328	0.199	0.646	2.912	0.714	89.11–14.06
RSS-U	0.367	1.157	4.843	**3.098**	0.019	21.432	0.001	89.11–14.06
RSS Ex Ante	−0.088	−1.026	5.322	**3.457**	0.019	27.996	0.000	89.11–14.06
RSS Knightian	−0.154	−0.814	2.058	1.369	0.025	16.946	0.005	89.11–14.06

Notes: See notes to Table 2.

Table 14
Two-pass estimation of two-factor beta-risk model on monthly carry excess returns: all countries, common sample 2.

		Two-Factor Model (First Factor is BBD Global)								
λ_1	t-ratio	2^{nd} Factor	λ_2	t-ratio	γ	t-ratio	R^2	Test-stat	p-val.	Sample
−0.552	**−3.914**	BBD US Equity	0.223	0.583	0.871	0.365	0.962	2.361	0.797	89.11–14.06
−0.589	**−3.471**	BBD US EPU	−0.255	−1.111	−0.324	−0.114	0.984	0.919	0.969	89.11–14.06
−0.561	**−2.088**	CI GeoPol	−0.266	−0.593	1.418	0.402	0.911	3.968	0.554	89.11–14.06
−0.498	**−2.227**	HRS MPU	0.027	0.047	0.036	0.010	0.911	3.584	0.611	89.11–14.06
−0.577	**−4.041**	JLN Macro	0.058	0.998	1.724	0.801	0.958	2.443	0.785	89.11–14.06
−0.478	**−3.287**	JLN Fin	0.083	0.970	2.183	1.166	0.971	2.443	0.785	89.11–14.06
−0.532	**−3.403**	OZ Global	0.033	0.243	0.639	0.285	0.909	3.723	0.590	89.11–14.06
−0.512	**−3.683**	RSS-U	0.492	1.171	2.091	1.011	0.948	3.245	0.662	89.11–14.06
−0.560	**−3.680**	RSS Ex Ante	−0.151	−1.016	2.902	1.137	0.953	1.446	0.919	89.11–14.06
−0.570	**−3.889**	RSS Knightian	0.247	1.452	3.121	1.275	0.964	2.649	0.754	89.11–14.06
−0.545	**−4.094**	First PC	0.186	0.519	1.266	0.587	0.969	2.062	0.840	89.11–14.06

Notes: See notes to Table 2. First PC is the first principal component of all of the uncertainty measures excluding BBD Global.

Table 15
Low and high beta currencies.

	First Quartile			Fourth Quartile	
Country	Beta	Excess Return	Country	Beta	Excess Return
Romania	−28.618	15.942	France	−1.957	5.443
Portugal	−20.276	5.582	Taiwan	−0.755	−0.909
Brazil	−19.186	12.199	Italy	0.681	2.695
Mexico	−17.655	8.516	South Africa	0.826	1.218
Turkey	−16.994	12.726	Malaysia	3.098	1.209
Germany	−16.941	1.806	Singapore	4.497	0.635
Belgium	−16.766	4.624	Thailand	7.446	1.088
Euro	−15.634	5.604	Philippines	11.244	0.124
Finland	−14.818	5.125	Ireland	20.250	1.400
Netherlands	−14.372	1.103	Greece	52.391	2.981
Average	−18.126	7.323	Average	9.772	1.588

The country beta is from a regression of $re_{i,t}$ on the BBD Global factor f_t^U. The excess return is $\overline{re}_i = \frac{1}{T}\sum_{t=1}^{T} re_{i,t}$.

7. Interpretation

A no-arbitrage model for interest rates and exchange rates provides an interpretative framework for our results.[9] Let $m_{j,t+1}$ be the log of country j's nominal SDF, and let $V_{j,t} = E_t(m_{j,t+1} - E_t m_{j,t+1})^2$ be its date t conditional variance. Under complete markets and log-normality of the SDF, the investor's Euler equations lead to the pricing relations

[9] The model is closely related to Lustig et al. (2011), who extend the Cox et al. (1985) affine-yield models of the term structure to pricing currency excess returns.

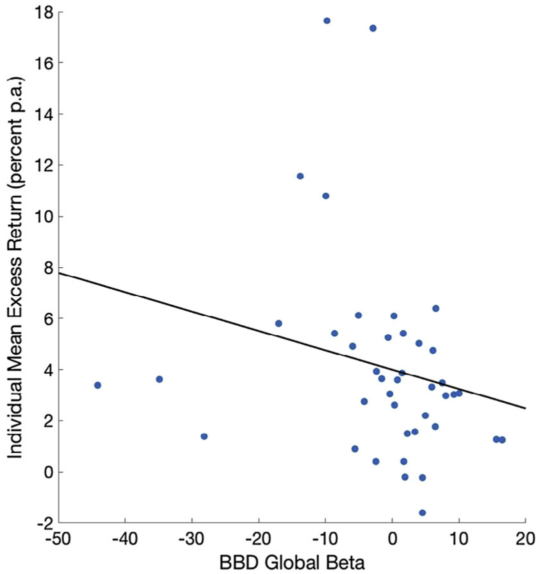

Fig. 3. Individual average excess returns and betas. Mean excess returns of individual currency return in excess of the US rate plotted against their BBD Global betas.

$$r_{j,t} = \mu_{j,t} + 0.5V_{j,t}, \quad (5)$$

$$\Delta s_{j,t} = m_{j,t} - m_{0,t}, \quad (6)$$

$$re_{j,t+1} = 0.5(V_{0,t} - V_{j,t}) + \epsilon_{j,t+1}, \quad (7)$$

where $re_{j,t+1} = \Delta s_{j,t+1} + r_{j,t} - r_{0,t}$ is the excess dollar return.[10] The last equation comes from $E_t(re_{j,t+1}) = 0.5(V_{0,t} - V_{j,t})$ and $\epsilon_{j,t+1}$ is the expectational error.

Let $z_{g,t}$ be the global risk factor and $z_{i,t}$ be a country-specific risk factor. Investor attention to, and influence by these risk factors is reflected through their loadings on the log nominal SDF ($m_{j,t+1}$),

$$m_{j,t+1} = -\theta_j(z_{j,t} + z_{g,t}) - u_{j,t+1}\sqrt{\omega_j\sigma_{j,t}} - u_{g,t+1}\sqrt{\delta_j\sigma_{g,t}} \quad (8)$$

where

$$z_{g,t+1} = \phi_g z_{g,t} + \sigma_{g,t}u_{g,t+1} \quad (9)$$

$$z_{j,t+1} = \phi_j z_{j,t} + \sigma_{j,t}u_{j,t+1} \quad (10)$$

$u_{g,t} \overset{iid}{\sim} (0, \eta_g^2)$ and $u_{j,t} \overset{iid}{\sim} (0, \eta_j^2)$. $\sigma_{g,t}$ and $\sigma_{j,t}$ are time-varying conditional volatility of a global factor $z_{g,t}$ and a country-specific factor $z_{j,t}$. We think of global factor volatility $\sigma_{g,t}$ as the object the uncertainty measures try to capture.[11] It is not necessary for us to specify the law of motion for these volatilities to make our point. Under this specification, the conditional mean ($\mu_{j,t}$) and conditional variance ($V_{j,t}$) of the log SDF are

$$\mu_{j,t} = -\theta_j(z_{j,t} + z_{g,t}) \quad (11)$$

$$V_{i,t} = \delta_j\eta_g^2\sigma_{g,t} + \omega_j\eta_j^2\sigma_{j,t}. \quad (12)$$

Hence, by (7) and (12), high excess return currencies or portfolios (those whose interest rates are higher than the US) are negatively correlated with global volatility $\sigma_{g,t}$. This will happen if the foreign SDF volatility loads more heavily on the global factor, $\delta_j > \delta_0$. Safe haven currencies (those with lower interest rates than the US and negative average excess returns) have excess returns that are positively correlated with global uncertainty. Their SDFs load less heavily on the global factor. Hence, higher exposure of the SDF to the global factor implies higher risk in carry trade currency excess returns.

[10] Let $M_{j,t} = \exp(m_{j,t})$ be country j's SDF. In pricing a risk-free bond we have $1/(r_{j,t}) = E_t(M_{j,t+1}) = \exp\left[\mu_{j,t} + \frac{1}{2}V_{i,t} + \cdots\right]$, where the last term comes from the cumulant expansion to the SDF (see Backus et al., 2001). Under log-normality of the SDF, third and higher-order cumulants are zero. Taking logs of both sides gives (5). (6) follows directly from the SDF approach to the exchange rate (Lustig and Verdelhan, 2012). (7) follows by direct substitution of (5) and (6) into the construction of the excess dollar return.

[11] Ozturk and Sheng (2016) decompose their overall uncertainty measure into global and idiosyncratic components. They find that economic activity is depressed following shocks to the global component but not to the idiosyncratic component.

8. Conclusion

It has long been known that systematic currency excess returns (deviations from uncovered interest rate parity) are available to investors. A simple strategy to earn these returns is the carry trade, whereby one borrows the low interest currency and lends in the high interest currency. The returns from the carry trade are compensation for exposure to systematic risk. In this paper, we study whether or not that risk is efficiently quantified and measured by recently proposed measures of macroeconomic and financial uncertainty. The alternative measures we study vary in their focus and by the methodology in their construction. Upward spikes in these uncertainty measures have been shown, by their authors, to be followed by subsequent periods of depressed economic activity.

We find an analogous effect of uncertainty on carry-trade-generated asset returns. While most of the uncertainty literature has focused on measuring US uncertainty, we find that a US centered measure is not a sufficient statistic for pricing currency excess returns. A global uncertainty factor, constructed as the cross-sectional average of the newspaper analysis of Baker et al.'s (2016) economic policy uncertainty index is found to be significantly priced into monthly carry-trade-generated excess returns. Periods of high measured global economic uncertainty are identified with the bad state. Interest-rate sorted portfolios of currency excess returns are found to have negative exposure (betas) to global uncertainty. That is, the currency excess returns tend to fall in times of high measured uncertainty. Significantly, the magnitude of the negative exposure is increasing with the average excess return.

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