Carry*

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Abstract

A security's expected return can be decomposed into its "carry" and its expected price appreciation, where carry can be measured in advance and without an asset pricing model. We find that carry predicts returns both in the cross section and time series of a variety of different asset classes that include global equities, bonds, currencies, and commodities. This predictability underlies the strong returns to "carry trades" that go long high-carry and short low-carry securities. Decomposing carry returns into static and dynamic components, we investigate the nature of this predictability. We identify "carry downturns"—when carry strategies across asset classes do poorly—and show that these episodes coincide with global recessions and liquidity crises.

Keywords: Carry Trade, Stocks, Bonds, Currencies, Commodities, Global Recessions

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1 Introduction

We define an asset's "carry" as its expected return assuming its price does not change. For any asset, we describe its return as

$$\text{return} = \underbrace{\text{carry} + \text{E(price appreciation)}}_{\text{expected return}} + \text{unexpected price shock}, \tag{1}$$

where the expected return is the carry on the asset plus its expected price appreciation. The concept of "carry" has been applied almost exclusively to currencies, where it simply represents the interest differential between two countries. However, as equation (1) shows, carry is a more general phenomenon that can be applied to any asset.

Carry can be an important component of the expected return on a security, and we examine the relation between the carry of each asset and its expected return. Applying this concept to a broad set of assets that include global equities, bonds, commodities, and currencies, we decompose a security's return into its carry plus its price appreciation. While both carry and the expected return are known in advance in principle, carry is a model-free measure of a component of expected returns that can be *observed directly*, whereas the part of the expected return coming from expected price appreciation must be estimated using a model. Carry is therefore an interesting security characteristic to examine, and we investigate the relation between carry and the total expected returns for a variety of assets.

Economic theory does not predict the nature of the relation between carry and total expected returns. For example, an asset's carry can change even when expected returns are constant, in which case a high carry would be offset by a low expected price appreciation. Carry could also be positively related to expected price appreciation, amplifying its relation to expected returns. Or, carry could be negatively related to total expected returns, depending upon the strength and nature of its relation with expected price appreciation/depreciation. We show empirically that carry is closely and positively related to expected returns in each of the major asset classes we study. Since carry varies over time and across assets, this result implies that expected returns vary through time and can be predicted by carry.

We examine the extent to which the time-varying risk premia we find linked to carry are driven by macroeconomic risk (Lucas (1978), Campbell and Cochrane (1999), Bansal and Yaron (2004)), market liquidity risk (Acharya and Pedersen (2005)), or funding liquidity risk (Brunnermeier and Pedersen (2009), Gârleanu and Pedersen (2011)), and what component of expected returns—the carry or expected price appreciation—is tied to these risks.

We start by analyzing "carry trades" in each asset class, which go long high carry securities and short low ones. The sample periods we consider differ across asset classes—the longest (shortest) for commodities (government bonds)—but in all cases the sample contains more than 20 years of data. We find that a carry trade within each asset class earns an annualized Sharpe ratio between 0.5 to 0.9, but a portfolio of carry strategies across all asset classes earns a Sharpe ratio of 1.4. This evidence suggests a strong cross-sectional link between carry and expected returns, as well as diversification benefits from applying carry more broadly across different asset classes.

We then decompose the returns to carry in each asset class into a passive and a dynamic component. The passive component is due to being long (short) on average high (low) unconditional expected return securities and the dynamic component captures how well carry predicts future price appreciation. We find that the dynamic component contributes to most of the returns to the equity carry strategy, a little more than half of the returns to the bond carry strategy, exactly half of the returns to the currency carry strategy, and less than a third of the returns to the commodity carry strategy. The substantial dynamic component in every asset class indicates that carry fluctuates over time and across assets, and that these fluctuations are associated with variation in expected returns.

To further study the fluctuations in risk premia, we consider a series of predictive regressions in which we regress the future returns of each asset on its carry. For each asset class, we find strong evidence of time-varying risk premia, where carry predicts future returns with a positive coefficient in every asset class. However, the magnitude of the predictive coefficient differs across asset classes and identifies whether carry is positively or negatively related to future price appreciation. For equities, we find that carry positively predicts future price appreciation and thus enhances expected returns beyond the carry itself. The same is true for bonds, but to a lesser extent. For currencies, carry has no additional predictability for future price appreciation and in commodities, carry predicts future decreases in asset prices so that the expected return is actually less than the carry. These results are consistent with those from the decomposition of carry returns into passive and dynamic components, where those asset classes with the greatest return predictability from carry derive the bulk of their carry trade profits from dynamic trading.

We then investigate how carry and the returns to carry vary with macroeconomic business cycle risk and liquidity risk. We start by showing that carry strategies can be simplified to a regional level for stocks, bonds, and currencies (North America, Europe, U.K., Asia, and Australia/New Zealand) and to an asset category for commodities (energy, agriculture/livestock, and metals). The same static and dynamic features we find for each asset are largely preserved at the coarser regional level, but where the dynamic component becomes even stronger. This suggests that an important component of carry strategies are bets *across* rather than *within* regions.

By studying multiple asset classes at the same time, we provide some out-of-sample evidence of existing theories, as well as some guidance for new theories to be developed on what drives carry returns. The common feature we highlight is that all carry strategies produce high Sharpe ratios. However, the crash risk commonly documented for currency carry trades appears to be absent in other asset classes. Moreover, a diversified carry strategy across all asset classes does not exhibit negative skewness. The question remains whether other risks inherent in carry strategies extend across asset classes at the same time and whether the high average returns to carry strategies are compensation for those risks. We find that, despite the high Sharpe ratios, carry strategies are far from riskless and exhibit sizeable declines, simultaneously across asset classes, for extended periods of time. Examining the carry strategy's downside returns, the most striking feature is that the downturns tend to coincide with plausibly bad aggregate states of the global economy. For example, global carry returns tend to be low during global recessions.

Flipping the analysis around, we also identify the worst and best carry return episodes for the global carry strategy applied across all asset classes, which we term carry "downturns" and "expansions." We find that the three biggest global carry downturns (August 1992 to March 1993, April 1997 to December 1998, and June 2007 to January 2009) coincide with major global business cycle and macroeconomic events and are also characterized by lower levels of global liquidity. Reexamining each individual carry strategy within each asset class, we further find that individual carry strategies in each asset classe separately do poorly during these times as well.

During carry downturns, equity, currency (with the exception of Asia), and commodities markets do poorly globally, while fixed income markets produce high returns. Carry strategies therefore appear risky since they are long equity, currency, and commodity markets that decline more during these episodes and are short the securities that decline less during these times. For fixed income, the opposite is true as fixed income does well overall during carry downturns. Hence, part of the return premium earned on average for going long carry may be compensation for this exposure that generates large losses during extreme times of global recessions and liquidity crunches.

Our work relates to the extensive literature on the currency carry trade and the associated failure of uncovered interest rate parity.[1] Recently, several theories have

[1]This literature goes back at least to Meese and Rogoff (1983). Surveys are presented by Froot and

been put forth to explain the curry carry trade premium. Brunnermeier, Nagel, and Pedersen (2008) show that the currency carry trade is exposed to liquidity risk, which is enhanced by occasional crashes and could lead to slow price adjustments. Bacchetta and van Wincoop (2010) present a related explanation based on infrequent revisions of investor portfolio decisions. Lustig and Verdelhan (2007) suggest that the carry trade is exposed to consumption growth risk from the perspective of a U.S. investor and Farhi and Gabaix (2008) develop a theory of consumption crash risk (see also Lustig, Roussanov, and Verdelhan (2010)). Our findings on carry are broader, ranging across an array of assets from several different asset classes, and we highlight the characteristics that are unique to and common across these asset classes. The crashes that characterize currency carry trades and are prominent features of the models seeking to explain currency carry returns, are unique to currencies and are not exhibited in the carry trades of other asset classes. While this may possibly be linked to currency carry trades also having the most significant funding liquidity risk exposure, it also indicates that this feature is not a robust explanation for carry strategies in general outside of currencies.

Our paper also contributes to a growing literature studying the risk-return trade-offs in global asset markets that analyzes mutiple markets jointly. Asness, Moskowitz, and Pedersen (2010) study cross-sectional value and momentum strategies within and across individual equity markets, country equity indices, government bonds, currencies, and commodities simultaneously.[2] Moskowitz, Ooi, and Pedersen (2010) also document time-series momentum in equity index, currency, commodity, and bond futures that is distinct from cross-sectional momentum. Fama and French (2011) study the relation between size, value, and momentum in global equity markets across four major regions (North America, Europe, Japan, and Asia Pacific).

The remainder of the paper is organized as follows. Section 2 defines carry is defined and how it relates to expected returns. Section 3 describes the data and our portfolio construction and the performance of global carry trades. Section 4 analyzes the predictability of carry for returns. Section 5 explores regional carry trades and Section 6 investigates how carry relates to global business cycle and liquidity risk. Section 7

Thaler (1990), Lewis (1995), and Engel (1996).

[2]Other studies focus on a single asset class or market at a time, ignoring how these markets behave simultaneously with respect to certain strategies. Studies focusing on international equity returns include Chan, Hamao, and Lakonishok (1991), Griffin (2002), Griffin, Ji, and Martin (2003), Hou, Karolyi, and Kho (2010), Rouwenhorst (1998), and Fama and French (1998). Studies focusing on government bonds across countries include Ilmanen (1995) and Barr and Priestley (2004). Studies focusing on commodities returns include Fama and French (1987), Bailey and Chan (1993), Bessembinder (1992), Casassus and Collin-Dufresne (2005), Erb and Harvey (2006), Acharya, Lochstoer, and Ramadorai (2010), Gorton, Hayashi, and Rouwenhorst (2007), Tang and Xiong (2010), and Hong and Yogo (2010).

concludes.

2 Understanding Carry

We decompose the return to any security into the security's carry and its price appreciation. The carry return can be thought of as the return to the security assuming prices stay constant, and is therefore known in advance. We detail below the decomposition of different securities' returns into carry versus price appreciation across four diverse asset classes: currencies, equities, bonds, and commodities. Since we examine futures contracts across these various asset classes, it is instructive to consider the carry of a futures contract in general, which we can then apply across different asset classes.

Consider a futures contract that expires in period $t+1$ with a current futures price F_t and spot price of the underlying security S_t. To compute the carry of holding this futures contract, assume that the spot price remains constant over the life of the contract, $S_{t+1} = S_t$. The carry C_t of the futures contract is then easily computed as the futures return under the assumption of constant spot price from t to $t+1$,

$$C_t = \frac{S_t - F_t}{F_t}, \tag{2}$$

since the futures contract expires at the future spot price, no spot price changes implies $F_{t+1} = S_{t+1} = S_t$. Applying this concept to each of the specific asset classes we examine below, we can also derive more intuition for the definition of carry in each asset class.

Decomposing returns into its expected return plus an unexpected price shock, we can provide further insight into carry and how it relates to expected returns. First, carry is related to the expected return, but the two are *not* the same. The expected return on an asset is comprised of both the carry on the asset and the expected price appreciation of the asset, which depends on the specific asset pricing model used to form expectations and the discount rate, including risk premia, applied to future cash flows. The carry component of an asset's expected return, however, can be measured in advance in a straightforward "mechanical" way without the need to specify a model or stochastic discount factor. Put differently, carry is a simple observable signal, which is a component of the expected return on an asset. Decomposing the time $t+1$ return on an asset, $r_{t+1} = (S_{t+1} - F_t)/F_t$ into its expected time $t+1$ return plus the unexpected price shock at $t+1$,

$$r_{t+1} = \underbrace{C_t + E_t(\frac{\Delta S_{t+1}}{F_t})}_{E_t(r_{t+1})} + u_{t+1}, \tag{3}$$

where $\Delta S_{t+1} = S_{t+1} - S_t$ and $u_{t+1} = (S_{t+1} - E_t(S_{t+1}))/F_t$ is the unexpected price shock. We see that carry provides one piece to the determination of $E_t(r_{t+1})$. In addition, carry may also be relevant for predicting expected price changes which also contribute to the expected return on an asset. That is, C_t may also provide information for predicting $E_t(\frac{\Delta S_{t+1}}{F_t})$, which we investigate empirically in the paper. We next discuss in more detail theoretically how carry is related to expected returns for each specific asset class; the rest of the paper tests these relations empirically.

2.1 Currency Carry

We begin with the classic carry trade studied in the literature—the currency carry trade—which is a trade that goes long high carry currencies and short low carry currencies. For a currency, the carry is simply the local interest rate in the corresponding country. For instance, investing in a currency by literally putting cash into a country's money market earns the interest rate if the exchange rate (the "price of the currency") does not change.

Most speculators get foreign exchange exposure through a currency forward and our data on currencies comes from currency forward contracts (detailed in the next section and Appendix A). To derive the carry of a currency from forward rates, recall that the no-arbitrage price of a currency forward contract with spot exchange rate S_t, local interest rate r^f, and foreign interest rate r^{f*} is $F_t = S_t(1 + r_t^f)/(1 + r_t^{f*})$. Therefore, the carry of the currency is

$$C_t = \frac{S_t - F_t}{F_t} = \left(r_t^{f*} - r_t^f\right)\frac{1}{1 + r_t^f}. \tag{4}$$

Hence, the carry of investing in a forward in the foreign currency is the interest-rate spread, $r^{f*} - r^f$, adjusted for a scaling factor close to one, $(1 + r_t^f)^{-1}$. The carry is the foreign interest rate *in excess* of the local risk-free rate r^f because the forward contract is a zero-cost instrument such that its return is an excess return. (The scaling factor simply reflects that a currency exposure using a futures contract corresponds to buying 1 unit of foreign currency in the future, which corresponds to buying $(1 + r_t^f)^{-1}$ units of currency today. The scaling factor could be eliminated if we changed the assumed leverage, i.e., the denominator in the carry and return calculations.)

There is an extensive literature studying the carry trade in currencies. The historical positive return to currency carry trades is a well known violation of the so-called uncovered interest-rate parity (UIP). The UIP is based on the simple assumption that all currencies should have the same expected return, but many economic settings would imply differences in expected returns across countries. For instance, differences in expected currency returns could arise from differences in consumption risk (Lustig and Verdelhan (2007)), crash risk

(Brunnermeier, Nagel, and Pedersen (2008), Burnside, Eichenbaum, Kleshchelski, and Rebelo (2006)), liquidity risk (Brunnermeier, Nagel, and Pedersen (2008)), and country size (Hassan (2011)). Indeed, if a country is exposed to consumption or liquidity risk then this could imply both a high interest rate and a cheaper exchange rate, everything else equal.

While we investigate the currency carry trade and its link between to macroeconomic and liquidity risks, the goal of our study is to investigate the role of carry more broadly across asset classes and identify the characteristics of carry returns that are common and unique to each asset class. As we show in the next section, some of the results in the literature pertaining to currency carry trades, such as crashes, are unique to currencies and not evident in other asset classes, while other characteristics, such as business cycle variation, are more common to carry trades in general across all asset classes.

2.2 Equity Carry

For equities, carry is simply defined as the expected dividend yield. If stock prices do not change, then the return on equities comes solely from dividends—hence, carry is the expected dividend yield today. The definition of carry can also be derived by considering equity futures. The no-arbitrage price of a futures contract is $F_t = S_t(1+r_t^f) - E_t^Q(D_{t+1})$, where the expected divided payment D is computed under the risk-neutral measure Q, and r_t^f is the risk-free rate at time t.[3] Substituting this expression back into equation (2), the carry for an equity future can be rewritten as

$$C_t = \frac{S_t - F_t}{F_t} = \left(\frac{E_t^Q(D_{t+1})}{S_t} - r_t^f \right) \frac{S_t}{F_t}. \tag{5}$$

In words, the carry of an equity futures contract is simply the expected dividend yield minus the risk-free rate (because a futures return is an excess return), multiplied by a scaling factor which is close to one, S_t/F_t.

To further see the relationship between carry and expected returns, consider Gordon's growth model for the price S_t of a stock with dividend growth g and expected return $E(R)$, $S_t = D/(E(R) - g)$. This standard equity pricing equation implies that the expected return is the dividend yield plus the expected dividend growth, $E(R) = D/S + g$. Or, the expected return is the carry D/S plus the expected price appreciation arising from the expected dividend growth, g.

[3]Binsbergen, Brandt, and Koijen (2010) and Binsbergen, Hueskes, Koijen, and Vrugt (2010) study the asset pricing properties of dividend futures prices, $E_t^Q(D_{t+n})$, $n = 1, 2, \ldots$, in the US, Europe, and Japan.

If the dividend yield D/S varies independently of g, then the dividend yield is clearly a signal of expected returns. If, on the other hand, dividend growth is high precisely when the dividend yield is low, then the dividend yield would not necessarily relate to expected returns, as the two components of $E(R)$ would offset each other.

If expected returns do vary, then it is natural to expect carry to be positively related to expected returns: If a stock's expected return increases while dividends stay the same, then its price drops and its dividend yield increases. Hence, a high expected return leads to a high carry. Indeed, this discount-rate mechanism follows from standard macro-finance models, such as Bansal and Yaron (2004), Campbell and Cochrane (1999), Gabaix (2009), Wachter (2010), and models of time-varying liquidity risk premia (Acharya and Pedersen (2005), Brunnermeier and Pedersen (2009), Gârleanu and Pedersen (2011)). We investigate in the next section the relation between carry and expected returns for each asset class and whether these relations are consistent with theory.

2.3 Commodity Carry

If you make a cash investment in a commodity by literally buying and holding the physical commodity itself, then the carry is the convenience yield or net benefits of use of the commodity in excess of storage costs. While the actual convenience yield is hard to measure (and may depend on the specific investor), the carry of a commodity futures or forward can be easily computed.[4] The no-arbitrage price of a commodity futures contract is $F_t = S_t(1 + r_t^f - \delta)$, where δ is the convenience yield in excess of storage costs. Hence, the carry for a commodity futures contract is,

$$C_t = \frac{S_t - F_t}{F_t} = \left(\delta - r^f\right) \frac{1}{1 + r_t^f - \delta}, \tag{6}$$

where the commodity carry is the convenience yield of the commodity in excess of the risk free rate (adjusted for a scaling factor that is close to one). To compute the carry from equation (6), therefore, we need only data on the current futures price F_t and current spot price S_t. However, commodity spot markets are often highly illiquid and clean spot price data on commodities is often unavailable. To combat this data issue, instead of examining the slope between the spot and futures prices, we consider the slope between two futures prices of different maturity. Specifically, we consider the price of the nearest to maturity

[4]Similar to the dividend yield on equities, where the actual dividend yield may be hard to measure since future dividends are unknown in advance, the expected dividend yield can be backed out from futures prices on equities easily. Indeed, one of the reasons we employ futures contracts for our empirical analysis is to easily and consistently compute the carry across asset classes.

commodity futures contract with the price of a futures contract on the same commodity at a longer-dated maturity. For example, suppose that the nearest to maturity futures price is F_t^1 with T_1 months to maturity and the second futures price is F_t^2 with T_2 months to maturity, where $T_2 > T_1$. In general, the no-arbitrage futures price can be written as $F_t^{T_i} = S_t(1+(r^f - \delta)T_i)$. Thus, the carry of holding the second contract can be computed by assuming that its price will converge to F_t^1 after $T_2 - T_1$ months, that is, assuming that the price of a T_1-month futures stays constant:

$$C_t = \frac{F_t^1 - F_t^2}{F_t^2(T_2 - T_1)} = \left(\delta - r_t^f\right)\frac{S_t}{F_t^2}, \tag{7}$$

where we divide by $T_2 - T_1$ to compute the carry on a per-month basis. Following equation (7), we can simply use data from the futures markets—specifically, the slope of the futures curve—to get a measure of carry that captures the convenience yield.[5]

2.4 Bond Carry

Calculating carry for bonds is perhaps the most difficult since there are several reasonable ways to define carry for fixed income instruments. For example, consider a bond with T-months to maturity, coupon payments of D, par value $\bar{P}$, price P_t^T, and yield to maturity y_t^T. There are several different ways to define the carry of this bond. Assuming that its price stays constant, the carry of the bond would be the current yield, D/P_t^T, if there is a coupon payment over the next time period, otherwise it is zero. However, since a bond's maturity changes as time passes, it is not natural to define carry based on the assumption that the bond *price* stays constant (especially for zero-coupon bonds).

A more compelling definition of carry arises under the assumption that the bond's *yield to maturity* stays the same over the next time period. The carry could then be defined as the yield to maturity (regardless of whether there is a coupon payment). To see this, note that the price today of the bond is,

$$P_t^T = \sum_{i \in \{\text{coupon dates} > t\}} D(1 + y_t^T)^{-(i-t)} + \bar{P}(1 + y_t^T)^{-(T-t)}, \tag{8}$$

[5]In principal, we could do the same for the other asset classes as well using the futures curve in those asset classes to provide a more uniform measure of carry across asset classes. However, since spot price data is readily available in the other asset classes, this is unnecessary. Moreover, in unreported results, we find that the carry calculated from the futures curve in the other asset classes is nearly identical to the carry computed from spot and futures prices in those asset classes. Hence, using the futures curve to calculate carry appears to be equivalent to using spot-futures price differences, justifying our computation for carry in commodities.

and if we assume that the yield to maturity says the same, then the same corresponding formula holds for the bond next period as well, P_{t+1}^{T-1}. Thus, the value of the bond including coupon payments, next period is,

$$P_{t+1}^{T-1} + D \cdot 1_{[t+1 \in \{\text{coupon dates}\}]} = \sum_{i \in \{\text{coupon dates} > t\}} D(1+y_t^T)^{-(i-t-1)} + \bar{P}(1+y_t^T)^{-(T-t-1)}. \quad (9)$$

Hence, the carry is

$$C_t = \frac{P_{t+1}^{T-1} + D \cdot 1_{[t+1 \in \{\text{coupon dates}\}]} - P_t^T}{P_t^T} = y_t^T. \quad (10)$$

Clearly, the carry on a funded position (the carry in excess of the short-term risk-free rate) is then the term spread:

$$C_t = y_t^T - r_t^f. \quad (11)$$

Perhaps the most compelling definition of carry is the return on the bond if *the entire term structure of interest rates* stays constant, i.e., $y_{t+1}^\tau = y_t^\tau$ for all maturities τ. In this case, the carry is the bond return assuming that the yield to maturity changes from y_t^T to y_t^{T-1}. In this case, the carry is

$$\begin{aligned} C_t &= \frac{P_{t+1}^{T-1} + D \cdot 1_{[t+1 \in \text{coupon dates}]} - P_t^T}{P_t^T} \\ &= y_t^T + \frac{P_{t+1}^{T-1}(y_t^{T-1}) - P_{t+1}^{T-1}(y_t^T)}{P_t^T} \\ &\cong y_t^T - modD\left(y_t^{T-1} - y_t^T\right), \end{aligned} \quad (12)$$

where the latter approximation involving the modified duration, *modD*, yields a simple way to think of carry. Intuitively, equation (12) shows that if the term structure of interest rates is constant, then the carry is the bond yield plus the "roll down," meaning the price increase due to the fact that the bond rolls down the yield curve. As the bond rolls down the yield curve, the yield changes from y_t^T to y_t^{T-1}, resulting in a return which is minus the yield change times the modified duration.

Similar to the other assets, we can subtract the risk free rate from this expression to compute the carry of a funded position for comparison to the futures contracts we use in the other asset classes. To derive a similar expression using bond futures directly requires futures prices on different maturity bonds. Unfortunately, liquid bond futures contracts are only traded in a few countries and, when they exist, there are often very few contracts (possibly only one). Further complicating matters is the fact that different bonds have different coupon rates (as well as cheapest-to-deliver options in futures contracts) that need to be accounted for. To avoid these issues, we instead use term structure data from the cash bond markets to compute bond carry as described above. Specifically, we start with a zero-coupon bond curve y_t^T and consider the 1-month carry of a 10-year zero-coupon bond. After one month, the 10-year bond becomes a 9-year-and-11-months bond with yield y_t^{9Y11M} and we apply equation (12) to compute the carry for the bond as follows,

$$C_t = \frac{1/(1+y_t^{9Y11M})^{9+11/12}}{1/(1+y_t^{10Y})^{10}} - 1. \tag{13}$$

This calculation is similar to the futures-based definitions of carry in the other asset classes in the following sense: we acknowledge that the 10-year bond will be a 9-year-and-11-months bond in 1 month. Hence, as the "spot price," we use the current price of a 9-year-and-11-months bond, just like we define carry using spot prices in the other asset classes. We also compute bond returns based on the time structure data.[6]

2.5 The Carry of a Portfolio

We compute the carry of a portfolio of securities as follows. Consider a set of securities indexed by $i = 1, ..., N_t$, where N_t is the number of available securities at time t. Security i has a carry of C_t^i computed at the end of month t and that is related to the return r_{t+1}^i over the following month $t+1$. Letting the portfolio weight of security i be w_t^i, the return of the portfolio is naturally the weighted sum of the returns on the securities, $r_{t+1} = \sum_i w_t^i r_{t+1}^i$. Similarly, since carry is also a return (under the assumption of no price changes), the carry of the portfolio is simply computed as,

$$C_t^{portfolio} = \sum_i w_t^i C_t^i. \tag{14}$$

2.6 Defining a Carry Trade Portfolio

A carry trade is a trading strategy that goes long high-carry securities and shorts low-carry securities. There are various ways of choosing the exact carry-trade portfolio weights, but our main results are robust across a number of portfolio weighting schemes. One way to construct the carry trade is to rank assets by their carry and go long the top 20, 25 or 30% of securities and short the bottom 20, 25 or 30%, with equal weights applied to all securities within the two groups, and ignore (e.g., place zero weight on) the securities in

[6] For countries with actual, valid bond futures data, the correlation between actual futures returns and our synthetic futures returns is in excess of 0.95.

between these two extremes. Another method, which we primarily focus on, is a carry trade specification that takes a position in all securities weighted by their carry ranking. Specifically, the weight on each security i at time t is given by

$$w_t^i = z_t \left(\text{rank}(C_t^i) - \frac{N_t + 1}{2} \right), \tag{15}$$

where the scalar z_t ensures that the sum of the long and short positions equals 1 and -1, respectively. This weighting scheme is similar to that used by Asness, Moskowitz, and Pedersen (2010) and Moskowitz, Ooi, and Pedersen (2012), who show that the resulting portfolios are highly correlated with other zero-cost portfolios such as top minus bottom 30%.

By construction, the carry trade portfolio always has a positive carry itself. The carry of the carry trade portfolio is equal to the weighted-average carry of the high-carry securities minus the average carry among the low-carry securities:

$$C_t^{\text{carry trade}} = \sum_{w_t^i > 0} w_t^i C_t^i - \sum_{w_t^i < 0} |w_t^i| C_t^i > 0. \tag{16}$$

Hence, the carry of the carry trade portfolio depends on the cross-sectional dispersion of carry among the constituent securities.

3 Carry Trade Returns Across Asset Classes

Following Equation (15), we construct carry trade portfolio returns for each asset class as well as across all the asset classes we examine. First, we briefly describe our sample of securities in each asset class and how we construct our return series, then we consider the carry trade portfolio returns within and across the asset classes and examine their performance over time.

3.1 Data and Summary Statistics

Appendix A details the data sources we use for the country equity index futures, currency forward rates, commodity futures, and synthetic bond futures returns (as described above). Table 1 presents summary statistics for each of the instruments we use, including the sample period and annualized mean and standard deviation of returns.

There are 13 country equity index futures: the U.S. (S&P 500), Canada (S&P TSE 60), the UK (FTSE 100), France (CAC), Germany (DAX), Spain (IBEX), Italy (FTSE

MIB), The Netherlands (EOE AEX), Norway (OMX), Switzerland (SMI), Japan (Nikkei), Hong Kong (Hang Seng), and Australia (S&P ASX 200), whose returns go as far back as May 1982 (for SPX) through February 2011. The sample mean annualized returns range from -3.05 (NKY from October 1988 to October 2011) to 12.47 (HSI from May 1992 to October 2011). Volatility ranges from 13.69 percent per year for Australia (AS51) to 28.05 percent for Hong Kong (HSI).

There are 19 foreign exchange forward contracts covering the period November 1983 to February 2011 (with some currencies starting as late as February 1997 and the Euro beginning in February 1999). Again, there is considerable heterogeneity in mean and volatility of returns across exchange rates.

The commodities sample covers 23 commodities futures dating as far back as January 1970 (through February 2011). Not surprisingly, commodities exhibit the largest cross-sectional variation in mean and standard deviation of returns since they contain the most diverse assets, covering commodities in metals, energy, and agriculture.

Finally, the fixed income sample covers 10 government bonds starting as far back as May 1989, but beginning in January 1995 for most countries, through February 2011. Bonds exhibit the least cross-sectional variation across markets, but there is still substantial variation in average returns and volatility across the markets.

3.2 Carry Trade Portfolio Returns within an Asset Class

For each global asset class, we construct a carry strategy that invests in high-carry securities while short selling low-carry instruments, where each instrument is weighted by the rank of its carry and the portfolio is rebalanced each month end following Equation (15).

We consider two measures of carry: (i) The "current carry", which is measured at the end of each month, and (ii) "carry1-12", which is the average of the current carry over the past 12 month ends (including the most recent one). We include carry1-12 because of potential seasonal components that can arise in calculating carry for certain assets. For instance, the equity carry over the next month depends on whether most companies are expected to pay dividends in that specific month, and countries differ widely in their dividend calendar (e.g., Japan vs. US). Current carry will tend to go long an equity index if that country is in its dividend season, whereas carry1-12 will go long an equity index that has a high overall dividend yield (for that year) regardless of what month those dividends were paid. In addition, some commodity futures have strong seasonal components that are also eliminated by using carry1-12. Averaging over the past year helps eliminate the potential influence of these seasonal components. Fixed income (the way we compute it) and currencies do not exhibit much seasonal carry pattern, but we also consider strategies based on both their current carry and carry1-12 for robustness.

Table 2 reports the annualized mean, standard deviation, skewness, excess kurtosis, and Sharpe ratio of the carry strategies within each asset class. For comparison, the same statistics are reported for the returns to a passive long investment in each asset class, which is just an equal weighted portfolio of all the securities in each asset class. The sample period for equities is February 1988 to February 2011, for fixed income it is November 1991 to February 2011, for commodities it is January 1980 to February 2011, and for currencies it is November 1983 to February 2011.

Table 2 indicates that all the carry strategies in all asset classes have significant positive returns. Using current carry, the average returns range from 4.8% for the currency carry trade to 10.4% for the commodity carry trade. Using carry1-12, the average returns range from 2.9% for the bond carry trade to 13.5% for the commodity carry trade. Sharpe ratios for the current carry range from 0.50 in commodities to 0.93 for equities and for carry1-12 they range from 0.47 in bonds to 0.64 in commodities. The current carry portfolio exhibits stronger performance than carry1-12 for equities,[7] bonds, and slightly for currencies, which may reflect that more timely data provides more predictive power for returns. However, for commodities, carry1-12 performs better, which is likely due to the strong seasonal variation in commodity carry that may not be related to returns.

The robust performance of carry strategies across asset classes indicates that carry is an important component of expected returns. The previous literature focuses on currency carry trades, finding similar results to those in Table 2. However, we find that a carry strategy works at least as well in other asset classes, too. In fact, the current carry strategy performs markedly better in equities and fixed income than currencies, and the carry1-12 strategy performs slightly better in equities and commodities than currencies. Hence, carry is a broader concept that can be applied to many assets in general and is not unique to currencies.[8]

Both the current carry and carry1-12 portfolios also seem to outperform a passive investment in each asset class. For example, in equities, the Sharpe ratio of a passive long position in all equity futures is only 0.37, compared to 0.93 for the current carry strategy and 0.62 for the carry1-12 strategy. In commodities, the passive portfolio delivers only a 0.18 Sharpe ratio, while the carry portfolios achieve 0.50 and 0.64 Sharpe ratios,

[7]This suggests that expected returns may vary over the dividend cycle, which can potentially be tested more directly using dividend futures as in Binsbergen, Hueskes, Koijen, and Vrugt (2010).

[8]Several recent papers also study carry strategies for commodities in isolation, see for instance Szymanowska, de Roon, Nijman, and van den Goorbergh (2011) and Yang (2011).

respectively. Consistent with the literature, currency carry strategies also outperform a passive investment in currencies. For fixed income, the carry strategy appears to perform about the same as a passive long investment. However, these comparisons are misleading because the beta of a carry strategy is typically smaller than one. As we show below, the alphas of the carry strategies with respect to these passive benchmarks are all consistently and significantly positive, even for fixed income.

Examining the higher moments of the carry trade returns in each asset class, we find the strong negative skewness associated with the currency carry trade documented by Brunnermeier, Nagel, and Pedersen (2008). However, negative skewness is not a feature of carry trades in other asset classes, such as equities and fixed income. Commodity carry portfolios seem to exhibit some negative skewness, but not as extreme as currencies. Hence, the "crashes" associated with currency carry trades do not seem to be as strong a feature in carry trades in other asset classes. Thus, explanations for the return premium to carry trades in currencies that rely on crash risk may not be suitable for explaining return premia to carry in other asset classes. All carry portfolios in all asset classes seem to exhibit excess kurtosis.

Figure 2 plots the cumulative monthly returns to each carry strategy in each asset class over their respective sample periods. The currency carry trade "crashes" are evident on the graphs, but there is less evidence for sudden crashes among carry strategies in other asset classes. In addition, the graphs also plot the cumulative carry itself, which represents the component of the carry portfolios' expected return that is observable ex ante and would comprise the total expected return if underlying spot prices remained constant. Hence, the difference between the two lines on each graph represents the component of expected returns to the carry trade that come from price appreciation. In the next section, we investigate in more detail the relationship between carry, expected price changes, and expected returns.

3.3 Diversified Carry Trade Portfolio

Table 2 also reports the performance of a diversified carry strategy across all asset classes, which is constructed as the equal-volatility-weighted average of carry portfolio returns across the asset classes. Specifically, we weight each asset classes' carry portfolio by the inverse of its sample volatility so that each carry strategy in each asset class contributes roughly equally to the total volatility of the diversified portfolio. This procedure is similar to that used by Asness, Moskowitz, and Pedersen (2010) and Moskowitz, Ooi, and Pedersen (2012) to combine returns from different asset classes that face very different volatilities. Since commodities have roughly three to four times the volatility of fixed income, a simple equal-weighted average of carry returns across asset classes will have its variation dominated by commodity carry risk and underrepresented by bond carry risk. Hence, we volatility-weight the asset classes when combining them into a diversified portfolio.

As the bottom of Table 2 reports, the diversified carry trade based on the current carry has a remarkable Sharpe ratio of 1.41 per annum and the diversified carry1-12 portfolio has an impressive 0.93 Sharpe ratio. A diversified passive long position in all asset classes produces only a 0.74 Sharpe ratio. These numbers suggest carry is a strong predictor of expected returns globally across asset classes. Moreover, the substantial increase in Sharpe ratio for the diversified carry portfolio relative to the individual carry portfolio Sharpe ratios in each asset class, indicates that the correlations of the carry trades across asset classes are quite low. Hence, sizeable diversification benefits are obtained by applying carry trades universally across asset classes.

Table 3 reports the correlations of carry trade returns across the four asset classes. Except for the correlation between currency carry and bond carry, the correlations are all very close to zero, and even for bonds and currencies, the correlation of their carry returns is only 0.23. The low correlations among carry strategies in other asset classes not only lowers the volatility of the diversified portfolio substantially, but also mutes the negative skewness associated with currency carry trades and mitigates the excess kurtosis associated with all carry trades. In fact, the negative skewness and excess kurtosis of the diversified portfolio of carry trades is smaller than those of the passive long position diversified across asset classes. Hence, the diversification benefits applying carry across asset classes seem to be larger than those obtained from investing passively long in the same asset classes.

3.4 Risk-Adjusted Performance and Exposure to Other Factors

Table 4 reports regression results for each carry portfolio's returns in each asset class on a set of other portfolio returns or factors.

For both the current carry and carry1-12 portfolios in each asset class, we regress the time series of their returns on the passive long portfolio returns (equal-weighted average of all securities) in each asset class, the value and momentum "everywhere" factors of Asness, Moskowitz, and Pedersen (2010), which are diversified portfolios of value and cross-sectional momentum strategies in global equities, equity indices, bonds, commodities, and currencies, and the time-series momentum (TS-momentum) factor of Moskowitz, Ooi, and Pedersen (2012) which is a diversified portfolio of time-series momentum strategies in futures contracts in the same asset classes we examine here for carry.

Panel A of Table 4 reports both the intercepts or alphas from these regressions as well as the betas on the various factors to evaluate the exposure of the carry trade returns to these other known strategies or factors. The first two columns of each panel of Table 4 report the results from regressing the carry trade portfolio returns in each asset class (both current carry and carry1-12) on the equal-weighted passive index for that asset class (e.g., CAPM for the asset class). The alphas for every carry strategy in every asset class are positive and statistically significant, indicating that in every asset class a carry strategy provides abnormal returns above and beyond simple passive exposure to that asset class. Put differently, carry trades offer excess returns over the local market return in each asset class. Examining the betas of the carry portfolios on the local market index for each asset class, we see that the betas are not significantly different from zero. Hence, carry strategies provide sizeable return premia without much market exposure to the asset class itself. The last two rows of each panel of Table 4 report the R^2 from the regression and the information ratio (IR, which is the alpha divided by residual volatility from the regression) of each carry strategy. The IRs are quite large, reflecting high risk-adjusted returns to carry strategies even after accounting for its exposures to standard risk factors.

Looking at the value, momentum, and time-series momentum factor exposures we find mixed evidence across the asset classes. For instance, in equities, we find that carry strategies have a positive value exposure, but no momentum or time-series momentum exposure. The positive exposure to value reduces the alpha slightly, especially for carry1-12, but the remaining alpha and information ratio are still significantly positive. In commodities, a carry strategy loads significantly negatively on value and significantly positively on cross-sectional momentum, but exhibits little relation to time-series momentum. The exposure to value and cross-sectional momentum captures a significant fraction of the variation in commodity carry's returns, as the R^2 jumps from less than 1% to more that 23% when the value and momentum everywhere factors are included in the regression. However, because the carry trade's loadings on value and momentum are of opposite sign, the impact on the alpha of the commodity carry strategy is small since the exposures to these two positive return factors offset each other. The alphas diminish by about 20-30 basis points per month, but remain economically large and statistically significant. Finally, for both fixed income and currency carry strategies, there is no reliable loading of the carry strategies' returns on value, momentum, or time-series momentum (except current carry for bonds seems to have a negative loading on TS-momentum), and consequently the alphas of bond and currency carry portfolios remain significant.

The regression results in Table 4 only highlight the average exposure of the carry trade returns to these factors. However, this may mask significant dynamic exposures to these factors. To see if the risk exposures vary significantly over time, Figure 3 examines the variation over time in the carry portfolio's returns to the market by plotting the three-year rolling correlations (using monthly returns data) of each carry trade's returns with the passive portfolio for that asset class. As the figure shows, the carry trade's correlation to the market in all asset classes varies significantly over time, perhaps most evident for currencies. Although on average the market exposure of each carry trade is insignificantly different from zero, there are times when the carry trade in every asset class has significant positive exposure to the market and other times when it has significant negative market exposure. We explore the dynamics of carry trade positions in the following sections.

4 How Does Carry Relate to Expected Returns?

In this section we investigate further how carry relates to expected returns and the nature of carry's predictability for future returns. We begin by decomposing carry trades into static and dynamic components.

4.1 Decomposing Carry Trade Returns Into Static and Dynamic Components

The average return of the carry trade depends on two sources of exposure: (i) a "passive" return component due to the *average* carry trade portfolio being long (short) securities that have high (low) unconditional returns, and (ii) a "dynamic" return component that captures how strongly variation in carry predicts returns. More formally, we decompose carry trade returns into its passive and dynamic components as follows:

$$\begin{aligned} E(r_{t+1}^{\text{carry trade}}) &= E(\sum_i w_t^i r_{t+1}^i) \\ &= \underbrace{\sum_i E(w_t^i)E(r_{t+1}^i)}_{E(r^{\text{passive}})} + \underbrace{\sum_i E\left[\left(w_t^i - E(w_t^i)\right)\left(r_{t+1}^i - E(r_{t+1}^i)\right)\right]}_{E(r^{\text{dynamic}})}. \end{aligned} \quad (17)$$

Here, $E(w_t^i)$ is the portfolio's "passive exposures", while the "dynamic exposures" $w_t^i - E(w_t^i)$ are zero on average but essentially represent a timing strategy in the asset by going long and short that asset according to its carry.

Panel A of Table 5 reports the results of this decomposition, where we estimate the static and dynamic components of returns according to equation (17). For equities, the dynamic component comprises the entirety of the current carry trade's returns and 75% of the carry1-12 portfolio returns. For commodities, we get a very different result, where the majority of the carry trades' profits come from the passive component and only 25-33% of profits are coming from the dynamic component. The results for fixed income and currencies are less extreme, where a little more than half of the bond carry returns come from the dynamic component and for the currency carry returns the split between passive and dynamic components is approximately equal. Overall, carry trade returns appear to be due to both passive exposures and dynamic rebalancing, with some variation across asset classes in terms of the importance of these two components.

Another way to look at the static versus dynamic component of returns to carry is to run the following panel regression for each asset class,

$$r_{t+1}^{i} = a^{i} + b_{t} + cC_{t}^{i} + \varepsilon_{t+1}^{i}, \tag{18}$$

where a^i is an asset-specific intercept or fixed effect and b_t are time fixed effects and C_t^i is the carry on asset i at time t. This predictive regression evaluates how well carry predicts returns for each asset on average. Without asset and time fixed effects, c represents the total predictability of returns from carry from both its passive and dynamic components. Including time fixed effects removes the predictable return component of carry coming from passive exposure to returns in general at a given point in time and including asset-specific fixed effects removes the predictable return component of carry coming from passive exposure to assets with different unconditional average returns. By including asset and time fixed effects, the slope coefficient c in equation (20) represents the predictability of returns to carry coming purely from its dynamic component.

Panel B of Table 5 reports the estimated c coefficients from this regression for each asset class. We report results with no fixed effects, with time fixed effects only, with asset fixed effects only, and with time and asset fixed effects. First, the results indicate that carry is a strong predictor of expected returns, with consistently positive and statistically significant coefficients on carry, save for the current carry commodity strategy, which may be tainted by strong seasonal effects in carry for commodities. The carry1-12 strategy, which mitigates seasonal effects, is a ubiquitously positive and significant predictor of returns, even in commodities. Second, examining the change in the size of the coefficient c across the different specifications that include various sets of fixed effects, we can see how the predictability of carry changes once these passive exposures are removed.

For example, the coefficient on carry for equities drops very little when including asset and time fixed effects, which is consistent with the dynamic component to equity carry strategies dominating the predictability of returns as shown in Panel A of Table 5. We also see that currency carry predictability is cut roughly in half when the fixed effects are included, meaning that the dynamic component of the currency carry strategy contributes about half of the return predictability, which is again consistent with the results in Panel A of Table 5. Likewise, the predictive value of the dynamic component for commodities is weakest, which is also consistent with the results in Panel A.

However, the magnitude of the coefficient c is even more interesting because it helps identify how carry is related to expected returns. A value of c greater than one means that carry "under predicts" expected returns in the sense that expected returns respond more than one-for-one with the carry. Conversely, c less than one means that carry "over predicts," i.e. expected returns move less than one-for-one with the carry.

4.2 Does the Market Take Back Part of the Carry?

The strong returns to the carry trade indicate that carry is indeed a signal of expected returns. However, to better understand the relation between carry and expected returns it is instructive to go back to equation (1), which decomposes expected returns into carry and expected price appreciation. Looking at the coefficient estimates c in Panel B of Table 5 we gain insight into how carry—one component of expected returns—is related to expected price appreciation—the other component of expected returns. For example, do prices change in such a way that high-carry securities are expected to have low price appreciation and thus "give back" part of the carry? In this case, carry would "over predict" returns resulting in a c coefficient less than one. Or, conversely, do prices change in such a way that high-carry securities earn an additional return premium as prices are expected to appreciate more? In this case carry "under predicts" returns. Or, is the average carry equal to average expected returns?

In Panel B of Table 5 we find that the predictive coefficient is greater than one for equities and fixed income, and smaller than one for commodities and currencies (when fixed effects are included). These results imply that for equities, for instance, when the dividend yield is high, not only is an investor rewarded by directly receiving large dividends (relative to the price), but also the price tends to appreciate more than usual. Hence, expected stock returns appear to be comprised of both high dividend yields and additionally high expected price appreciation. Similarly for fixed income securities, where buying a 10-year bond with a high carry (high yield spread over the short rate) in addition to providing returns itself also implies higher returns from rolling down the yield curve. One might conjecture that the term spread is high simply because short rates are expected to increase, which could also raise long-term interest rates. However, the predictive coefficient c being larger than one means that, not only is the carry high, but the bond also appreciates in value on average, meaning that its yield goes down, not up.

For currencies, the predictive coefficient is close to one, which means that high-interest currencies neither depreciate, nor appreciate, on average. Hence, the currency investor earns the interest-rate differential on average. This finding goes back to Fama (1984), who ran these regressions slightly differently. Fama (1984)'s well-known result is that the predictive coefficient has the "wrong" sign relative to uncovered interest rate parity, which corresponds to a coefficient larger than one in our regression.

Finally, for commodities, the coefficient is significantly less than one, so that when a commodity has a high spot price relative to its futures price, implying a high carry, the spot price tends to depreciate on average, thus lowering the realized return on average below the carry.

Looking back at Figure 2, which plots the carry trades' cumulative returns and their cumulative carries, the difference between the two return series highlights the relation between carry and expected returns. Since carry is similar to a return (namely, it is the hypothetical return if the price does not change), the cumulative carry can be computed (and interpreted) just like any cumulative return. For simplicity, we compute the cumulative returns and cumulative carry by summation: for instance, the cumulative carry at time t is computed as $\sum_{\tau=1}^{t} C_\tau$. Consistent with the regression results in Panel B of Table 5, the cumulative carry is greater than the cumulative return for equities and fixed income, carry is similar to returns for currencies, and carry is substantially lower than returns for commodities. These plots indicate that carry "under-predicts" returns on average in equities and fixed income, "over-predicts" in commodities, and neither really over- or under-predicts in currencies.

Finally, for robustness, Table B in the appendix shows the results from similar predictive regressions where the value of each security's carry is replaced by the cross-sectional rank of its carry (scaled by the number of securities N_t) to rely less on the magnitude of the carry. More specifically,

$$r_{t+1}^i = a^i + b_t + c\frac{\text{rank}(C_t^i)}{N_t} + \varepsilon_{t+1}^i. \tag{19}$$

The predictive power of these rank-based carry weights is even stronger than the carry itself, particularly for commodities, which provided the weakest results when using the magnitude of the carry to weight securities. However, the drawback of using rank-based carry weights is that the magnitudes of the coefficients from these regressions are more difficult to interpret. The additional predictive power we get from using ranks instead of the size of the carry itself may be due to the benefits of trimming outliers in measured carry. This explanation is consistent with the biggest improvement coming for commodities, where their seasonal components and their diversity likely generate the most noisy carry measures. On the other hand, the stronger predictive power of ranks may also indicate that a very large value of the carry is not associated with a commensurately high expected return, an issue we study further below.

4.3 How Far Into the Future Does Carry Predict Returns?

It is also interesting to consider how far into the future carry predicts returns. To address this question, we run the following regression

$$r^i_{t+1} = a^i + b_t + cC^i_{t+1-k} + \varepsilon^i_{t+1}, \tag{20}$$

where we consider the current carry with $k = 1$ as well as lagged values of the carry for $k = 1, 3, 6, 12$, and 24. Figure 4 reports the regression coefficients and their 95% confidence intervals. All of the coefficients for the most recent value of carry are significantly positive, but in most cases the predictive strength of carry declines over the course of one year. Hence, carry's predictive power for returns seems to extend to about a year before dissipating for every asset class.

4.4 Does the Carry of the Carry Trade Predict Returns?

Table 6 reports how the carry of the carry trade predicts the returns of the carry trade. Specifically, we report results from the following regression

$$r^{\text{carry trade}}_{t+1} = a + bC^{\text{carry trade}}_t + \varepsilon^i_{t+1}, \tag{21}$$

where $r^{\text{carry trade}}_t$ is the return of the carry trade and $C^{\text{carry trade}}_t$ is the carry of the carry trade portfolio at time t. As Table 6 reports, the carry of the carry trade does not predict the returns to the carry trade, except marginally in equities. Hence, while carry predicts returns in general, such that the carry trade makes money on average in all asset classes, it does not appear to be the case that a larger spread in the carry itself is associated with larger expected returns. That is, timing the carry strategy using the size of the carry itself does not seem to yield much predictive power.[9]

Table 6 also shows how the average carry in each asset class predicts the return to the passive long position in each asset class. This is similar to the panel regression of equation (20), with the exception that it only relies on time series information for a single diversified portfolio, whereas the previous regressions used all the information from all the securities as well as their cross-sectional differences. The point estimates of the predictive coefficients for the passive index in each asset class are positive, but are significant only for equities and currencies.

5 Regional Carry Trades

In this section, and the following, we provide evidence that the high returns to carry strategies may reflect compensation for macro-economic and liquidity risks. As a starting point, we first show that the carry strategies can be simplified to a large extent by thinking about broad geographic regions for equities, fixed income, and currencies, and about broad categories of commodities.

In particular, we form five regions for equities, fixed income, and currencies: (i) North America, (ii) Continental Europe, (iii) the United Kingdom, (iv) Asia, and (v) Australia/New Zealand. Within each region, we average the carry signal and form an equally-weighted portfolio of returns. For commodities, we form three groups: (i) metals, (ii) energy, and (iii) aggriculturals/live stock. Again, we weigh the carry signals and returns within each group equally. We then form carry strategies based on these new carry signals and returns.

Table 7 summarizes the return properties of these regional carry strategies. (For simplicity, we refer to these strategies as "regional carry strategies," having noted that for commodities we trade across three groups that are not directly linked to a geographic region.) The table shows that most of the properties of carry strategies by asset class are preserved: the Sharpe ratios are high in every asset class, and in this case even lowest for currencies, and the negative skewness is a property of the currency carry strategy only.

The bottom panel constructs the global carry factor. As before, we weigh each asset class proportional to the inverse of the standard deviation of returns and we scale the

[9]This might be due to a non-linear effect, where a very large difference in carry across securities in an asset class might suggest that the higher-carry securities are exposed to risks or expected price depreciation. For instance, a currency under attack tends to have a high carry but may also have a low expected return. For example, when George Soros attacked the British pound in 1992, the Bank of England raised interest rates to defend the currency, thus making the pound a high-carry currency, but, as judged by Soros and other speculators, the expected return was still quite low, and, as it turned out, so was the realized return when the British Pound eventually plummeted.

weights to make sure they sum to one. The annualized Sharpe ratio for the current carry strategy equals 1.10; it equals 0.73 for the carry1-12 strategy.

In Table 8, we present the results of the return decomposition of the regional carry strategies as in (17). Relative to the carry strategies based on individual contracts (Table 5) we find that the contribution of the dynamic component of carry strategies is equally, if not more, important for regional carry strategies. This suggests that an important dynamic component of carry strategies are bets *across regions* instead of *within regions*.

6 How Risky Are Carry Strategies?

In this section we investigate whether the high returns to carry strategies compensate investors for certain risk factors. A large and growing literature studying the currency carry strategy suggests that carry returns may compensate investors for crash risk, liquidity risk, US business cycle risk, or global volatility risk. By studying multiple asset classes at the same time, we provide some out-of-sample evidence of existing theories, as well as some guidance for new theories to be developed. The common feature we highlight is that all carry strategies produce high Sharpe ratios. However, the crash risk for currencies appears to be unique to this asset class, and does not extend to other asset classes. The question remains whether other risks inherent in carry strategies extend across asset classes at the same time and whether the high average returns to carry strategies can be plausibly explained as compensation for those risks.

To identify the risk in carry strategies, we focus on the global carry factor in which we combine all four carry strategies across all asset classes. We argue that the carry1-12 strategy is more plausibly related to macro-economic risk than the current carry strategy, which moves at a higher frequency and is more susceptible to seasonal features. In the top panel of Figure 5 we plot the cumulative return on the global carry1-12 strategy. The bottom panel removes a linear time trend from the cumulative returns and plots the cyclical component of returns over time. We find that, despite the high Sharpe ratio, the global carry strategy is far from riskless and exhibits sizeable declines for extended periods of time.

Examining the carry strategy's downside returns, the most striking feature is that the downturns tend to coincide with plausibly bad aggregate states of the global economy, which we measure using a global recession indicator, which is a GDP-weighted average of the regional recession dummies. Global carry returns tend to be low during global recessions. The figure also indicates that the timing between real variables and asset prices differs per recession. Hence, it may not be best to focus on recessions as measured by the NBER methodology.

As an alternative approach, we identify what we call carry "downturns" and "expansions." We first compute the maximum draw-down of the global carry strategy, which is defined as:

$$D_t \equiv \sum_{s=1}^{t} r_s - \max_{u \in \{1,\ldots,t\}} \sum_{s=1}^{u} r_s,$$

where r_s denotes the return on the global carry1-12 strategy. The draw-down dynamics are presented in Figure 6. Three carry downturns stand out: August 1992 to March 1993, April 1997 to December 1998, and June 2007 to January 2009. The period August 1992 to March 1993 is identified as a recession in Continental Europe and Asia. The period April 1997 to December 1998 coincides with the Asian crisis. The third carry recession, June 2007 to January 2009 coincides with the recent "Great Recession." This preliminary evidence suggests carry strategies are exposed to global business cycles.

To show that these downturns are indeed shared among all four asset classes, we further explore the return properties of the different asset classes in Table 9. The top panel reports (annualized) average returns on the current carry and the carry1-12 strategy for each asset class during carry downturns and carry expansions. For all strategies in all asset classes, the returns are lower during carry downturns. This implies that the downturns of the global carry factor are not particular to a single asset class.

The second panel breaks the average returns down for each of the three downturns and for all strategies. The returns are below the average returns for 22 out of 24 cases. This evidence implies that carry downturns are bad periods for all carry strategies at the same time across all asset classes.

The third panel shows the performance of our carry strategies using individual contracts instead of broad regions and groups. We again find that all carry strategies perform worse during carry downturns relative to during carry expansions. The differences are more pronounced for the carry1-12 strategy, which has been used to define the carry downturns, than for the current carry strategies.

The bottom panel then illustrates that these are also periods in which global economic activity, as measured by the global recession indicator, slows down. During carry downturns, the average value of the global recession indicator equals 0.35 versus 0.17 during carry expansions. The difference is statistically significant at the 5%-significance level. We further show that carry downturns are characterized by lower levels of global liquidity as well. If we average global liquidity shocks (obtained from Asness, Moskowitz, and Pedersen (2010) during carry downturns and carry expansions, we find that the average level of liquidity is lower during carry downturns. The difference is again significant at the 5%-significance level.

Figure 7 displays the drawdowns per carry strategy, based on the broad regions or groups, alongside the drawdown dynamics of the global carry factor. The shaded areas indicate the carry drawdowns identified before. The drawdown dynamics of the different strategies tend to coincide with the drawdown dynamics of the global carry factor, consistent with the evidence in Table 6. Furthermore, the figure highlights that there are severe drawdowns that are specific to a single asset class, such as in 2001 for equities and in 2003 for commodities.

To further illustrate that carry downturns correspond to bad aggregate states, we study the returns in all asset classes by region and group during carry downturns and expansions. The results are summarized in Table 10. The average return for equities, currencies, and commodities are much lower during carry downturns. Fixed income returns, by contrast, are much higher, reflecting the fact that the yield curve tends to flatten during recessions. This implies that equally weighted strategies do poorly during carry episodes as well for equities, currencies, and commodities, while fixed income is a hedge.

If we zoom in at the level of regions and groups, we see that for equities, commodities, and fixed income, this pattern emerges for each and every region or group. For currencies, the returns are lower for all regions, apart from Asia, where the Japanese Yen tends to appreciate during carry downturns. Carry strategies do poorly during these episodes as, for instance for equities, it is long the regions that decline most and short the regions that do not decline as much. This makes carry strategies risky bets on global business cycle risk.

Lastly, we study whether the poor returns of carry strategies are the result of the passive or the dynamic component of carry strategies. For instance, for equities, are the poor returns driven by the fact that regions with, on average, high dividend yields (and hence on average held long in the carry strategy) experience larger declines in their stock market during carry downturns? Or, do dividend yields shift during carry downturns such that carry strategies become risky during these bad aggregate states?

In Table 11, we decompose the return during carry expansions and downturns into the passive and dynamic components. We find, consistently across asset classes, that carry downturns are largely driven by the passive component. The high returns during carry expansions, by contrast, are largely the result of the dynamic component, in particular for equities and commodities. Hence, hedging out the passive component of carry strategies should mitigate the risk exposure to global business cycles and liquidity shocks.

7 Conclusion: Caring about Carry

Appendix

A Data sources

We describe below the data sources we use to construct our return series. Table 1 provide summary statistics on our data, including sample period start dates.

Equities We use equity index futures data from 13 countries: the U.S. (S&P 500), Canada (S&P TSE 60), the UK (FTSE 100), France (CAC), Germany (DAX), Spain (IBEX), Italy (FTSE MIB), The Netherlands (EOE AEX), Norway (OMX), Switzerland (SMI), Japan (Nikkei), Hong Kong (Hang Seng), and Australia (S&P ASX 200). The data source is Bloomberg. We collect data on spot, nearest-, and second-nearest-to-expiration contracts to calculate the carry as described in Section 2. We calculate the returns on the most active equity futures contract for each market (which is typically the front-month contract). This procedure ensures that we do not require any form of interpolation to compute returns.

Currencies The currency data consist of spot and one-month forward rates for 19 countries: Austria, Belgium, France, Germany, Ireland, Italy, The Netherlands, Portugal and Spain (replaced with the euro from January 1999), Australia, Canada, Denmark, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States. Our basic dataset is obtained from Barclays Bank International (BBI) prior to 1997:01 and WMR/Reuters thereafter and is similar to the data in Burnside, Eichenbaum, Kleshchelski and Rebelo (2011), Lustig, Roussanov and Verdelhan (2011), and Menkhoff, Sarno, Schmeling and Schrimpf (2010). However, we verify and clean our quotes with data obtained from HSBC, Thomson Reuters, and data from BBI and WMR/Reuters sampled one day before and one day after the end of the month using the algorithm described below.

At the start of our sample in 1983:10, there are 6 pairs available. All exchange rates are available since 1997:01, and following the introduction of the euro there are 10 pairs in the sample since 1999:01.

There appear to be several data errors in the basic data set. We use the following algorithm to remove such errors. Our results do not strongly depend on removing these outliers. For each currency and each date in our sample, we back out the implied foreign interest rate using the spot- and forward exchange rate and the US 1-month LIBOR. We subsequently compare the implied foreign interest rate with the interbank offered rate obtained from Global Financial Data and Bloomberg. If the absolute difference between the currency-implied rate and the IBOR rate is greater than a specified threshold, which we set at 2%, we further investigate the quotes using data from our alternative sources. More specifically:

- before (after) 1997:01, if data is available from WMR/Reuters (BBI) and the absolute difference of the implied rate is below the threshold, replace the default source BBI (WMR/Reuters) with WMR/Reuters (BBI)
  - if data is available from WMR/Reuters (BBI) and the absolute difference of the implied rate is also above the threshold, keep the default source BBI (WMR/Reuters)
- else, if data is available from HSBC and the absolute difference of the implied rate is below the threshold, replace the default source with HSBC
  - if data is available from HSBC and the absolute difference of the implied rate is also above the threshold, keep the default source
- else, if data is available from Thomson/Reuters and the absolute difference of the implied rate is below the threshold, replace the default source with Thomson/Reuters
  - if data is available from Thomson/Reuters and the absolute difference of the implied rate is also above the threshold, keep the default source

If none of the other sources if available, we compare the end-of-month quotes with quotes sampled one day before and one day after the end of the month and run the same checks.

In cases where the interbank offered rate has a shorter history than our currency data, we include the default data if the currency-implied rate is within the tolerance of the currency-implied rate from any of the sources described above.

There are a few remaining cases, for example where the interbank offered rate is not yet available, but the month-end quote is different from both the day immediately before and after the end of the month. In these cases, we check whether the absolute difference of the implied rates from these two observations is within the tolerance, and take the observation one day before month-end if that is the case.

Figure 1 for Sweden illustrates the effects of our procedure by plotting the actual interbank offered rate ("Libor BB") with the currency-implied rate from the original data (“Libor implied”) and the currency-implied rate after our data cleaning algorithm has been applied (“Libor implied NEW”). Sweden serves as an illustration only, and the impact for other countries is similar.

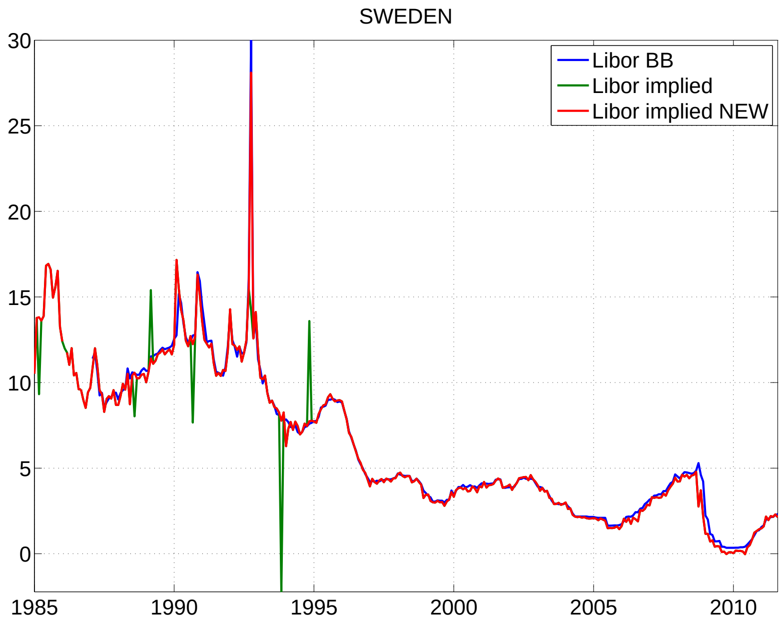

Figure 1: **Libor rates for Sweden.** The figure shows the dynamics of three Libor rates: From Bloomberg (“Libor BB”), the one implied by currency data (“Libor implied”), and the one implied by our corrected currency data (“Libor implied NEW”).

Some of the extreme quotes from the original source are removed (for instance, October 1993), whereas other extremes are kept (like the observations in 1992 during the banking crisis).

Commodities Since there are no reliable spot prices for commodities, we use the nearest-, second-nearest, and third-nearest to expiry futures prices from Bloomberg. Our commodities data set consists of 23 commodities: 6 in metals (aluminum, copper, nickel, zinc, lead, and tin), 6 in energy (brent crude oil, gasoil, WTI crude, RBOB gasoline (spliced with the unleaded gasoline contract which was delisted at the end of 2006), heating oil, and natural gas), 8 in agriculture (cotton, coffee, cocoa, sugar, soybeans, Kansas wheat, corn, and wheat), and 3 in livestock (lean hogs, feeder cattle, and live cattle).

The industrial metals contracts (from the London Metals Exchange, LME) are different from the other contracts, as futures contracts can have daily expiration dates up to 3 months out. We collect cash- and 3-month (constant maturity) futures prices and use linear interpolation to calculate returns.

Fixed income Bond futures are only available for a very limited number of countries and for a relatively short sample period. We therefore create synthetic futures returns for 10 countries: the US, Australia, Canada, Germany, the UK, Japan, New Zealand, Norway, Sweden, and Switzerland. We collect zero coupon 10-year, 9-year, and 3-month constant maturity yields from Bloomberg. Each month, we calculate the price of the 10-year zero coupon bond and a bond with a remaining maturity of nine year and 11 months (by linearly interpolating the 9- and 10-year yields). Our fixed income carry measure is the percent price difference between these two bonds, minus the short rate (to make it comparable to a non-funded basis like a futures contract). The rate of return is defined similarly. For countries with bond futures data, the correlation between actual futures returns and our synthetic futures returns is in excess of 0.95.

A.1 Return Computation

We compute the returns of each instrument in two ways. First, we always invest in the nearest-to-maturity futures contract, and then roll the contract at expiration to the new nearest-to-delivery contract. Second, we use the interpolated futures prices. We prefer the former as these are actual returns, however results are very similar using either method to compute returns.[10]

B Predictive Regressions Using Ranks

The table below shows the results from predictive regressions where the value of each security's carry is replaced by the cross-sectional rank of its carry (scaled by the number of securities N_t) to rely less on the magnitude of the carry. More specifically,

$$r_{t+1}^i = a^i + b_t + c\frac{\text{rank}(C_t^i)}{N_t} + \varepsilon_t^i. \tag{B.1}$$

[10]One caveat to this computation for commodity returns is that we condition on whether the return actually exists.

	Global Equities				Commodities			
Slope current carry	1.16%	1.15%	1.28%	1.25%	1.42%	1.47%	0.87%	0.96%
t-stat	4.32	4.12	4.64	4.34	3.12	3.09	1.72	1.81
Slope carry 1-12	0.69%	0.68%	0.94%	0.95%	1.52%	1.57%	0.87%	0.97%
t-stat	2.50	2.36	2.73	2.65	3.32	3.27	1.72	1.81
Contract FE	No	No	Yes	Yes	No	No	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes

	Fixed Income				Currencies			
Slope current carry	0.62%	0.62%	0.66%	0.68%	0.56%	0.58%	0.79%	0.97%
t-stat	3.92	3.79	3.61	3.52	2.82	2.80	2.26	2.70
Slope carry 1-12	0.32%	0.32%	0.23%	0.26%	0.46%	0.47%	0.54%	0.72%
t-stat	2.04	1.94	1.25	1.33	2.39	2.38	1.56	2.07
Contract FE	No	No	Yes	Yes	No	No	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes

Table B.1: **How Carry Predicts Returns: Using Ranks.**

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Tables

Instrument	Begin sample	Mean return (annual)	St.dev. (annual)	Instrument	Begin sample	Mean return (annual)	St.dev. (annual)
Equities				**Commodities**			
SPX	May-82	7.11	15.62	Aluminum	Feb-91	-1.16	19.13
SPTSX60	Oct-99	6.54	16.44	Copper	Feb-80	9.09	27.10
UKX	Mar-88	3.88	15.22	Nickel	Mar-93	14.69	35.72
CAC	Jan-89	4.48	19.73	Zinc	Mar-91	1.83	25.59
DAX	Dec-90	6.52	21.63	Lead	Mar-95	11.85	29.78
IBEX	Aug-92	9.63	21.66	Crude Oil	Feb-99	22.81	32.96
FTSEMIB	Apr-04	1.63	20.59	Gasoil	Feb-99	22.54	34.17
AEX	Feb-89	7.51	20.75	WTI Crude	Feb-87	12.62	33.74
OMX	Mar-05	9.22	19.73	Unleaded Gasoline	Feb-88	17.77	35.71
SMI	Nov-91	5.60	15.01	Heating Oil	Feb-83	10.49	32.74
NKY	Oct-88	-2.85	22.22	Natural Gas	Feb-94	-14.96	54.86
HSI	May-92	12.44	27.92	Cotton	Feb-80	2.48	24.83
AS51	Jun-00	4.06	13.59	Coffee	Feb-81	4.16	37.98
				Cocoa	Feb-84	-2.91	28.94
Currencies				Sugar	Feb-80	1.29	39.80
Australia	Jan-85	4.68	11.96	Soybeans	Feb-80	2.02	23.36
Austria	Feb-97	-2.64	8.70	Kansas Wheat	Feb-99	1.49	28.62
Belgium	Feb-97	-2.69	8.67	Corn	Feb-80	-4.36	24.71
Canada	Jan-85	2.15	7.06	Wheat	Feb-80	-5.16	24.53
Denmark	Jan-85	4.45	11.11	Lean Hogs	Feb-80	-2.74	24.65
France	Nov-83	4.55	11.24	Feeder Cattle	Feb-02	3.20	14.99
Germany	Nov-83	2.71	11.70	Live Cattle	Feb-80	2.53	14.07
Ireland	Feb-97	-2.51	8.89				
Italy	Apr-84	4.46	11.22	**Fixed Income**			
Japan	Nov-83	1.62	11.65	Australia	Jan-95	4.70	10.50
Netherlands	Nov-83	2.95	11.71	Canada	Jan-95	6.48	7.92
New Zealand	Jan-85	7.03	12.41	Germany	Nov-91	4.64	6.94
Norway	Jan-85	4.81	10.93	UK	Jan-95	4.30	8.26
Portugal	Feb-97	-2.26	8.42	Japan	May-89	4.37	7.80
Spain	Feb-97	-1.48	8.52	New Zealand	Jan-95	2.68	9.69
Sweden	Jan-85	3.60	11.45	Norway	Aug-98	2.53	7.58
Switzerland	Nov-83	1.75	11.97	Sweden	Jan-95	7.39	8.87
UK	Nov-83	2.92	10.57	Switzedland	Jan-95	4.84	5.71
Euro	Feb-99	1.84	10.76	US	Jan-95	5.06	10.05

Table 1: **Summary Statistics.** This table contains all the instruments that we use, the start data of data availability, and the annualized mean return and standard deviation.

	Carry Trade: Current Carry	Carry Trade: Carry 1-12	Passive Long: Equal Weighted
	Global Equities		
Average	9.9%	6.6%	5.9%
St.dev.	10.6%	10.7%	15.8%
Skewness	0.10	0.11	-0.66
Kurtosis	4.81	3.81	4.15
SR	**0.93**	**0.62**	**0.37**
	Commodities		
Average	10.4%	13.5%	2.4%
St.dev.	21.0%	21.2%	13.5%
Skewness	-0.53	-0.92	-0.45
Kurtosis	5.54	6.18	5.70
SR	**0.50**	**0.64**	**0.18**
	Fixed Income		
Average	5.1%	2.9%	5.1%
St.dev.	6.2%	6.2%	6.4%
Skewness	-0.13	-0.01	0.03
Kurtosis	4.95	4.70	3.11
SR	**0.82**	**0.47**	**0.78**
	Currencies		
Average	4.8%	4.0%	3.2%
St.dev.	8.0%	7.8%	8.8%
Skewness	-0.83	-0.88	-0.10
Kurtosis	5.09	5.19	3.45
SR	**0.61**	**0.52**	**0.36**
	Diversified Across All Asset Classes		
Average	6.9%	4.7%	4.1%
St.dev.	4.9%	5.0%	5.5%
Skewness	-0.31	-0.44	-1.13
Kurtosis	4.05	4.29	8.43
SR	**1.41**	**0.93**	**0.74**

Table 2: **The Returns to Global Carry Strategies.** For each asset class, we construct long/short carry trades and this table reports the average, standard deviation, skewness, and kurtosis.

Correlations of Carry Trades: Current Carry				
	Equities	Commodities	Fixed income	Currencies
Equities				
Commodities	-0.004			
Fixed income	-0.023	0.019		
Currencies	0.060	0.007	0.230	

Correlations of Carry Trades: Carry 1-12				
	Equities	Commodities	Fixed income	Currencies
Equities				
Commodities	0.022			
Fixed income	0.065	-0.122		
Currencies	0.125	0.095	0.210	

Table 3: **The Correlation across Global Carry Strategies.**

	Global Equities								
	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry
Alpha	0.86%	0.53%	0.82%	0.39%	0.85%	0.40%	0.86%	0.41%	0.85%
t-stat	4.67	2.83	4.48	1.99	4.65	1.95	4.76	2.04	4.66
Passive long	-0.07	0.04	-0.07	0.03	-0.07	0.03	-0.09	0.03	-0.10
t-stat	-1.26	0.65	-1.38	0.57	-1.23	0.59	-1.64	0.54	-1.73
Value ”everywhere”			0.12	0.32	0.14	0.32	0.08	0.30	0.08
t-stat			1.19	3.59	1.38	3.66	0.82	3.35	0.85
Momentum ”everywhere”			0.02	0.08	0.06	0.09	0.01	0.09	0.01
t-stat			0.18	1.07	0.69	1.13	0.18	1.19	0.07
TS momentum					-0.04	0.00			
t-stat					-1.46	-0.11			
Funding liquidity							0.01	0.00	
t-stat							1.36	-0.28	
Market liquidity									0.00
t-stat									1.10
R-square	1.07%	0.30%	1.86%	5.52%	2.65%	5.52%	2.35%	4.82%	2.28%
IR	0.98	0.60	0.93	0.45	0.96	0.45			

	Commodities								
	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry
Alpha	0.88%	1.15%	0.79%	1.03%	0.63%	0.85%	0.01	0.01	0.01
t-stat	2.83	3.68	2.89	3.72	2.25	3.04	2.05	1.86	1.93
Passive long	-0.04	-0.14	-0.08	-0.19	-0.01	-0.12	0.00	-0.17	0.03
t-stat	-0.46	-1.17	-1.02	-1.82	-0.15	-1.13	0.00	-1.70	0.32
Value ”everywhere”			-0.21	-0.23	-0.24	-0.26	-0.21	-0.21	-0.20
t-stat			-3.10	-3.83	-3.18	-4.16	-2.63	-3.44	-2.48
Momentum ”everywhere”			0.28	0.33	0.34	0.42	0.29	0.39	0.30
t-stat			4.21	5.67	3.78	5.18	4.07	7.40	4.24
TS momentum					-0.13	-0.15			
t-stat					-1.04	-1.36			
Funding liquidity							0.01	0.03	
t-stat							0.82	2.96	
Market liquidity									0.00
t-stat									0.01
R-square	0.07%	0.83%	17.04%	23.12%	20.30%	27.15%	19.98%	30.41%	19.43%
IR	0.50	0.66	0.49	0.66	0.42	0.59			

	Fixed Income								
	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry
Alpha	0.40%	0.27%	0.41%	0.27%	0.45%	0.27%	0.00	0.00	0.00
t-stat	3.09	2.16	3.13	2.08	3.51	2.16	2.97	2.08	3.06
Passive long	0.07	-0.07	0.05	-0.07	0.20	-0.04	0.06	-0.07	0.05
t-stat	0.84	-0.85	0.64	-0.86	1.87	-0.34	0.70	-0.87	0.57
Value "everywhere"			-0.05	0.04	-0.08	0.03	-0.05	0.03	-0.06
t-stat			-0.33	0.24	-0.53	0.20	-0.34	0.21	-0.36
Momentum "everywhere"			0.12	0.06	0.21	0.08	0.10	0.04	0.11
t-stat			0.91	0.44	1.63	0.57	0.77	0.31	0.84
TS momentum					-0.06	-0.01			
t-stat					-2.46	-0.51			
Funding liquidity							0.00	0.00	
t-stat							1.30	1.26	
Market liquidity									0.00
t-stat									-0.79
R-square	0.46%	0.47%	1.31%	0.64%	4.60%	0.80%	1.92%	1.41%	1.49%
IR	0.77	0.53	0.80	0.51	0.88	0.53			

	Currencies								
	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry	Carry1-12	Current Carry
Alpha	0.38%	0.32%	0.35%	0.31%	0.30%	0.28%	0.00	0.00	0.00
t-stat	2.91	2.50	2.64	2.42	2.10	2.04	2.47	2.40	2.34
Passive long	0.10	0.05	0.11	0.06	0.13	0.07	0.12	0.06	0.16
t-stat	1.41	0.72	1.87	0.92	2.11	1.06	1.82	0.87	2.19
Value "everywhere"			0.08	0.03	0.10	0.04	0.15	0.10	0.07
t-stat			0.70	0.27	0.83	0.36	1.80	1.34	0.74
Momentum "everywhere"			-0.01	0.00	-0.05	-0.02	0.08	0.10	0.09
t-stat			-0.12	-0.03	-0.40	-0.17	1.17	1.37	1.02
TS momentum					0.02	0.01			
t-stat					0.46	0.26			
Funding liquidity							0.03	0.03	
t-stat							5.63	6.29	
Market liquidity									0.01
t-stat									2.82
R-square	1.18%	0.34%	2.11%	0.48%	2.74%	0.67%	17.07%	19.30%	9.28%
IR	0.57	0.50	0.53	0.48	0.45	0.43			

Table 4: **Carry Trade Risk Exposures.**

	Mean	Passive	Dynamic	% dynamic	Mean	Passive	Dynamic	% dynamic
PANEL A: Decomposition of carry trade returns into passive and dynamic exposure								
	Global Equities				**Commodities**			
Current carry	0.83%	0.00%	0.83%	100%	0.87%	0.65%	0.22%	25%
Carry 1-12	0.55%	0.14%	0.41%	75%	1.13%	0.75%	0.37%	33%
	Fixed Income				**Currencies**			
Current carry	0.42%	0.09%	0.34%	81%	0.40%	0.18%	0.23%	58%
Carry 1-12	0.24%	0.10%	0.14%	58%	0.34%	0.18%	0.16%	47%
PANEL B: Predictive regressions of asset returns on carry								
	Global Equities				**Commodities**			
Slope current carry	1.48	1.21	1.53	1.25	0.05	0.05	-0.01	-0.01
t-stat	3.49	4.27	3.45	4.29	0.56	0.59	-0.06	-0.12
Slope carry 1-12	2.42	1.46	2.89	1.76	0.34	0.41	0.21	0.26
t-stat	3.48	2.82	3.49	2.83	2.87	3.35	1.58	1.94
Contract FE	No	No	Yes	Yes	No	No	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes
	Fixed Income				**Currencies**			
Slope current carry	1.54	1.64	1.58	1.85	1.24	0.69	1.54	0.90
t-stat	2.64	3.78	2.25	3.63	3.56	2.70	3.03	2.60
Slope carry 1-12	1.52	1.05	1.56	1.03	1.14	0.53	1.48	0.61
t-stat	2.43	2.36	2.04	1.93	3.27	1.71	2.75	1.21
Contract FE	No	No	Yes	Yes	No	No	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes

Table 5: **How Does Carry Predict Returns? Decomposing Carry Trade Returns into Static and Dynamic Components.**

	Current carry returns predicted by current carry	Carry 1-12: Predicted by its Carry 1-12	Passive Long: Predicted by its Current Carry	Passive Long: Predicted by its Carry 1-12
	Global Equities			
Intercept	-0.14%	-0.50%	0.65%	0.78%
t-stat	-0.39	-1.23	2.22	2.66
Carry	1.29	2.52	1.84	3.38
t-stat	2.58	2.62	1.49	2.10
R-square	0.03	0.03	0.01	0.02
	Commodities			
Intercept	1.10%	0.70%	0.23%	0.26%
t-stat	1.32	0.51	1.18	1.36
Carry	-0.06	0.18	0.09	0.15
t-stat	-0.28	0.32	0.35	0.39
R-square	0.00	0.00	0.00	0.00
	Fixed Income			
Intercept	0.32%	0.26%	0.31%	0.26%
t-stat	0.66	0.45	1.66	1.31
Carry	0.43	-0.06	0.72	1.11
t-stat	0.23	-0.02	0.65	0.96
R-square	0.00	0.00	0.00	0.00
	Currencies			
Intercept	0.39%	0.44%	0.08%	0.07%
t-stat	1.46	1.33	0.55	0.50
Carry	0.03	-0.22	2.48	2.56
t-stat	0.05	-0.31	2.99	3.02
R-square	0.00	0.00	0.03	0.03

Table 6: **How the Carry of a Portfolio Predicts the Portfolio Return.**

	Carry Trade: Current Carry	Carry Trade: Carry1-12		Carry Trade: Current Carry	Carry Trade: Carry1-12
	Global Equities			Commodities	
Average	7.0%	5.2%	Average	20.9%	15.5%
St.dev.	10.8%	11.2%	St.dev.	34.7%	32.7%
Skewness	0.39	0.12	Skewness	0.24	-0.07
Kurtosis	4.48	4.17	Kurtosis	4.23	4.18
SR	0.65	0.47	SR	0.60	0.47

	Carry Trade: Current Carry	Carry Trade: Carry1-12		Carry Trade: Current Carry	Carry Trade: Carry1-12
	Fixed Income			Currencies	
Average	4.4%	2.9%	Average	4.8%	4.1%
St.dev.	7.6%	7.5%	St.dev.	10.6%	10.4%
Skewness	-0.04	-0.15	Skewness	-1.07	-1.11
Kurtosis	4.52	3.94	Kurtosis	5.58	6.17
SR	0.59	0.38	SR	0.45	0.40

	Carry Trade: Current Carry	Carry Trade: Carry1-12
	Global carry factor	
Average	6.6%	4.6%
St.dev.	6.0%	6.3%
Skewness	-0.02	-0.58
Kurtosis	4.04	4.78
SR	1.10	0.73

Table 7: **The Returns to Global Carry Strategies across Regions.**

	Mean	Passive	Dynamic	% Dynamic	Mean	Passive	Dynamic	% Dynamic
	Global Equities				Commodities			
Current carry	0.58%	-0.02%	0.61%	105%	1.74%	0.25%	1.49%	86%
Carry1-12	0.43%	-0.10%	0.53%	123%	1.29%	0.32%	0.97%	75%
	Fixed Income				Currencies			
Current carry	0.37%	0.05%	0.32%	86%	0.40%	0.20%	0.20%	50%
Carry1-12	0.24%	0.05%	0.19%	79%	0.34%	0.21%	0.14%	41%

Table 8: **Decomposing Regional Carry Strategy Returns.**

	Carry Trade: Current Carry				Carry Trade: Carry1-12			
Average return	**Equities**	**Commodities**	**Fixed income**	**Currencies**	**Equities**	**Commodities**	**Fixed income**	**Currencies**
Carry expansions	7.1%	27.5%	6.1%	10.7%	8.0%	17.9%	5.4%	11.2%
Carry downturns	0.7%	2.8%	-2.1%	-19.0%	-9.0%	-13.6%	-7.4%	-22.6%
Average return per carry downturn	**Equities**	**Commodities**	**Fixed income**	**Currencies**	**Equities**	**Commodities**	**Fixed income**	**Currencies**
August 1992-March 1993	-17.4%	8.9%	-4.4%	-40.8%	-6.8%	-11.8%	-4.4%	-43.4%
April 1997-December 1998	0.4%	-5.8%	-1.7%	-6.5%	-16.5%	21.8%	-11.3%	-8.2%
June 2007-January 2009	7.7%	9.5%	-1.7%	-24.2%	-1.9%	-51.5%	-4.4%	-30.1%
Number of downturns below average	2	3	3	3	3	2	3	3

Carry strategies using individual contracts

Average return	Equities	Commodities	Fixed income	Currencies	Equities	Commodities	Fixed income	Currencies
Carry expansions	9.7%	15.4%	6.2%	9.9%	7.9%	12.2%	4.4%	9.6%
Carry downturns	8.8%	5.1%	0.7%	-14.1%	-2.4%	1.2%	-2.8%	-17.6%

Average macro and liquidity variables	Carry expansions	Carry recessions
Global recession dummy	0.17	0.35
Global liquidity shocks	0.04	-0.21

Table 9: **The Returns to Global Carry Strategies across Regions During Carry Recessions and Expansions.**

		NA	CE	UK	AS	AUS/NZ	Average
EQ	Downturn	-0.41	-2.09	-1.65	-15.18	-37.28	-11.32
	Expansion	9.33	9.02	5.00	8.65	11.20	8.64
FI	Downturn	13.62	12.24	15.41	6.47	16.09	12.76
	Expansion	3.80	3.27	1.50	5.36	0.57	2.90
FX	Downturn	-3.61	-5.53	-12.34	10.68	-12.97	-4.76
	Expansion	1.67	3.88	4.89	-2.68	8.73	3.30

		Energy	Aggs/LS	Metals			Average
CO	Downturn	-31.20	-11.38	-38.50			-27.03
	Expansion	13.83	3.25	19.46			12.18

Table 10: **The Returns across Regions During Carry Downturns and Expansions.**

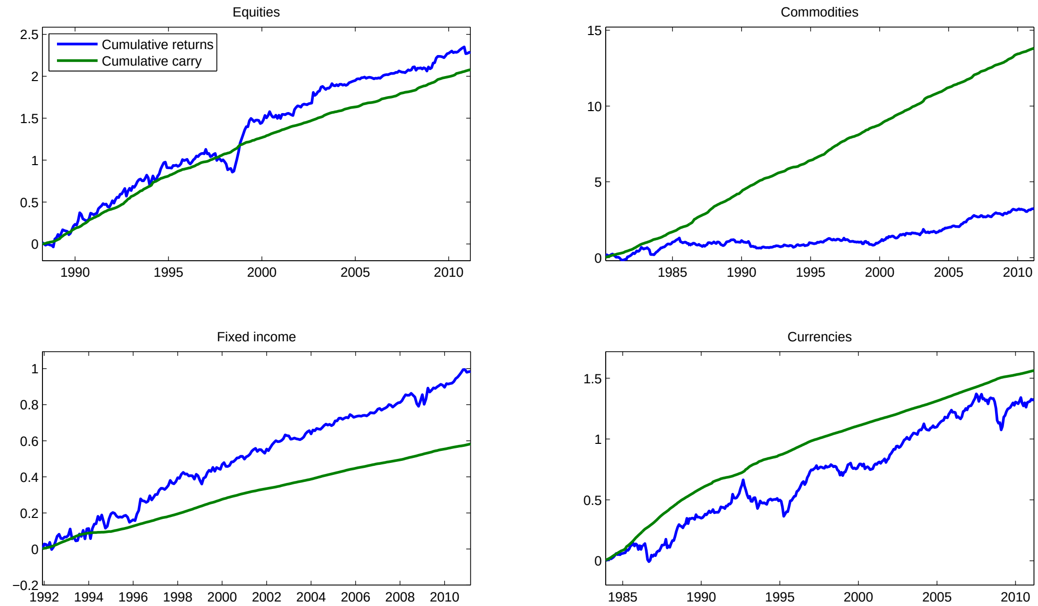
		Total	Dynamic	% Dynamic
Equities	Carry downturn	-9.01	-0.19	2%
	Carry expansion	8.03	7.55	94%
Fixed income	Carry downturn	-7.39	-2.51	34%
	Carry expansion	5.41	3.05	56%
Currencies	Carry downturn	-22.58	-5.67	25%
	Carry expansion	11.21	3.89	35%
Commodities	Carry downturn	-13.60	-6.30	46%
	Carry expansion	17.94	13.39	75%

		% Dynamic
Average	Carry downturn	27%
	Carry expansion	65%
Average w/o FX	Carry downturn	27%
	Carry expansion	75%

Table 11: **Return Decomposition during Carry Downturns and Expansions.**

Figures

Panel A: Current Carry



Panel B: Carry1-12

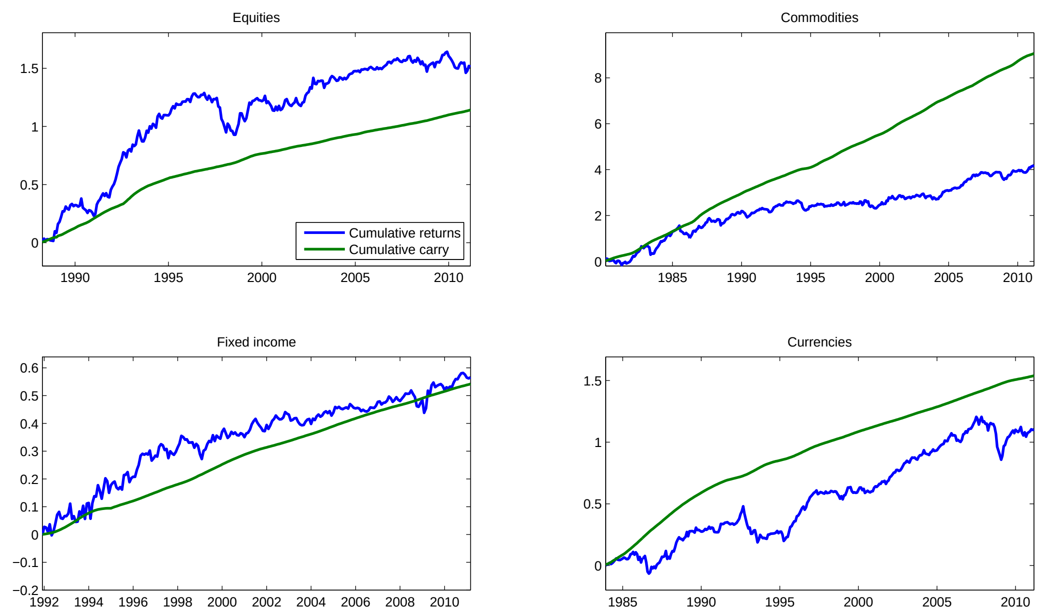


Figure 2: **Cumulative Return and Cumulative Carry of the Global Carry Trades.** The figure shows the cumulative return on carry strategies and the cumulative carry for equities (top-left panel), fixed income (bottom-left panel), commodities (top-right panel), and currencies (bottom-right panel). Panel A uses the current carry to construct the carry trade and to compute the cumulative carry, whereas Panel B uses carry1-12 for both of these. The sample period is February 1988 - February 2011 for equities, October 1991 - February 2011 for fixed income, January 1980 - February 2011 for commodities, and October 1983 - February 2011 for currencies.

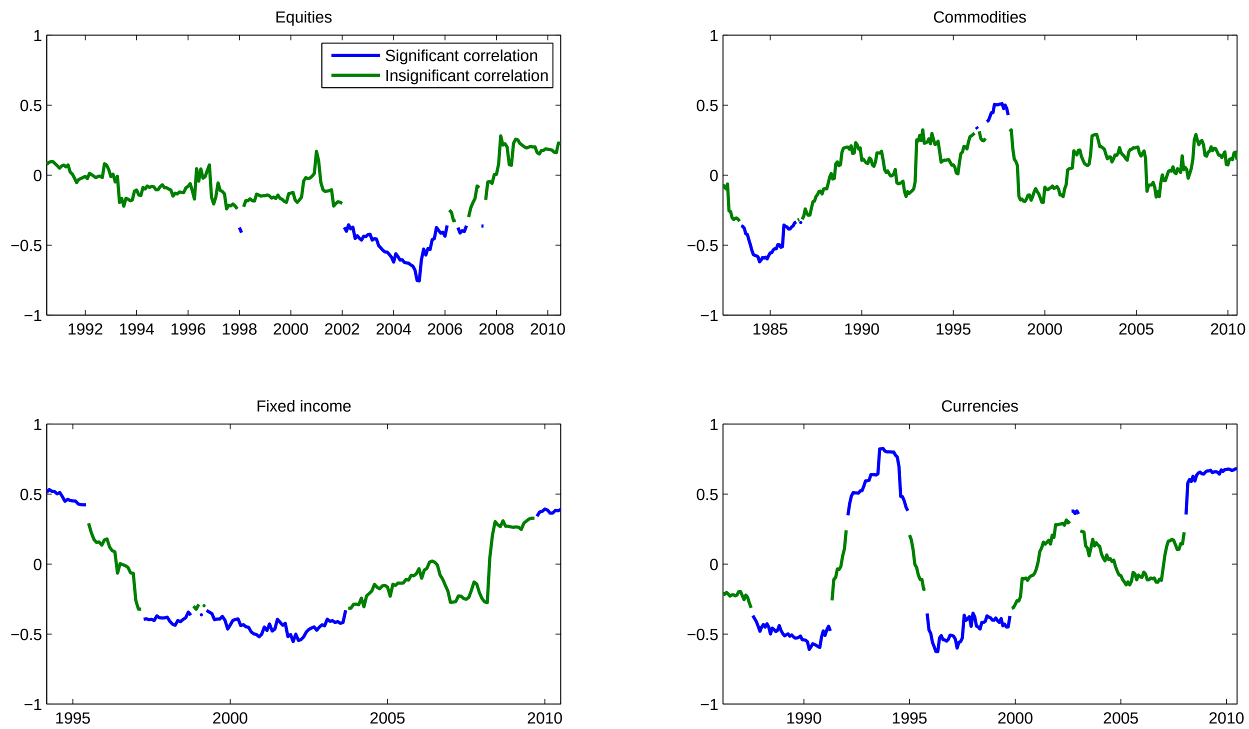


Figure 3: **Rolling Correlations of Carry Strategies with the Stock Market.** The figure shows the 3-year rolling correlation between carry returns and the passive, equal-weighted strategy for equities (top-left panel), fixed income (bottom-left panel), commodities (top-right panel), and currencies (bottom-right panel). We use the current carry in the carry strategies. The sample period is February 1988 - February 2011 for equities, October 1991 - February 2011 for fixed income, January 1980 - February 2011 for commodities, and October 1983 - February 2011 for currencies.

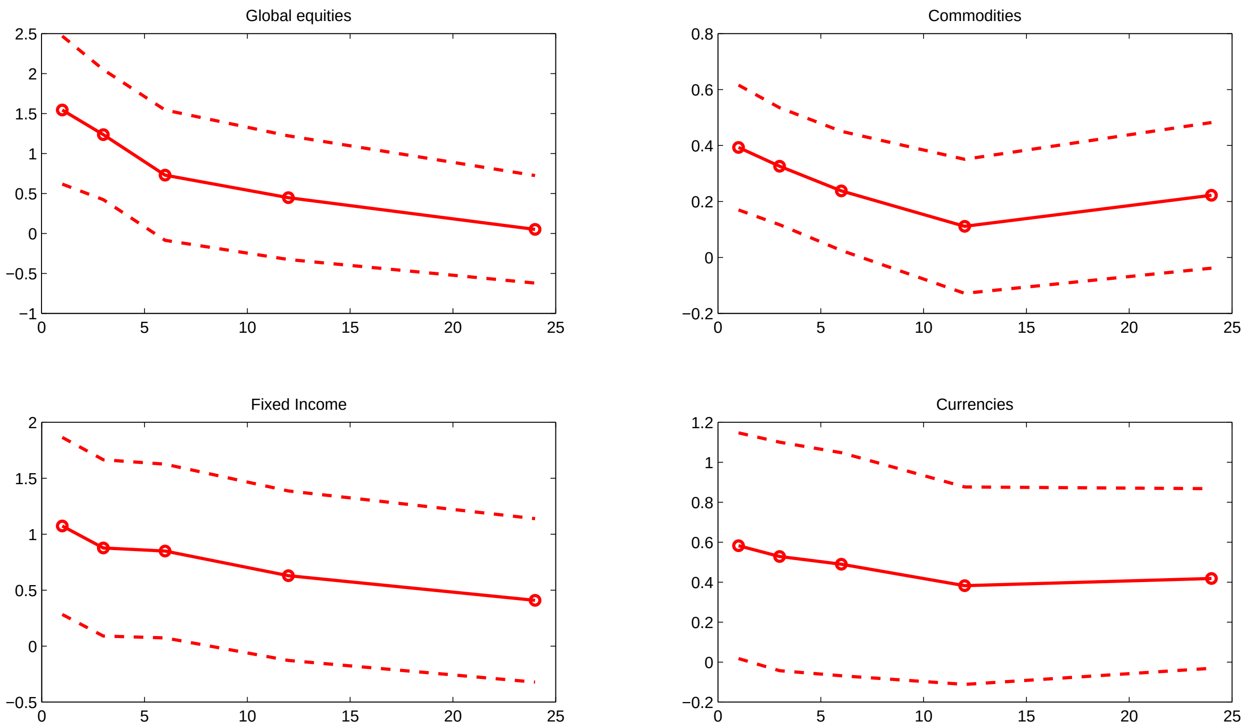


Figure 4: **Carry Predicts Returns: Panel Regression.** The figure shows the predictive coefficient (c) of panel regressions of the form $r_{i,t+1} = a + b_t + cC_{i,t+1-k} + \varepsilon_{i,t+1}$ (for $k = 1, 3, 6, 12$, and 24) for equities (top-left panel), fixed income (bottom-left panel), commodities (top-right panel), and currencies (bottom-right panel). We use the Carry1-12 to forecast future returns. The dashed lines indicate the 95%-confidence interval, where the standard errors are clustered by time period. The sample period is February 1988 - February 2011 for equities, October 1991 - February 2011 for fixed income, January 1980 - February 2011 for commodities, and October 1983 - February 2011 for currencies.

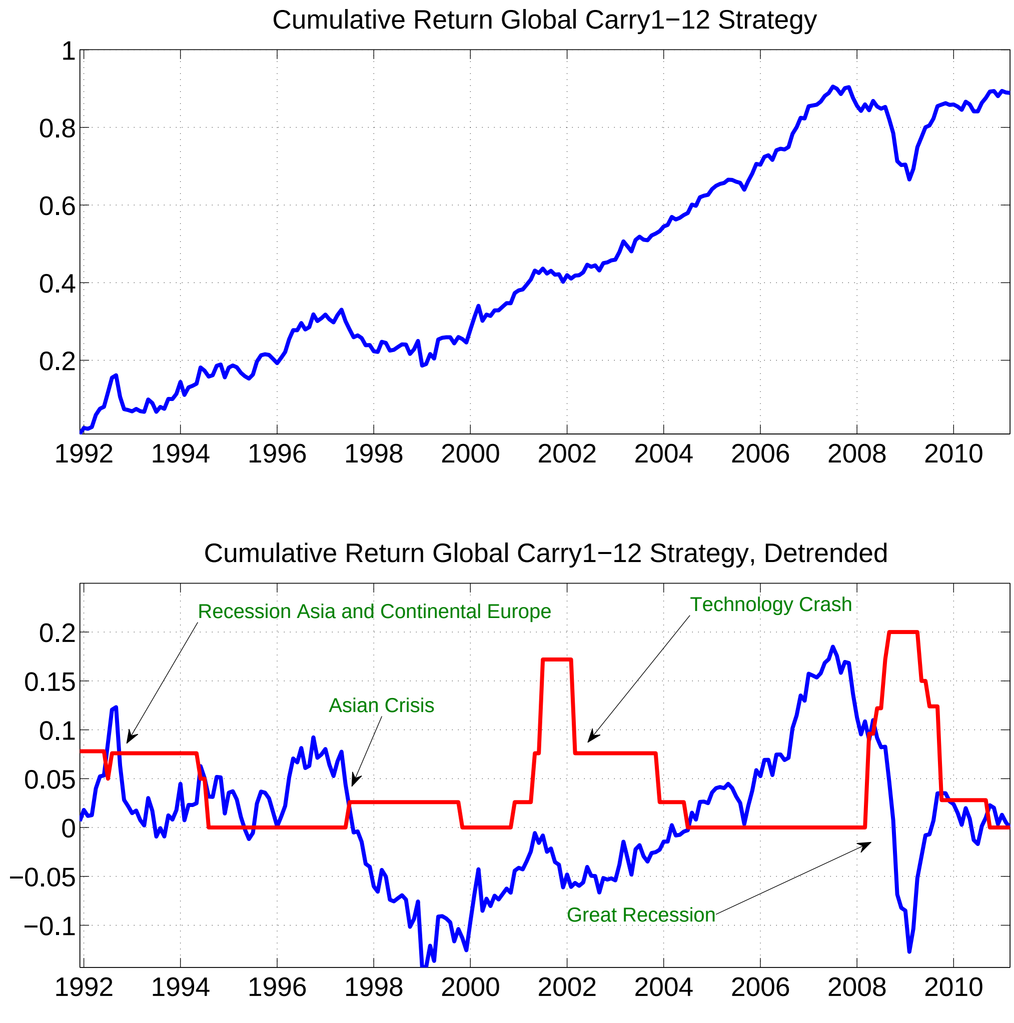


Figure 5: **Returns on the Global Carry1-12 Factor and Global Recessions.** The figure shows the cumulative return on the global carry1-12 factor in the top panel. We construct the global carry factor by weighing the carry strategy of each asset classes by the inverse of the standard deviation of returns, and scaling the weights so that they sum to one. The bottom panel displays the de-trended cumulative return alongside the global recession dummy. We construct the global recession dummy by weighting regional recession dummies by GDP. We de-trend the cumulative return series using a linear time trend. We indicate the major recessions. The sample period is November 1991 to February 2011.

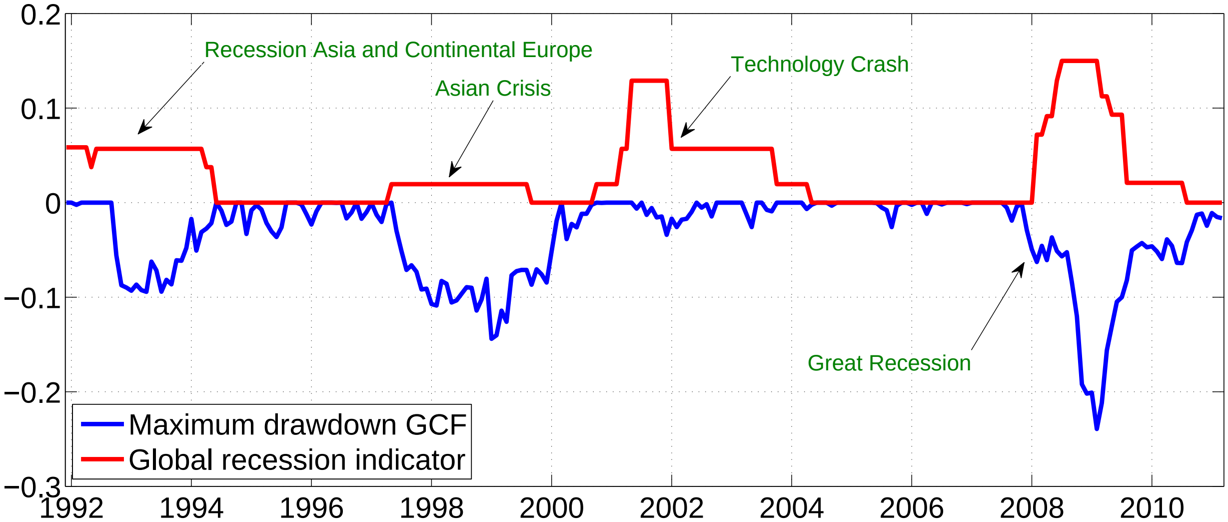


Figure 6: **Draw-down Dynamics of the Global Carry1-12 Factor.** The figure shows the maximum draw-down dynamics of the global carry1-12 strategy. We define the draw down as: $D_t \equiv \sum_{s=1}^{t} r_s - \max_{u\in\{1,\ldots,t\}} \sum_{s=1}^{u} r_s$, where r_s denotes the return on the global carry1-12 strategy. We construct the global carry factor by weighing the carry strategy of each asset classes by the inverse of the standard deviation of returns, and scaling the weights so that they sum to one. The sample period is November 1991 to February 2011.

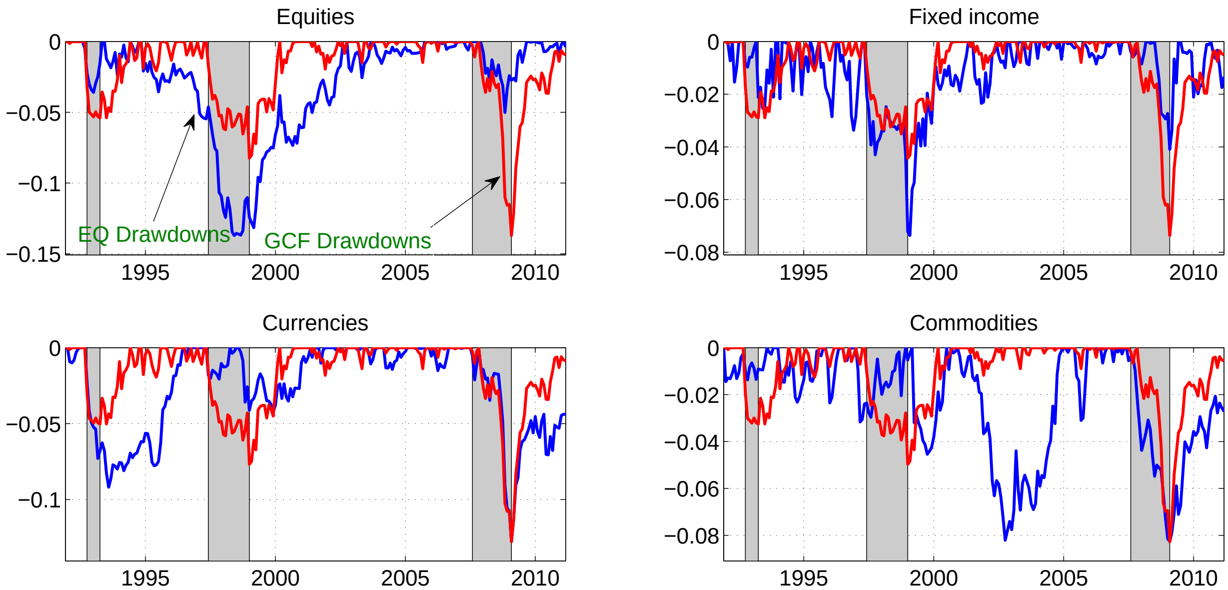


Figure 7: **Draw-down Dynamics Per Asset Class.** The figure shows the maximum draw-down dynamics of the global carry1-12 strategy. We define the draw down as: $D_t \equiv \sum_{s=1}^{t} r_s - \max_{u\in\{1,\ldots,t\}} \sum_{s=1}^{u} r_s$, where r_s denotes the return on the global carry1-12 strategy. We construct the global carry factor by weighing the carry strategy of each asset classes by the inverse of the standard deviation of returns, and scaling the weights so that they sum to one. The sample period is November 1991 to February 2011.