Euro Carry Trade and Downside Market Risk

Supervisor: Pierpaolo Benigno

Co–supervisor: Nicola Borri

Author: Beatrice Antonelli – 685171

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Abstract

CAPM cannot price the cross section of currency returns. The Downside risk capital asset pricing model (DR-CAPM) is used for Dollar-based stategies in order to solve this problem, but for Euro-based strategies it looses its effectiveness, because the market beta differential between high and low forward discount currencies is not higher conditional on bad market returns than it is conditional on good market returns. However, the DR-CAPM goodness of fit is higher than for CAPM, denoting a better empirical performance in explaining portfolios' returns.

Keywords: carry trade, downside risk, currency excess returns, downstate beta.

1. Introduction

According to the Uncovered interest rate parity, the difference between current forward and spot exchange rates (forward discount) should be a good predictor of future exchange rate movements.

From now on, I use the notation of Lusting, Roussanov and Verdelhan (2008), defining currencies forward discount as $f_t^i - e_t^i > 0$, because forward rates and spot exchange rates are in terms of foreign currency per unit of Euro (an increase in e corresponds to an appreciation of Euro or depreciation of foreign currency).

A large literature started with Fama (1984) explains that exchange rate changes do not follow forward discounts, showing that currencies with a forward discount tend to appreciate while the forward discount, in general, should predict a depreciation.

This forward premium puzzle can be potentially rationalized by time-varying risk premium explanations, premium that investors demand on foreign currency denominated investments because foreign exchange is a risky investment.

Also if the debate over whether currency returns can be explained by their association with risk factors remains ongoing, many studies regarding Dollar-based cross-sectional strategies demonstrated that excess returns could be explained by a risk model in which investors are concerned about downside risk: high forward discount currencies earn higher excess returns than low forward discount currencies because their correlation with market return is stronger conditional on bad market returns than it is conditional on good market returns.

They suggest a risk-based model, the Downside risk capital asset pricing model (DR-CAPM), which captures the changes in correlation between carry trade and aggregate market returns: this strategy is more correlated with market during market downturns than it is during upturns (Lusting and Verdelhan (2011) analysed that the correlation between the typical carry trade return and the US stock market is about 0,7 during the crisis period from 2007 to 2009, while it is virtually zero in normal times).

My thesis is based on the analysis and application of this model, which prices effectively Dollar-based cross-sectional strategies, in order to test its performance with Euro-based strategies.

Looking at the historical data, Euro carry trade showed a poor performance with respect to the Dollar, but since 2015 investors have been increasingly turning to the Euro to fund carry trade indicating a trend reversal which could be substantial in the years to come.

In fact, the European Central Bank in the last few years embarked on more aggressive monetary easing while the US experienced a stronger recovery: we would expect to see higher interest rates in US and a considerable persistence of low interest rates in the Eurozone.

The unconditional CAPM fails in pricing Euro-based carry trade excess returns: the resulting coefficient of determination is very low and the predicted values obtained

for the four analysed portfolios' mean returns are almost identical, showing a poor differentiation between portfolios.
But what is different from Dollar-based analysis is that the difference between downstate betas, the portfolios' sensitivity to market changes during market downturns, and unconditional betas is negative: portfolios taking into analysis are more correlated to the market during normal times than during market downturns.
Moreover, portfolio with the lowest mean excess return has a higher downstate beta than portfolio with the highest mean excess return, which shows a negative downstate beta, meaning an inverse relation to the market during market downturns.
However, DR-CAPM shows a better predictive capacity in pricing portfolios' returns, with a higher differentiation between the four portfolios and a higher coefficient of determination.

2. Related Literature

There is a large literature that documents the failure of UIP and that tries to understand the causes.
This papers can be divided into two broad classes. The first class aims to understand exchange rate predictability within a standard asset pricing framework based on systematic risk. Conversely, the second class looks for non-risk based explanations.
My thesis falls in the class of absolute risk-based asset pricing research because my interest is understanding the macroeconomic basis of risk in currency excess returns.
It is more closely related to Berg and Mark (2016), Lusting and Verdhelan (2005), Burnside (2011), who model global risk factors with macroeconomic data.
Other recent contributions include Burnside's peso problem and investor overconfidence explanation (2008) and Verdelhan's habit based explanation of the exchange rate risk premium (2007).
Some previous works also considered the country fundamentals as important determinant of currency excess returns. For example, Jordà and Taylor (2012) emphasize the relation of the real exchange rate and default risk with the currency returns, while Kim and Song (2014) consider fundamental variables such as capital control and interest rate in the multi-factor model framework.
An important methodological innovation, introduced by Lusting and Verdelhan (2007), was to change the observational unit from individual returns to portfolios of returns.
The use of portfolios averages out idiosyncratic return fluctuations and aids in the identification of systematic risk. This methodological innovation is used by Berg and Mark (2016), Lettau, Maggiori and Weber (2014), Galsband and Nitschka (2014), and Lustig, Roussanov and Verdelhan (2008).
Moreover, my thesis explores papers that study carry trade, one of the oldest and most popular currency speculation strategies, motivated by the failure of uncovered interest parity (UIP). This papers include Mankhoff, Sarno, Schmeling and Schrimpf (2016), Burside (2011) and Burnside, Eichenbaum, Rebelo (2011).

3. The Carry Trade: Basic Facts

The carry trade strategy, motivated by the failure of Uncovered interest rate parity (UIP) documented by Fama (1984), has received a great deal of attention in the academic literature as researchers struggle to explain its apparent profitability.

3.1 UIP regressions and Currency Excess Return

I focus on an Eurozone investor who invests in foreign T-bills.
R^{i}_{t+1} is the risky Euro return from buying a foreign T-bill in country *i* and selling it after one period, converting the proceeds into Euro.
$R^{i}_{t+1} = R^{i,f}_{t} \left(\frac{E^{i}_{t}}{E^{i}_{t+1}}\right)$, where E^{i}_{t} is the spot exchange rate in foreign currency per unit of Euro, $R^{i,f}_{t}$ is the risk-free (because is the nominal rate known at time t) one-period return in units of foreign currency.
So, $R^{i,e}_{t+1} = (R^{i}_{t+1} - R^{€}_{t}) \left(\frac{P_t}{P_{t+1}}\right)$ is the real excess return from investing in foreign T-bills, and $R^{€}_{t}$ is the nominal risk-free return in Euro currency.
If UIP holds, the slope in a regression of the change in the log exchange rate for currency *i* on the interest rate differential is equal to one and the constant is equal to zero:

$$\Delta e^{i}_{t+1} = \alpha^{i}_{0} + \alpha^{i}_{1} (i^{i,f}_{t} - i^{€}_{t}) + \epsilon^{i}_{t+1}$$

But, in regressions of the future exchange rate depreciation on the interest rate differential, the slope coefficient is not equal to one but is typically negative.
Because the interest rate differential is not fully offset by subsequent exchange rate movements, systematically positive excess returns can be earned by shorting low interest rate country's currency and using the proceeds to take a long position in the high interest rate country's currency.
Formally, currency excess returns are defined as ex post deviations from the uncovered interest rate parity condition:

$$\varphi^{i}_{t+1} = i^{i,f}_{t} - i^{€}_{t} - \Delta e^{i}_{t+1}$$

where $i^{€}_{t}$ is the Euro short-term interest rate, $i^{i,f}_{t}$ is the country *i* short-term interest rate, Δe^{i}_{t+1} is the change in log spot exchange rate of country *i* relative to the Euro currency. An increase in *e* corresponds to an appreciation of the Euro or depreciation of the foreign currency.

3.2 Carry Trade Strategy

In the carry trade, an investor borrows funds in a low-interest-rate currency and lends in a high-interest-rate currency. Abstracting from transactions costs, the payoff to take a long position in foreign currency is:

$$z_{t+1}^{L} = (1+i_t^{i,f})\left(\frac{E_t^i}{E_{t+1}^i}\right) - (1+i_t^{€})$$

The payoff to the carry trade strategy is:

$$z_{t+1}^{C} = \text{sign}\,(i_t^{i,f} - i_t^{€})\, z_{t+1}^{L}.$$

An alternative way to implement carry trade is to use forward contracts. The carry trade can be implemented by selling forward currencies that are at a forward premium and buying forward currencies that are at a forward discount. The payoff to this strategy is:

$$z_{t+1}^{F} = \text{sign}\,(E_t^i - F_t)(E_{t+1}^i - F_t)$$

where F_t is the time-*t* forward exchange rate for contracts that mature at time *t*+1, expressed as FCU per Euro. A currency is said to be at forward premium relative to the Euro if E_t exceeds F_t.
Covered interest rate parity implies that:

$$\frac{(1+i_t^{€})}{(1+i_t^{i,f})} = \frac{E_t}{F_t}$$

When Covered interest rate parity holds, these two ways of implementing the carry trade are equivalent in the sense that z_{t+1}^{C} and z_{t+1}^{F} are proportional.

3.3 Carry Trade and Downside Market Risk

Ang, Chen, and Xing (2006) and Lettau, Maggiori, Weber (2014) differentiated downside risk from unconditional risk, creating a risk model in which investors are concerned about aggregate market returns.
This captures the idea that assets that have a higher beta with market returns conditional on low realization of the market returns are particularly risky.[1]
Markowitz (1959) was the first to note that analyses based on semi-variance (downside risk) tend to produce better portfolios than those based on variance, because agents require an additional premium the more an asset covaries with market returns conditional on low market returns.
These findings could be a reflection of a more general notion of loss aversion: investors in foreign exchange markets place a greater emphasis on the disutility of large losses.
To capture the relative importance of downside risk in Euro Carry Trade, I will apply the Downside Risk CAPM of Lettau, Maggiori and Weber (2014), starting from the assumption that expected returns follow:

$$\mathrm{E}(r_i) = \beta_i \delta + (\beta_i^- - \beta_i)\, \delta^- \,, \qquad i = 1, \ldots, N,$$

$$\beta_i = \frac{cov(r_i, r_m)}{var(r_m)},$$

$$\beta_i^- = \frac{cov(r_i, r_m | r_m < \theta)}{var(r_m | r_m < \theta)},$$

where r_i is the log excess return of asset *i* over the risk-free rate, r_m is the log market excess return, β_i is the unconditional beta, β_i^- is the downside beta defined by an exogenous threshold θ for the market return, δ is the unconditional price of risk and δ^- is the downside price of risk.
Obviously, DR-CAPM reduce to classic CAPM when $\beta_i^- = \beta_i$, so the downside beta equals the CAPM beta, and when $\delta^- = 0$, so the downside price of risk is zero and there is not differentiation in pricing downside risk and unconditional risk.
Moreover, the unconditional price of risk is equal to the expected market excess return because both the unconditional beta and downside beta of the market with itself are equal to one:

1 While Ang, Chen, and Xing analysed downside risk for stocks' return, Lettau, Maggiori and Weber showed that downside risk is a prevalent feature in many asset classes (currency, commodity, sovereign bond, equity and option markets).

$E(r_m) = \delta$.

Based on the evidence that returns on carry trade strategies are highly correlated with the market return in times of distress (Lusting and Verdelhan, 2011)[2], I apply this reasoning to cross-sectional currency excess returns using the DR-CAPM. One important difference with these studies is my application of a Dollar-based model to Euro currency, because since 2015 investors have been increasingly turning to the Euro to fund carry trade. In fact, the Dollar no longer displays dominant "safe-haven" behaviour since European Central Bank embarked on more aggressive monetary easing just as the Federal Reserve pared back stimulus.

[2] Lusting and Verdelhan show that the payoff from a typical carry trade strategy and the excess return on the US stock market are highly correlated in the 2008 crisis period and less correlated in more tranquil times.

4. Building Currency Portfolios

I have defined currency excess returns as:

$$\varphi_{t+1}^{i} = i_t^{i,f} - i_t^{€} - \Delta\, e_{t+1}^{i}$$

in which $i_t^{€}$ is the Euro short-term interest rate, $i_t^{i,f}$ is the country i short-term interest rate, $\Delta\, e_{t+1}^{i}$ is the change in log spot exchange rate of country i relative to the Euro currency.

I follow Lusting, Roussanov, Verdelhan (2008) in defining a cross-section of currency returns based on their forward and spot rates.

In fact, I regard excess returns at monthly frequency at which Covered interest rate parity usually holds. Thus interest rate differentials are approximately equal to forward discounts:

$$i_t^{i,f} - i_t^{€} \approx f_t^{i} - e_t^{i},$$

where f_t^i is the log forward exchange rate and e_t^i is the log spot exchange rate. The log currency excess return can be written as a difference between the log forward discount and the log spot rate change:

$$\varphi_{t+1}^{i} = (f_t^{i} - e_t^{i}) - \Delta\, e_{t+1}^{i}.$$

This is equivalent to buying a foreign currency in the forward market and selling it one period (one month) later in the spot market:

$$\varphi_{t+1}^{i} = f_t^{i} - e_{t+1}^{i}.$$

Compared to Treasury Bill markets, forward currency markets exist for a limited set of currencies and shorter time-periods. However, the carry trade is easier to implement in forward currency markets, and the data on bid-ask spreads for these markets are readily available. Moreover, the forward contracts are subject to minimal default and counterparty risks.

Currency Portfolios At the end of each period t, I allocate all currencies in the sample to four portfolios on the basis of their forward discounts $f - e$ observed at the end of period t. Portfolios are re-balanced at the end of every month and are sorted on forward discount with Euro.

Portfolio 1 contains the currencies with the smallest forward discounts, and Portfolio 4 contains the currencies with the largest forward discounts.
I compute the log currency excess return φ_{t+1}^{i} for portfolio j by taking the average of the log currency excess returns in each portfolio j.
For each portfolio j, I report changes in the spot rate $-\Delta e^{j}$, the forward discounts $f^{j} - e^{j}$ and the log currency excess returns $\varphi^{j} = -\Delta e^{j} + f^{j} - e^{j}$.[3]

Data are monthly, from January 2003 to December 2016, from the Euro point of view. I consider 16 currencies: Australia, Canada, Japan, New Zaeland, Sweden, Switzerland, United Kingdom, Czech Republic, Hungary, India, Kuwait, Mexico, Philippines, Poland, South Africa, Thailand. I sort currencies into 4 portfolios, in ascending order of their forward discounts. According to the Morgan Stanley Capital International (MSCI) classification of stock markets my sample comprises 7 developed and 9 emerging markets.
Table 1 presents the average foreign currency excess return (in % p.a.) from the Euro investor's point of view (standard errors are provided below the mean in parentheses): for example, from an Euro investor's perspective, the currency excess return in going long on the Australian Dollar and going short on Euro, delivers a return of 0,162%.
The data sources for the spot and forward exchange rates are WM/Reuters and Barclays available via Datastream.
For the market return I use the MSCI Europe Equity Index for the period January 2003 to December 2016, while for the risk free rate I use Euribor rate (both are monthly values).[4] I use a broad Europe equity market return as benchmark because it is the most commonly used return to test CAPM-based asset pricing models.
Fig. 1 depicts the empirical distribution of market returns, where on the vertical axis is showed the absolute frequency and on the horizontal axis are showed the market returns divided in 12 blocks.

[3] I use Matlab for calculations.
[4] I can not use Fama/French excess return for Euro because it is expressed in U.S. dollars and the risk free rate used for calculation is the U.S. one month T-bill rate, which has not economical meaning in an Euro-based analysis.

Developed	in % p.a.	Emerging	in % p.a
Japan	-0,037	Czech Republic	0,036
	(0,12)		(0,05)
Australia	0,162	Hungary	0,101
	(0,11)		(0,08)
Canada	0,008	India	0,096
	(0,11)		(0,10)
New Zeland	0,195	Kuwait	0,030
	(0,10)		(0,09)
Sweden	0,002	Mexico	-0,004
	(0,06)		(0,10)
Switzerland	0,043	Philippines	0,128
	(0,07)		(0,09)
United Kingdom	-0,034	Poland	-0,038
	(0,09)		(0,11)
		South Africa	0,120
			(0,15)
		Thailand	0,108
			(0,09)

Table 1. Overview of countries in sample and average currency excess return.

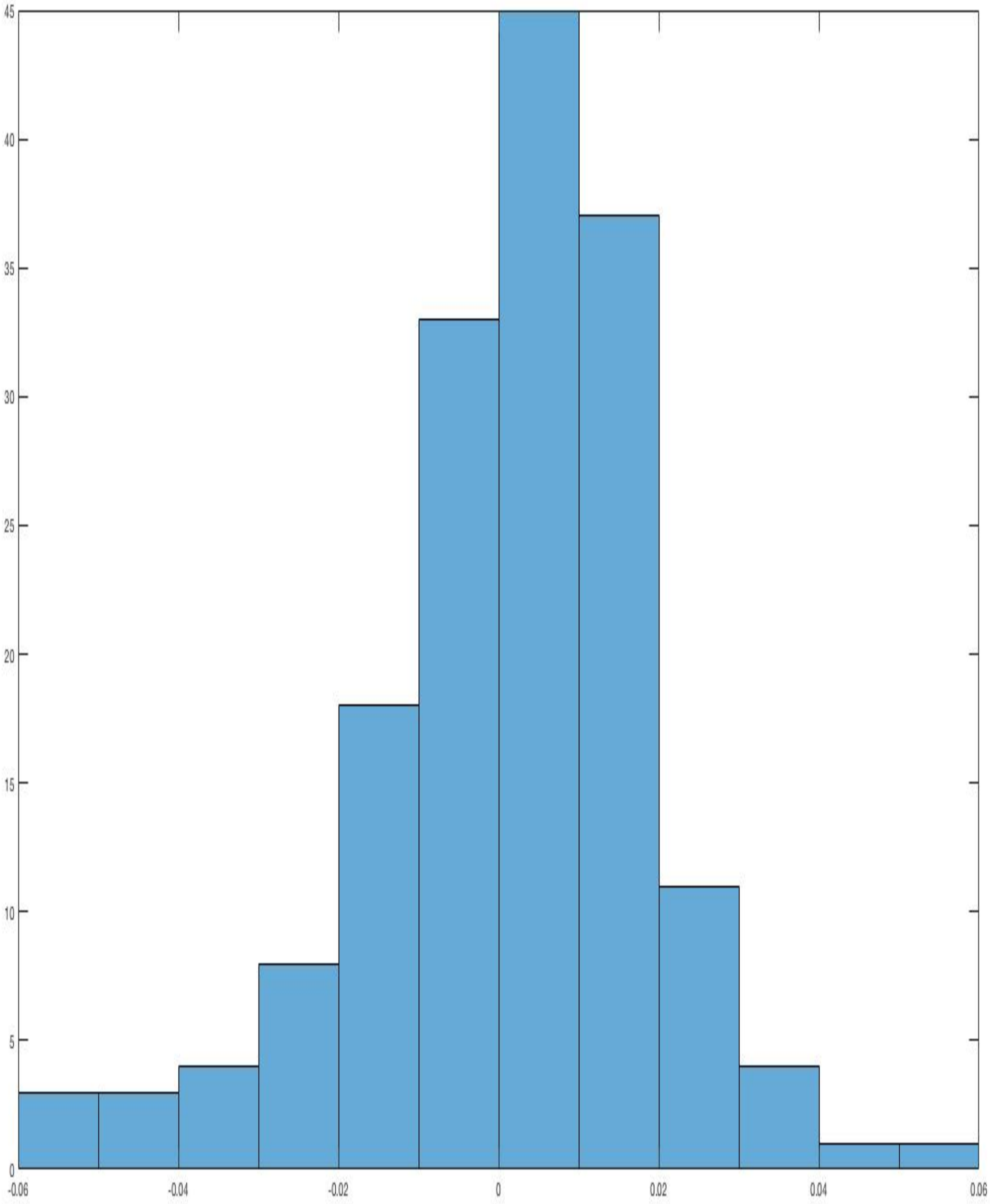

Fig.1 Histogram of market return

4.1 Portfolios Analysis

Descriptive statistics are reported in Fig. 2, Fig. 3 and Fig. 4.
Depicted are monthly mean excess returns, standard deviations, and Sharpe ratios for four currency portfolios, based on the forward discounts; every portfolio contains a total of 168 observations.
Figure 2 shows that the sorting produces a monotonic increase in returns from Portfolio 1 to 4.
Standard deviations of Portfolio 1 and Portfolio 4, as shown in Figure 3, are very much higher than standard deviations of Portfolios 2 and 3, while Figure 4 shows a negative Sharpe ratio for Portfolio 1 and a higher Sharpe ratio for Portfolio 3 than for Portfolio 4.
In order to have a detailed representation of portfolios performance, Table 2 reports exactly the values on which the figures are based on.

	Mean	Standard Deviation	Sharpe Ratio
Portfolio 1	-0,00257291	0,00235493	-1,09256440
Portfolio 2	0,00019398	0,00028162	0,68880828
Portfolio 3	0,00110167	0,00039807	2,76752479
Portfolio 4	0,00392415	0,00211341	1,85678658

Table 2. Descriptive analysis of portfolios sorted on forward discount and change in spot rates: $-\Delta e^j + f^j - e^j$.

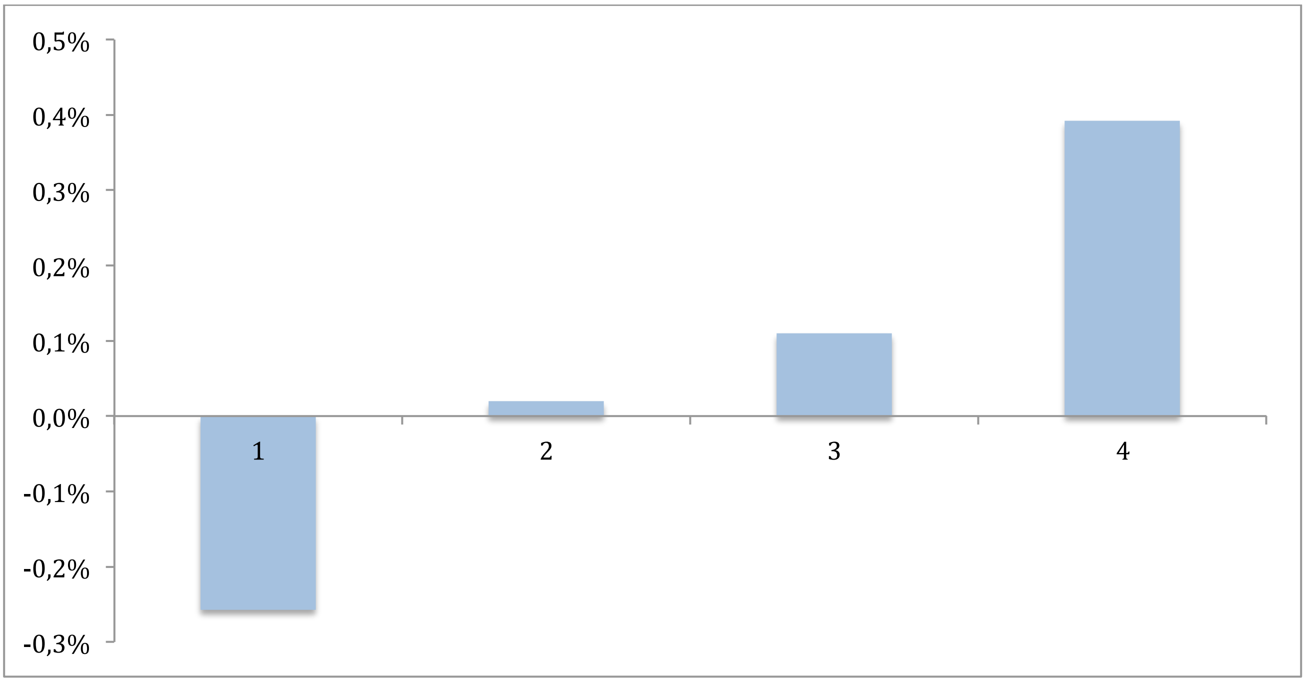

Fig.2. Mean (percent) of the 4 currency portfolios.

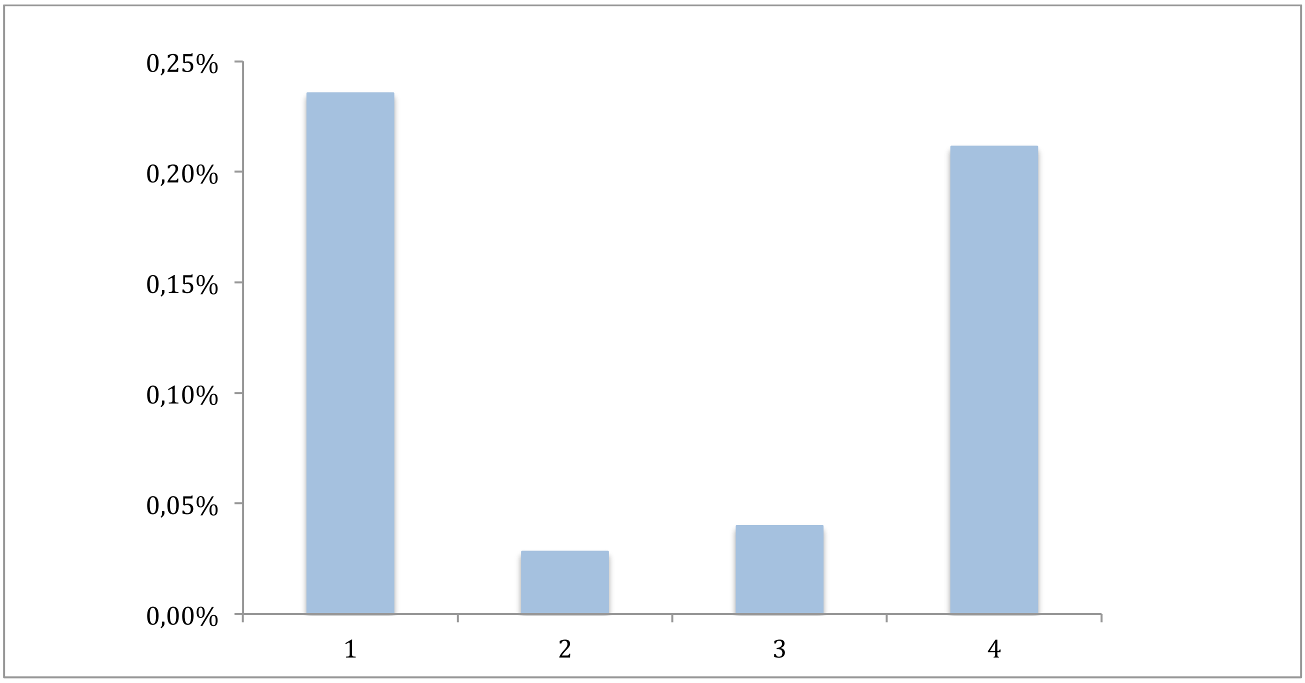

Fig. 3. Standard deviation (percent) of the 4 currency portfolios.

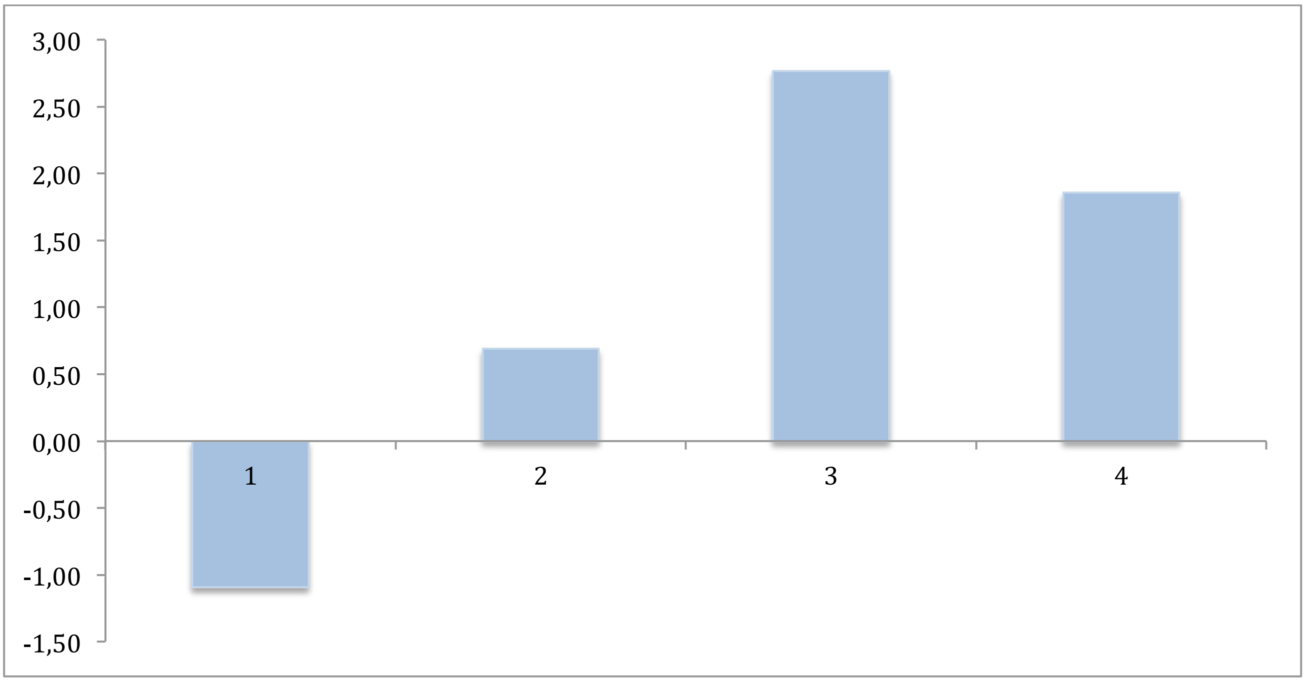

Fig. 4. Sharpe ratios of the 4 currency portfolios.

4.2 Conditional Correlation

The central insight of Lettau, Maggiori and Weber (2014) and of Galsband and Nitschka (2014) is that cross-sectional currency strategies are more highly correlated with aggregate market returns conditional on low aggregate returns than conditional on high market returns.

In order to study conditional correlations and apply the model also for Euro carry trade, I define the downstate to be months when the contemporaneous market return is more than 0,5 standard deviation below its sample average, that is a sufficiently high threshold to have a coherent number of downstate observations in the sample and a sufficiently low threshold to trigger concerns about downside risk.

Analysing the MSCI Europe equity Index for the period to January 2003 to December 2016, I obtain 42 monthly observations to the downstate for a total of 168 observations.

Moreover, months where market return is more than 0,5 standard deviation below the sample average corresponds to quarters of low or also negative GDP Growth rate in the Euro Area as shown in Fig. 5 (I quarter of 2003, all quarters of 2008, I quarter of 2009, III quarter of 2011, II quarter and IV quarter of 2012, II quarter of 2015 and I quarter of 2016).

What it is demonstrated for Dollar currency is that portfolios with high forward discounts have a correlation with market returns which is a decreasing function of market returns (conditional on the downstate the correlation increases). [5]

The opposite is true for portfolios with low forward discounts, where the correlation with market returns is an increasing function of market returns (conditional on the downstate the correlation decreases).

Now, applying the econometric model described in the next section, I will demonstrate if also for Euro currency, carry trade (as well as other cross-sectional strategies) is more correlated with the market during market downturns.

[5] Lettau, Maggiori and Weber analyze that the correlation between Dollar carry trade and market excess return conditional on the downstate is 1,16 times bigger than unconditional correlation.

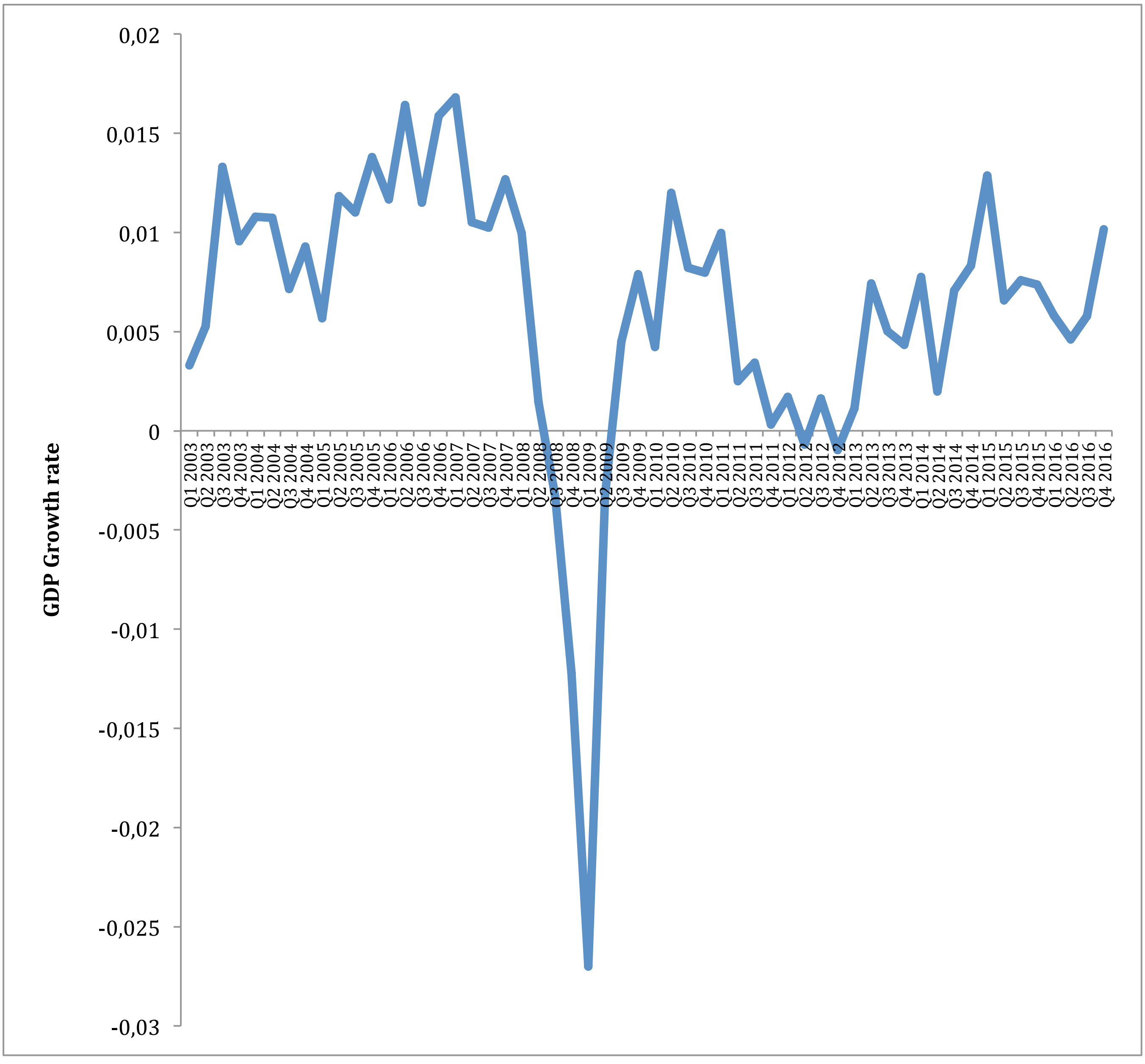

Fig.5 Quarterly GDP growth rate in the Euro Area (19 Countries) from 2003 to 2016

5. Econometric model

My analysis is based on the two-stage procedure of Fama and MacBeth (1973). The first stage consists of two time series regressions, one for the entire time series and one for the downstate observations.
The first stage regressions are:

(1.1) $r_{it} = a_i + \beta_i r_{mt} + \varepsilon_{it}$

and

(1.2) $r_{it} = a_i^- + \beta_i^- r_{mt} + \varepsilon_{it}^-$ whenever $r_{mt} \leq \bar{r}_m - \sigma_{rm}$

where $\bar{r}_m$ and σ_{rm} are the sample average and standard deviation of the market excess return.
These two regressions estimate the unconditional and downstate betas, $\hat{\beta}$ and $\hat{\beta}^-$, which are than used as explanatory variables in the second stage.
The second stage regression is a cross-sectional regression of the average return of the portfolios on their unconditional and downstate betas.
I restrict the market price of risk to equal the sample average of the market excess return. Therefore, the second stage estimates the downside price of risk δ^-.
The second stage regression is:

(2) $\bar{r}_i = \hat{\beta}_i \bar{r}_m + \left(\hat{\beta}_i^- - \hat{\beta}_i\right)\delta^- + \alpha_i,$ $i = 1,\dots,4$

where $\bar{r}_i$ and $\bar{r}_m$ are the average excess returns of the portfolios and the market excess return, and α_i are pricing errors.
I do not include a constant in the second stage regression, imposing that an asset with zero beta with the risk factors has a zero excess return.
The average monthly log excess return of the market, measured subtracting the Euribor rate to the market return rate obtained from the MSCI Europe Equity Index, is negative for the sample period from January 2003 to December 2016 and equal to – 0,0130 with a standard deviation of 2,542%.

5.1 First stage results

Starting from the first stage of the analysis, I obtain the unconditional betas $\hat{\beta}_i$ and the unconditional intercepts a_i for the four portfolios from the first time series regression (1.1), which takes into account all 168 months. Table 3 reports exactly the values resulting from this regression.

	Intercepts	**Betas**
Portfolio 1	-0,0023981	0,0134025
Portfolio 2	0,0002185	0,0018865
Portfolio 3	0,0010835	-0,0013910
Portfolio 4	0,0040193	0,0073001

Table 3. Intercepts and betas resulting from the first time series regression (1.1)

Fig. 6 shows that CAPM beta cannot explain the cross section of currency returns: the highest beta is associated with the portfolio with the lowest forward discount, while the portfolio with the lowest beta is Portfolio 3. The failure of classic CAPM models in pricing the cross section of currency returns and cross-sectional strategies is confirmed also for Dollar-based strategies (Ang, Chen, and Xing, 2006, Lettau, Maggiori and Weber, 2014, Galsband and Nitschka, 2014).

With the second time series regression (1.2) based on the downstate observations (42 observations where $r_{mt} \leq \bar{r}_m - 0{,}5$) I find the downstate betas $\hat{\beta}_i^-$ and the downstate intercepts a_i^- in order to check if the average currency returns are related to downstate beta.

Table 4 reports the second time series regression (1.2) results.

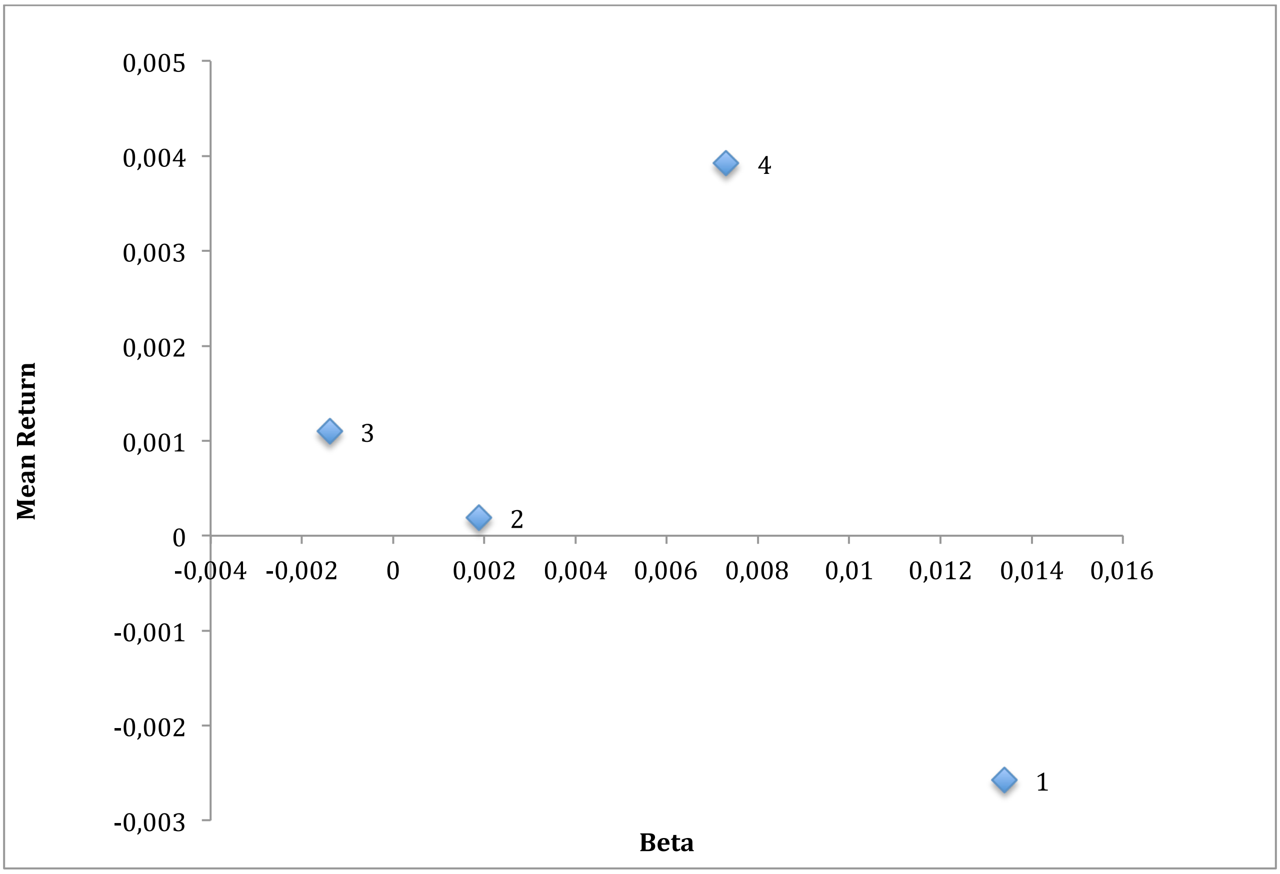

Fig. 6 Realized mean excess returns versus the capital asset pricing model betas β.

	Intercepts	Betas
Portfolio 1	-0,0029501	0,0089919
Portfolio 2	0,0001328	0,0003035
Portfolio 3	0,0007806	-0,0069032
Portfolio 4	0,0037308	-0,0029518

Table 4. Intercepts and betas resulting from the second time series regression (1.2)

The important result given by the two time series regressions analysis is that for each portfolio the unconditional beta is higher than the downstate beta.
While for Dollar the downside betas are higher than unconditional betas (Lettau, Maggiori, Weber, 2014), showing that Dollar carry trade, as well as other cross-sectional currencies based on Dollar, is more highly correlated with aggregate market returns conditional on low aggregate market returns, for Euro the opposite is true.
Fig. 7 reports exactly this evidence.

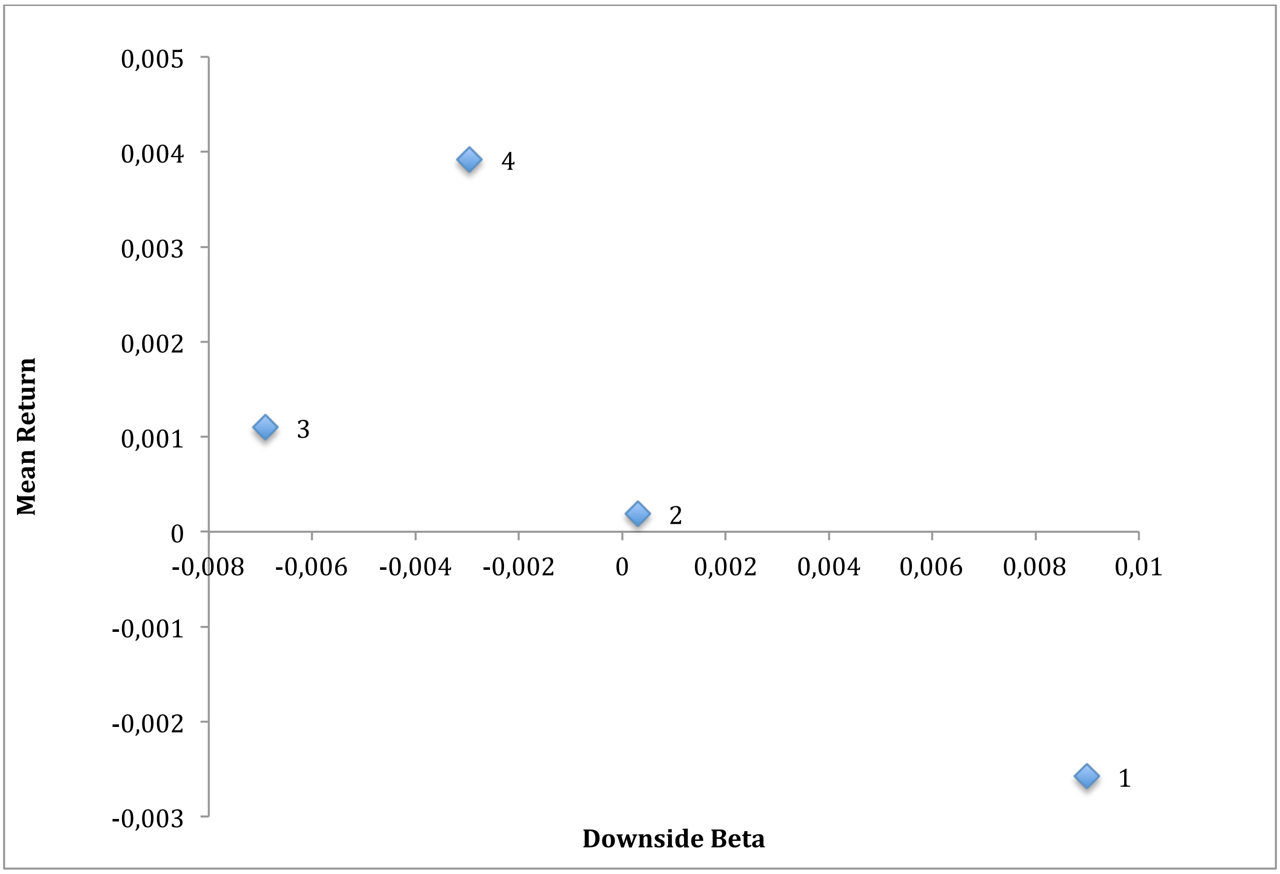

Fig. 7 Realized mean excess returns versus the downside betas β^{-}.

The graph shows a negative trend, where Portfolio 1 with the lowest excess return has the highest downstate beta and Portfolio 4 with the highest excess return reports a negative downstate beta (-0,0029518).
Analyzing the relative downstate betas, difference between downstate and unconditional beta, it is even more evident the negative trend in portfolios data:

	Relative downside betas	Mean Return
Portfolio 1	-0,00441065	-0,00257291
Portfolio 2	-0,00158297	0,00019398
Portfolio 3	-0,00551211	0,00110167
Portfolio 4	-0,01025187	0,00392415

Table 5. Portfolios' mean excess returns and relative downside betas.

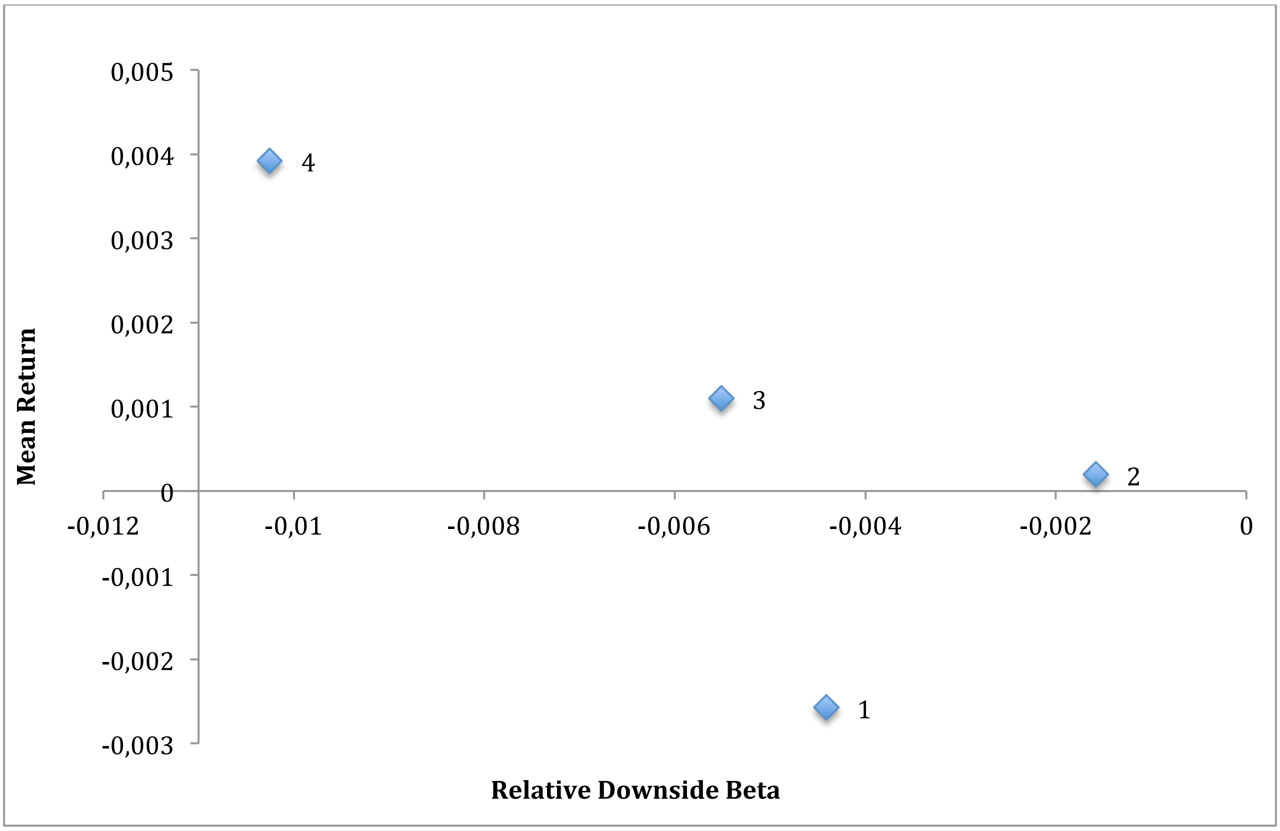

Fig. 8 Realized mean excess returns versus the relative downside betas $\beta^{-} - \beta$

Portfolio 2 has the highest relative downside beta while Portfolio 4 has the lowest relative downside beta, proving that the difference between downstate and unconditional beta is not associated with contemporaneous returns: all portfolios have lower downstate than unconditional betas (all relative downside betas are negative), and portfolios with higher excess returns are on average less risky.

5.2 Second stage results

The second stage regression (2) is a cross sectional regression of the average return of the portfolios on their unconditional and downstate betas in order to estimate a single parameter: the downside price of risk δ^{-}. The estimated price of downside risk is negative and equal to – 0,5383 with a coefficient of determination R^2 of 0,6, meaning that Euro investors don't demand a positive extra return to bear downstate risk (while in the analysis of Lettau, Maggiori and Weber for Dollar δ^{-} is equal to 0,0218).
Fig. 9 and Fig. 10 illustrate both the failure of the CAPM and the performance of the DR-CAPM in terms of pricing.

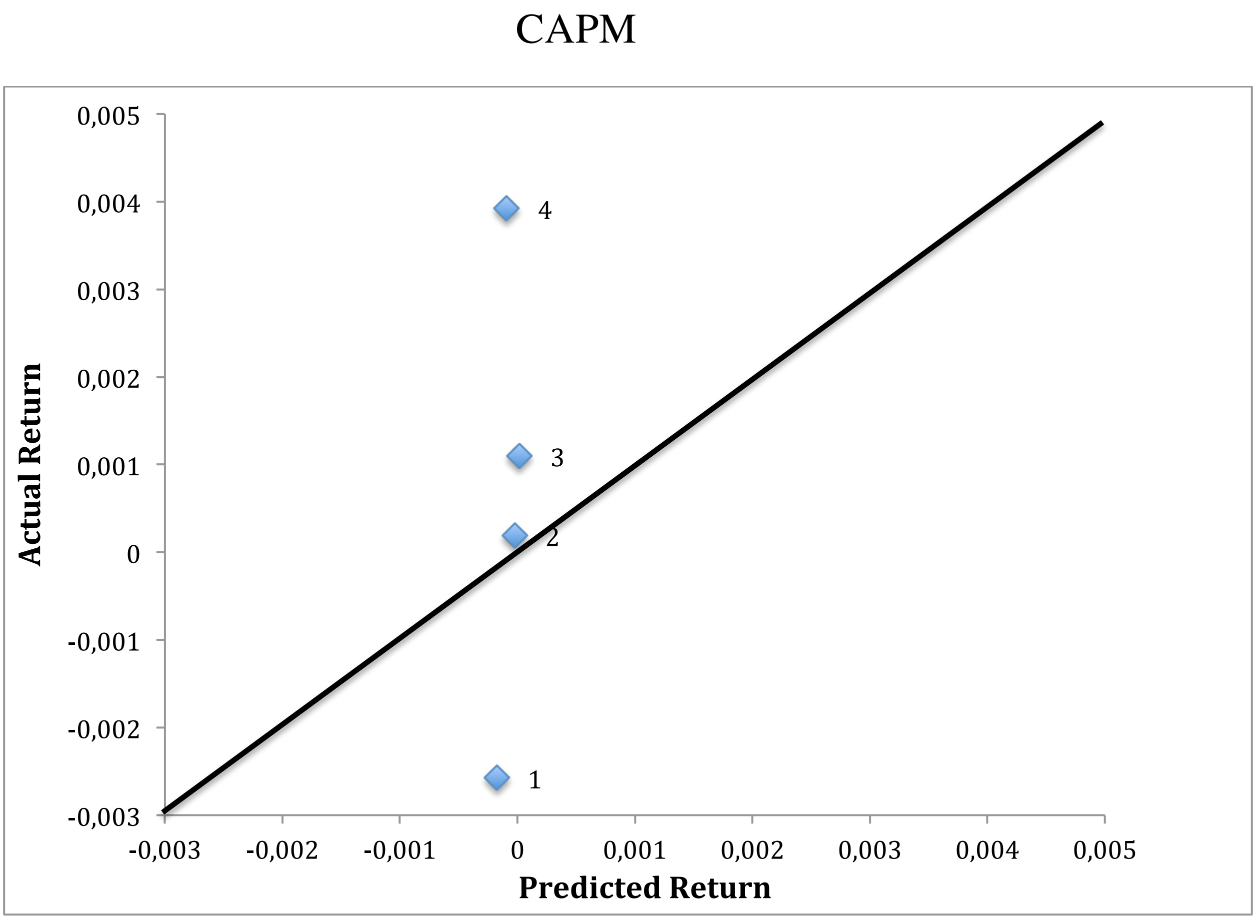

Fig. 9 Mean excess returns versus predicted excess returns for the unconditional capital asset pricing model (CAPM).

DR-CAPM

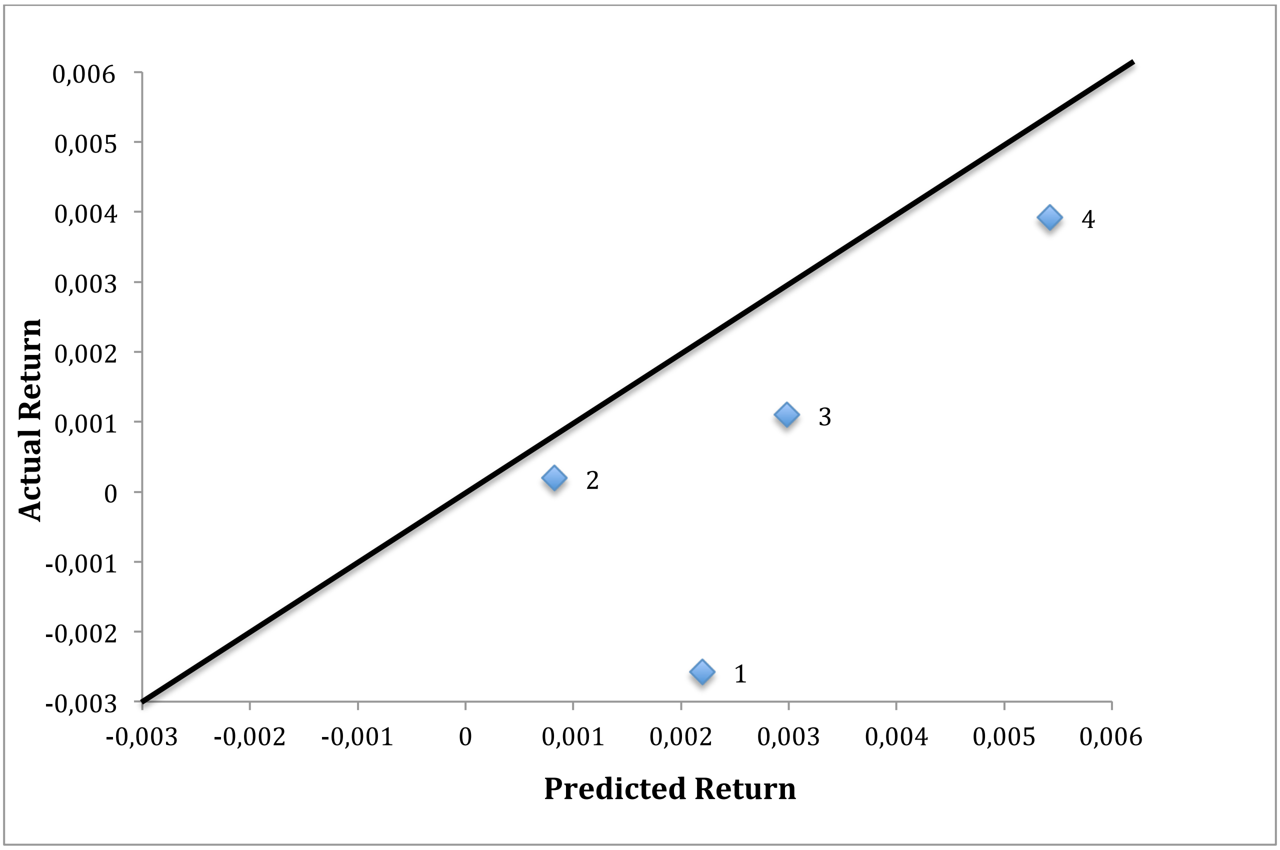

Fig. 10 Mean excess returns versus predicted excess returns for the downside risk capital asset pricing model (DR-CAPM).

As shown in Figure 9, CAPM predicts almost identical mean returns for the four portfolios: all predicted returns are close to zero, and only predicted return for Portfolio 3 is positive.

Differently from Dollar-based cross-sectional strategies, DR-CAPM doesn't explain perfectly the cross section of currency returns: Fig. 9 shows that the test assets don't lie on the 45 degree line.

However, the DR-CAPM performance in portfolios pricing is better than CAPM for a greatest differentiation in portfolio returns.

Table 6 reports pricing errors for CAPM and DR-CAPM:

	CAPM	DR-CAPM
Portfolio 1	-0,0024	-0,0047
Portfolio 2	0,0002	-0,0006
Portfolio 3	0,0011	-0,0018
Portfolio 4	0,0041	-0,0015

Table 6. CAPM and DR-CAPM pricing errors for the four portfolios.

Pricing errors are defined as the difference between the actual and the model-predicted excess return, so that a positive price error corresponds to an underprediction of the excess return by the model.
DR-CAPM overpredicts excess returns for all portfolios while CAPM overpredicts only for Portfolio 1.
In absolute terms is evident the failure for both models in explaining the cross section of currency returns also if DR-CAPM better predicts the excess returns differentiation for the portfolios.
Finally, Table 7 resumes some important two-stage regression results:

	CAPM	DR-CAPM
Price of risk	-0,0130	-0,0130
Price of downside risk		-0,5383
R^2	0,16	0,56
RMSPE	0,0024	0,0026
Number of observations	168	168

Table 7. Estimation of linear pricing models.

Table 7 reports prices of risks, number of observations, root mean squared pricing errors (RMSPE) and the cross sectional R^2's for the unconditional capital asset pricing model and the downside risk CAPM.
The coefficient of determination R^2, statistical measure about the model goodness of fit, is very low for CAPM, while for DR-CAPM is equal to 0,56, denoting a better performance in explaining the cross-sectional variation in mean returns[6].
Conversely, the root mean squared pricing errors, which represents the sample standard deviation of the differences between predicted values and observed values, is very similar for both models.

[6] The DR-CAPM coefficient of determination for Dollar-based cross-sectional strategies is 0,78 (Lettau, Maggiori and Weber, 2014).

6. Conclusion

I find that Euro currency returns are not associated with aggregate market risk, thus not supporting a risk-based view of forward discount.
However, as for Dollar currency, I find that unconditional CAPM cannot explain the cross section of currency returns because the beta associated with the portfolio with the lowest mean excess return is higher than the unconditional beta associated with the portfolio with the highest mean excess return (in Lettau, Maggiori and Weber analysis concerning Dollar-based portfolios there is a positive relation between CAPM betas and portfolios' mean return, but the increase in CAPM beta going from the low- excess return portfolio to the high- excess return portfolio is small compared to the increase in average returns).
Focusing on downstate market periods, the resulting portfolios' downstate betas presents an inverse relation with portfolios' mean excess return: Portfolio 1 shows the highest sensibility to market downturns. Moreover, Portfolio 4 reports a negative downstate beta, meaning an inverse movement of portfolio's returns with respect to the market during bad market conditions.
Relative downside betas, calculated in order to apply the DR-CAPM, are negative for all portfolios, because unconditional betas are all higher than downstate betas, showing an opposite behaviour of Euro portfolios with respect to Dollar portfolios: Portfolio 4 shows the lowest relative downside beta, indicating a greater correlation with aggregate market during "normal" times than during market downturns, while, in Lettau, Maggiori and Weber analysis, Dollar-based portfolio with the highest mean excess return shows the highest relative downside beta confirming that the difference between downstate and unconditional beta is associated with contemporaneous returns.
However, while CAPM predicts almost identical returns for the four portfolios, DR-CAPM prediction presents a higher mean return differentiation between portfolios, with a higher coefficient of determination.
Based on this observations, DR-CAPM, which explicitly distinguishes states of the world in which the market return is falling, is not successful in explaining excess returns on Euro currency portfolios, rejecting the economic rationale of loss aversion, i.e. investors tend to value the disutility of a certain loss of wealth more than the utility of an equally high gain.
The link between downside risk and average excess returns for Euro-based cross-sectional strategies is not verified, confirming Burnside (2011) cautioning against the weak connection between currency excess returns and standard risk factors.

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Summary

Introduction

According to the Uncovered interest rate parity, the difference between current forward and spot exchange rates (forward discount) should be a good predictor of future exchange rate movements.

From now on, I use the notation of Lusting, Roussanov and Verdelhan (2008), defining currencies forward discount as $f_t^i - e_t^i > 0$, because forward rates and spot exchange rates are in terms of foreign currency per unit of Euro (an increase in e corresponds to an appreciation of Euro or depreciation of foreign currency).

A large literature started with Fama (1984) explains that exchange rate changes do not follow forward discounts, showing that currencies with a forward discount tend to appreciate while the forward discount, in general, should predict a depreciation.

This forward premium puzzle can be potentially rationalized by time-varying risk premium explanations, premium that investors demand on foreign currency denominated investments because foreign exchange is a risky investment.

Papers that documents the failure of UIP and that tries to understand the causes can be divided into two broad classes. The first class aims to understand exchange rate predictability within a standard asset pricing framework based on systematic risk. Conversely, the second class looks for non-risk based explanations.

My thesis falls in the class of absolute risk-based asset pricing research because my interest is understanding the macroeconomic basis of risk in currency excess returns. It is more closely related to Berg and Mark (2016), Lusting and Verdhelan (2005), Burnside (2011), who model global risk factors with macroeconomic data.

Other recent contributions include Burnside's peso problem and investor overconfidence explanation (2008) and Verdelhan's habit based explanation of the exchange rate risk premium (2007).

An important methodological innovation, introduced by Lusting and Verdelhan (2007), was to change the observational unit from individual returns to portfolios of returns. The use of portfolios averages out idiosyncratic return fluctuations and aids in the identification of systematic risk. This methodological innovation is used by Berg and Mark (2016), Lettau, Maggiori and Weber (2014), Galsband and Nitschka (2014), and Lustig, Roussanov and Verdelhan (2008).

Also if the debate over whether currency returns can be explained by their association with risk factors remains ongoing, many studies regarding Dollar-based cross-sectional strategies demonstrated that excess returns could be explained by a risk model in which investors are concerned about downside risk: high forward discount currencies earn higher excess returns than low forward discount currencies because their correlation with market return is stronger conditional on bad market returns than it is conditional on good market returns.

They suggest a risk-based model, the Downside risk capital asset pricing model (DR-CAPM), which captures the changes in correlation between carry trade and aggregate market returns: this strategy is more correlated with market during market downturns than it is during upturns (Lusting and Verdelhan (2011) analysed that the correlation between the typical carry trade return and the US stock market is about 0,7 during the crisis period from 2007 to 2009, while it is virtually zero in normal times).
My thesis is based on the analysis and application of this model, which prices effectively Dollar-based cross-sectional strategies, in order to test its performance with Euro-based strategies. Looking at the historical data, Euro carry trade showed a poor performance with respect to the Dollar, but since 2015 investors have been increasingly turning to the Euro to fund carry trade indicating a trend reversal which could be substantial in the years to come.
In fact, the European Central Bank in the last few years embarked on more aggressive monetary easing while the US experienced a stronger recovery: we would expect to see higher interest rates in US and a considerable persistence of low interest rates in the Eurozone.
The unconditional CAPM fails in pricing Euro-based carry trade excess returns: the resulting coefficient of determination is very low and the predicted values obtained for the four analysed portfolios' mean returns are almost identical, showing a poor differentiation between portfolios.
But what is different from Dollar-based analysis is that the difference between downstate betas, the portfolios' sensitivity to market changes during market downturns, and unconditional betas is negative: portfolios taking into analysis are more correlated to the market during normal times than during market downturns.
Moreover, portfolio with the lowest mean excess return has a higher downstate beta than portfolio with the highest mean excess return, which shows a negative downstate beta, meaning an inverse relation to the market during market downturns.
However, DR-CAPM shows a better predictive capacity in pricing portfolios' returns, with a higher differentiation between the four portfolios and a higher coefficient of determination.

Carry trade strategy and currency excess returns

I focus on an Eurozone investor who invests in foreign T-bills.
R^i_{t+1} is the risky Euro return from buying a foreign T-bill in country *i* and selling it after one period, converting the proceeds into Euro.
$R^i_{t+1} = R^{i,f}_t \left(\frac{E^i_t}{E^i_{t+1}}\right)$, where E^i_t is the spot exchange rate in foreign currency per unit of Euro, $R^{i,f}_t$ is the risk-free (because is the nominal rate known at time t) one-period return in units of foreign currency. So, $R^{i,e}_{t+1} = (R^i_{t+1} - R^€_t)\left(\frac{P_t}{P_{t+1}}\right)$ is the real excess return from investing in foreign T-bills, and $R^€_t$ is the nominal risk-free return in Euro

currency. If UIP holds, the slope in a regression of the change in the log exchange rate for currency i on the interest rate differential is equal to one and the constant is equal to zero:

$$\Delta\, e_{t+1}^{i} = \alpha_0^{i} + \alpha_1^{i}\,(i_t^{i,f} - i_t^{€}) + \epsilon_{t+1}^{i}$$

But, in regressions of the future exchange rate depreciation on the interest rate differential, the slope coefficient is not equal to one but is typically negative.

Because the interest rate differential is not fully offset by subsequent exchange rate movements, systematically positive excess returns can be earned by shorting low interest rate country's currency and using the proceeds to take a long position in the high interest rate country's currency.

Formally, currency excess returns are defined as ex post deviations from the uncovered interest rate parity condition:

$$\varphi_{t+1}^{i} = i_t^{i,f} - i_t^{€} - \Delta\, e_{t+1}^{i}$$

where $i_t^{€}$ is the Euro short-term interest rate, $i_t^{i,f}$ is the country *i* short-term interest rate, $\Delta\, e_{t+1}^{i}$ is the change in log spot exchange rate of country *i* relative to the Euro currency (an increase in *e* corresponds to an appreciation of the Euro or depreciation of the foreign currency). In the carry trade, an investor borrows funds in a low-interest-rate currency and lends in a high-interest-rate currency. Abstracting from transactions costs, the payoff to take a long position in foreign currency is:

$$z_{t+1}^{L} = (1+i_t^{i,f})\,\left(\frac{E_t^{i}}{E_{t+1}^{i}}\right) - (1+i_t^{€})$$

The payoff to the carry trade strategy is:

$$z_{t+1}^{C} = \text{sign}\,(i_t^{i,f} - i_t^{€})\, z_{t+1}^{L}.$$

In order to explain currency excess returns, Ang, Chen, and Xing (2006) and Lettau, Maggiori, Weber (2014) differentiated downside risk from unconditional risk, creating a risk model in which investors are concerned about aggregate market returns. This captures the idea that assets that have a higher beta with market returns conditional on low realization of the market returns are particularly risky.

Markowitz (1959) was the first to note that analyses based on semi-variance (downside risk) tend to produce better portfolios than those based on variance, because agents require an additional premium the more an asset covaries with market returns conditional on low market returns. These findings could be a reflection of a more general notion of loss aversion: investors in foreign exchange markets place a greater emphasis on the disutility of large losses.

To capture the relative importance of downside risk in Euro Carry Trade, I will apply the Downside Risk CAPM of Lettau, Maggiori and Weber (2014), starting from the assumption that expected returns follow:

$\mathrm{E}(r_i) = \beta_i\delta + (\beta_i^{-} - \beta_i)\,\delta^{-}$, $\quad\quad$ *i =1,…..,N,*

$\beta_i = \frac{cov(r_i, r_m)}{var(r_m)}$,

$\beta_i^{-} = \frac{cov(r_i, r_m | r_m < \theta)}{var(r_m | r_m < \theta)}$,

where r_i is the log excess return of asset *i* over the risk-free rate, r_m is the log market excess return, β_i is the unconditional beta, β_i^{-} is the downside beta defined by an exogenous threshold θ for the market return, δ is the unconditional price of risk and δ^{-} is the downside price of risk. Obviously, DR-CAPM reduce to classic CAPM when $\beta_i^{-} = \beta_i$, so the downside beta equals the CAPM beta, and when $\delta^{-} = 0$, so the downside price of risk is zero and there is not differentiation in pricing downside risk and unconditional risk.
Moreover, the unconditional price of risk is equal to the expected market excess return because both the unconditional beta and downside beta of the market with itself are equal to one:
$\mathrm{E}(r_m) = \delta$.

Based on the evidence that returns on carry trade strategies are highly correlated with the market return in times of distress (Lusting and Verdelhan, 2011), I apply this reasoning to cross-sectional currency excess returns using the DR-CAPM. One important difference with these studies is my application of a Dollar-based model to Euro currency, because since 2015 investors have been increasingly turning to the Euro to fund carry trade. In fact, the Dollar no longer displays dominant "safe-haven" behaviour since European Central Bank embarked on more aggressive monetary easing just as the Federal Reserve pared back stimulus.

Portfolio analysis

I have defined currency excess returns as:

$\varphi_{t+1}^{i} = i_t^{i,f} - i_t^{€} - \Delta\, e_{t+1}^{i}$

in which $i_t^{€}$ is the Euro short-term interest rate, $i_t^{i,f}$ is the country *i* short-term interest rate, $\Delta\, e_{t+1}^{i}$ is the change in log spot exchange rate of country *i* relative to the Euro currency. I follow Lusting, Roussanov, Verdelhan (2008) in defining a cross-section of currency returns based on their forward and spot rates. In fact, I regard excess returns at monthly frequency at which Covered interest rate parity usually holds.

Thus interest rate differentials are approximately equal to forward discounts:

$$i_t^{i,f} - i_t^{€} \approx f_t^i - e_t^i,$$

where f_t^i is the log forward exchange rate and e_t^i is the log spot exchange rate. The log currency excess return can be written as a difference between the log forward discount and the log spot rate change:

$$\varphi_{t+1}^i = (f_t^i - e_t^i) - \Delta\, e_{t+1}^i.$$

This is equivalent to buying a foreign currency in the forward market and selling it one period (one month) later in the spot market:

$$\varphi_{t+1}^i = f_t^i - e_{t+1}^i.$$

Compared to Treasury Bill markets, forward currency markets exist for a limited set of currencies and shorter time-periods. However, the carry trade is easier to implement in forward currency markets, and the data on bid-ask spreads for these markets are readily available. Moreover, the forward contracts are subject to minimal default and counterparty risks.

In order to create currency portfolios, at the end of each period t, I allocate all currencies in the sample to four portfolios on the basis of their forward discounts $f - e$ observed at the end of period t. Portfolios are re-balanced at the end of every month and are sorted on forward discount with Euro.

Portfolio 1 contains the currencies with the smallest forward discounts, and Portfolio 4 contains the currencies with the largest forward discounts. I compute the log currency excess return φ_{t+1}^i for portfolio j by taking the average of the log currency excess returns in each portfolio j.

For each portfolio j, I report changes in the spot rate $-\Delta e^j$, the forward discounts $f^j - e^j$ and the log currency excess returns $\varphi^j = -\Delta e^j + f^j - e^j$.

Data are monthly, from January 2003 to December 2016, from the Euro point of view. I consider 16 currencies: Australia, Canada, Japan, New Zaeland, Sweden, Switzerland, United Kingdom, Czech Republic, Hungary, India, Kuwait, Mexico, Philippines, Poland, South Africa, Thailand. I sort currencies into 4 portfolios, in ascending order of their forward discounts. According to the Morgan Stanley Capital International (MSCI) classification of stock markets my sample comprises 7 developed and 9 emerging markets.

The data sources for the spot and forward exchange rates are WM/Reuters and Barclays available via Datastream. For the market return I use the MSCI Europe Equity Index for the period January 2003 to December 2016, while for the risk free rate I use Euribor rate (both are monthly values). I use a broad Europe equity market

return as benchmark because it is the most commonly used return to test CAPM-based asset pricing models.
Descriptive statistics about portfolios' performance are reported in Table 2, which shows monthly mean excess returns, standard deviations, and Sharpe ratios for four currency portfolios, based on the forward discounts; every portfolio contains a total of 168 observations. The sorting produces a monotonic increase in returns from Portfolio 1 to 4. Standard deviations of Portfolio 1 and Portfolio 4 are very much higher than standard deviations of Portfolios 2 and 3. Sharpe ratio is negative for Portfolio 1 and it is higher for Portfolio 3 than for Portfolio 4.

	Mean	**Standard Deviation**	**Sharpe Ratio**
Portfolio 1	-0,00257291	0,00235493	-1,09256440
Portfolio 2	0,00019398	0,00028162	0,68880828
Portfolio 3	0,00110167	0,00039807	2,76752479
Portfolio 4	0,00392415	0,00211341	1,85678658

Table 2. Descriptive analysis of portfolios sorted on forward discount and change in spot rates: $-\Delta e^{j} + f^{j} - e^{j}$.

Econometric Model

The central insight of Lettau, Maggiori and Weber (2014) and of Galsband and Nitschka (2014) is that cross-sectional currency strategies are more highly correlated with aggregate market returns conditional on low aggregate returns than conditional on high market returns. In order to study conditional correlations and apply the model also for Euro carry trade, I define the downstate to be months when the contemporaneous market return is more than 0,5 standard deviation below its sample average, that is a sufficiently high threshold to have a coherent number of downstate observations in the sample and a sufficiently low threshold to trigger concerns about downside risk. Analysing the MSCI Europe equity Index for the period to January 2003 to December 2016, I obtain 42 monthly observations to the downstate for a total of 168 observations.
Moreover, months where market return is more than 0,5 standard deviation below the sample average corresponds to quarters of low or also negative GDP Growth rate in the Euro Area (I quarter of 2003, all quarters of 2008, I quarter of 2009, III quarter of

2011, II quarter and IV quarter of 2012, II quarter of 2015 and I quarter of 2016).
What it is demonstrated for Dollar currency is that portfolios with high forward discounts have a correlation with market returns which is a decreasing function of market returns (conditional on the downstate the correlation increases). The opposite is true for portfolios with low forward discounts, where the correlation with market returns is an increasing function of market returns (conditional on the downstate the correlation decreases).
Applying the econometric model with the two-stage procedure of Fama and MacBeth (1973), I will demonstrate if also for Euro currency, carry trade (as well as other cross-sectional strategies) is more correlated with the market during market downturns. The first stage consists of two time series regressions, one for the entire time series and one for the downstate observations.
The first stage regressions are:

(1.1) $r_{it} = a_i + \beta_i r_{mt} + \varepsilon_{it}$

and

(1.2) $r_{it} = a_i^- + \beta_i^- r_{mt} + \varepsilon_{it}^-$ whenever $r_{mt} \leq \bar{r}_m - \sigma_{rm}$

where $\bar{r}_m$ and σ_{rm} are the sample average and standard deviation of the market excess return. These two regressions estimate the unconditional and downstate betas, $\hat{\beta}$ and $\hat{\beta}^-$, which are than used as explanatory variables in the second stage.
The second stage regression is a cross-sectional regression of the average return of the portfolios on their unconditional and downstate betas. I restrict the market price of risk to equal the sample average of the market excess return. Therefore, the second stage estimates the downside price of risk δ^-.
The second stage regression is:

(2) $\bar{r}_i = \hat{\beta}_i \bar{r}_m + \left(\hat{\beta}_i^- - \hat{\beta}_i\right)\delta^- + \alpha_i,$ $i = 1,\dots,4$

where $\bar{r}_i$ and $\bar{r}_m$ are the average excess returns of the portfolios and the market excess return, and α_i are pricing errors. I do not include a constant in the second stage regression, imposing that an asset with zero beta with the risk factors has a zero excess return. The average monthly log excess return of the market, measured subtracting the Euribor rate to the market return rate obtained from the MSCI Europe Equity Index, is negative for the sample period from January 2003 to December 2016 and equal to – 0,0130 with a standard deviation of 2,542%.

First stage results

Starting from the first stage of the analysis, I obtain the unconditional betas $\hat{\beta}_i$ and the unconditional intercepts a_i for the four portfolios from the first time series regression (1.1), which takes into account all 168 months.

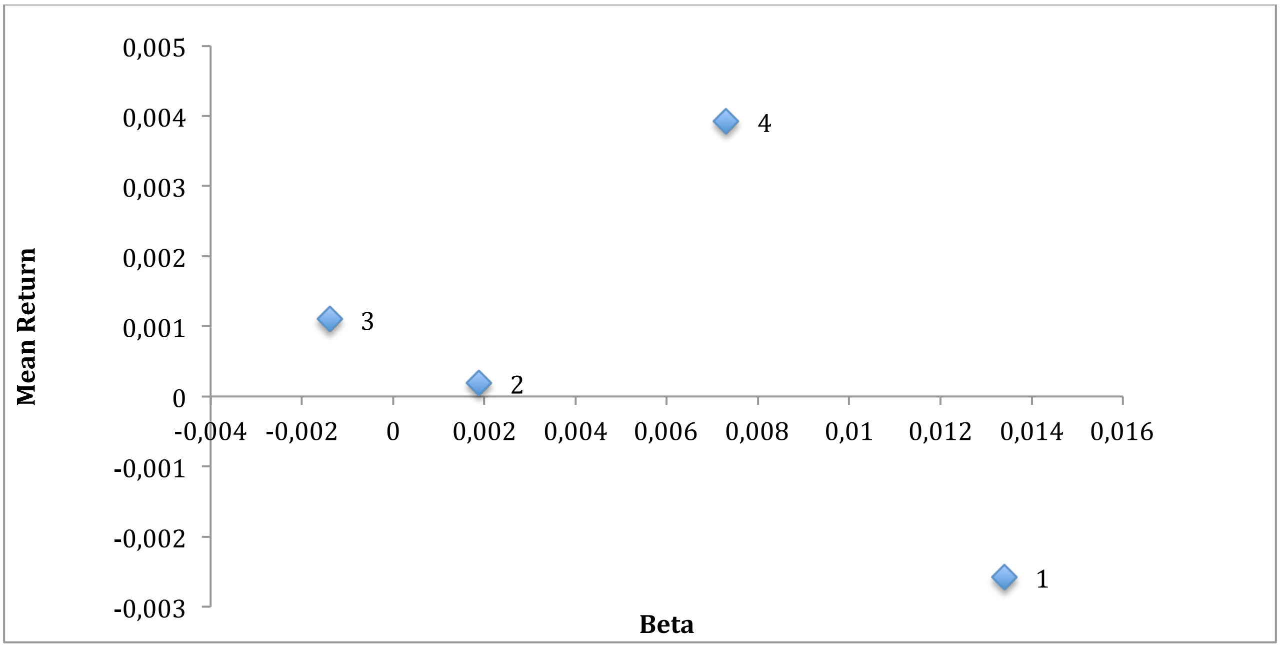

Fig. 6 Realized mean excess returns versus the capital asset pricing model betas β.

Fig. 6 shows that CAPM beta cannot explain the cross section of currency returns: the highest beta is associated with the portfolio with the lowest forward discount, while the portfolio with the lowest beta is Portfolio 3. The failure of classic CAPM models in pricing the cross section of currency returns and cross-sectional strategies is confirmed also for Dollar-based strategies (Ang, Chen, and Xing, 2006, Lettau, Maggiori and Weber, 2014, Galsband and Nitschka, 2014).

With the second time series regression (1.2) based on the downstate observations (42 observations where $r_{mt} \leq \bar{r}_m - 0{,}5$) I find the downstate betas $\hat{\beta}_i^-$ and the downstate intercepts a_i^- in order to check if the average currency returns are related to downstate beta. The important result given by the two time series regressions analysis is that for each portfolio the unconditional beta is higher than the downstate beta.

While for Dollar the downside betas are higher than unconditional betas (Lettau, Maggiori, Weber, 2014), showing that Dollar carry trade, as well as other cross-sectional currencies based on Dollar, is more highly correlated with aggregate market returns conditional on low aggregate market returns, for Euro the opposite is true.

Fig. 7 reports exactly this evidence.

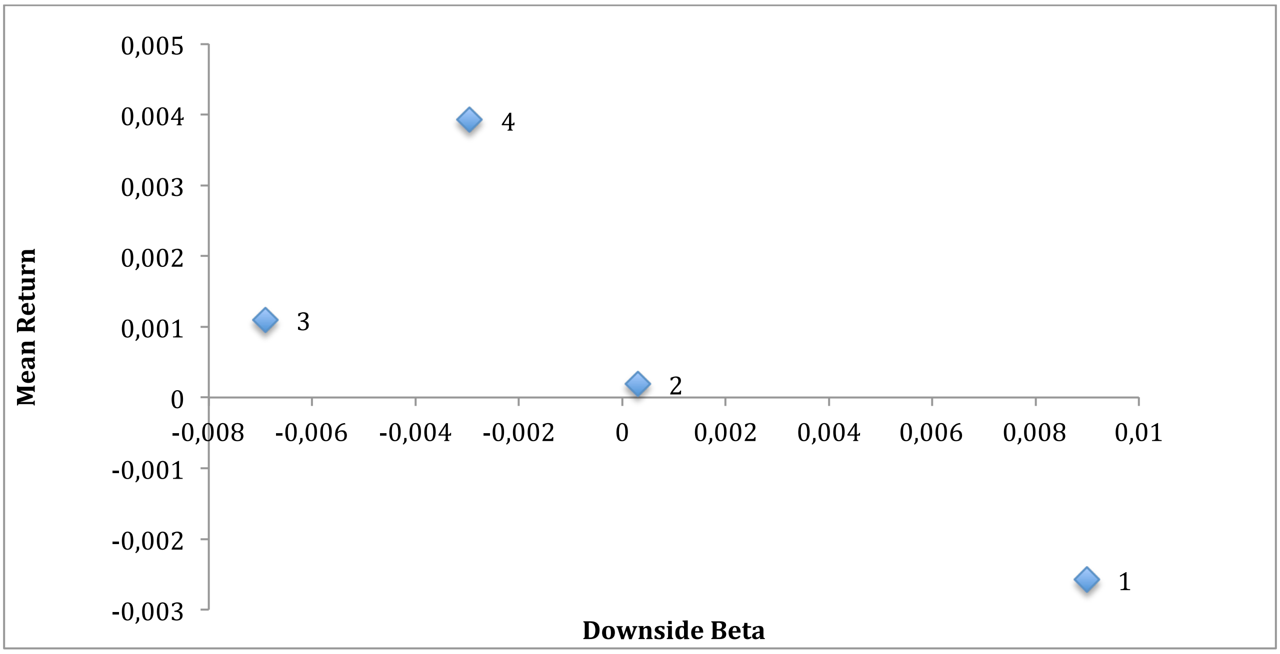

Fig. 7 Realized mean excess returns versus the downside betas β^{-}.

The graph shows a negative trend, where Portfolio 1 with the lowest excess return has the highest downstate beta and Portfolio 4 with the highest excess return reports a negative downstate beta (-0,0029518). Analyzing the relative downstate betas, difference between downstate and unconditional beta, it is even more evident the negative trend in portfolios data: as shown in Fig. 8, Portfolio 2 has the highest relative downside beta while Portfolio 4 has the lowest relative downside beta, proving that the difference between downstate and unconditional beta is not associated with contemporaneous returns: all portfolios have lower downstate than unconditional betas (all relative downside betas are negative), and portfolios with higher excess returns are on average less risky.

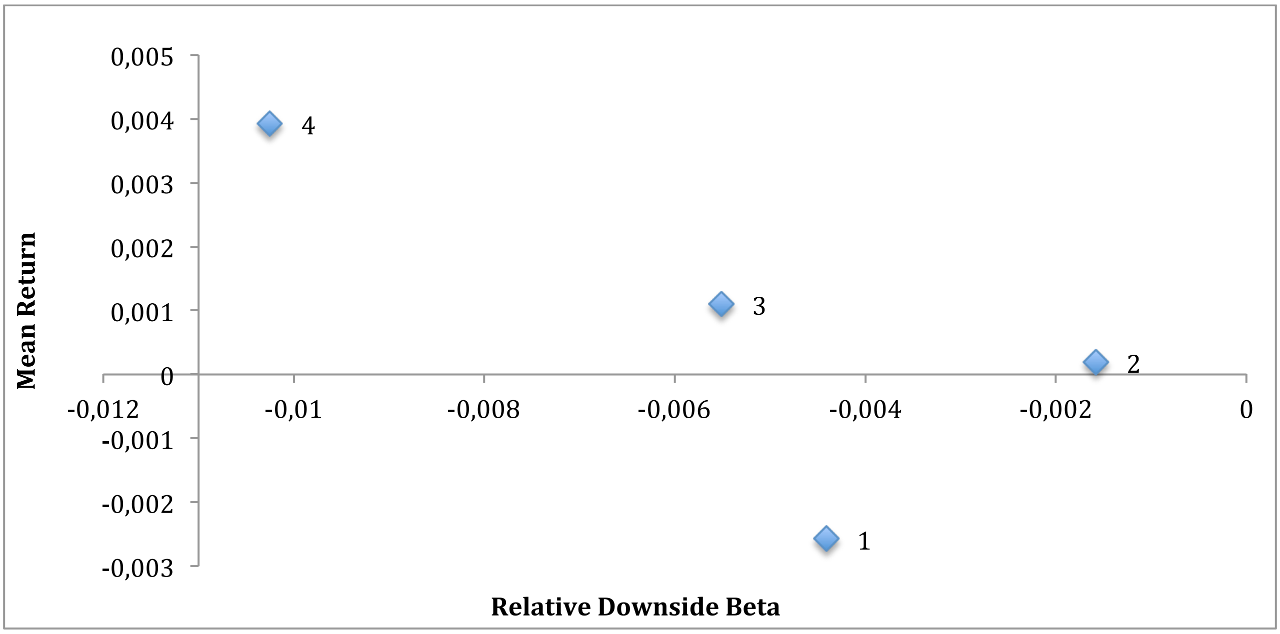

Fig. 8 Realized mean excess returns versus the relative downside betas $\beta^{-} - \beta$

Second stage results

The second stage regression (2) is a cross sectional regression of the average return of the portfolios on their unconditional and downstate betas in order to estimate a single parameter: the downside price of risk δ^{-}. The estimated price of downside risk is negative and equal to – 0,5383 with a coefficient of determination R^2 of 0,6, meaning that Euro investors don't demand a positive extra return to bear downstate risk (while in the analysis of Lettau, Maggiori and Weber for Dollar δ^{-} is equal to 0,0218).
Fig. 9 and Fig. 10 illustrate both the failure of the CAPM and the performance of the DR-CAPM in terms of pricing. As shown in Figure 9, CAPM predicts almost identical mean returns for the four portfolios: all predicted returns are close to zero, and only predicted return for Portfolio 3 is positive. Differently from Dollar-based cross-sectional strategies, DR-CAPM doesn't explain perfectly the cross section of currency returns: Fig. 9 shows that the test assets don't lie on the 45 degree line.
However, the DR-CAPM performance in portfolios pricing is better than CAPM for a greatest differentiation in portfolio returns.

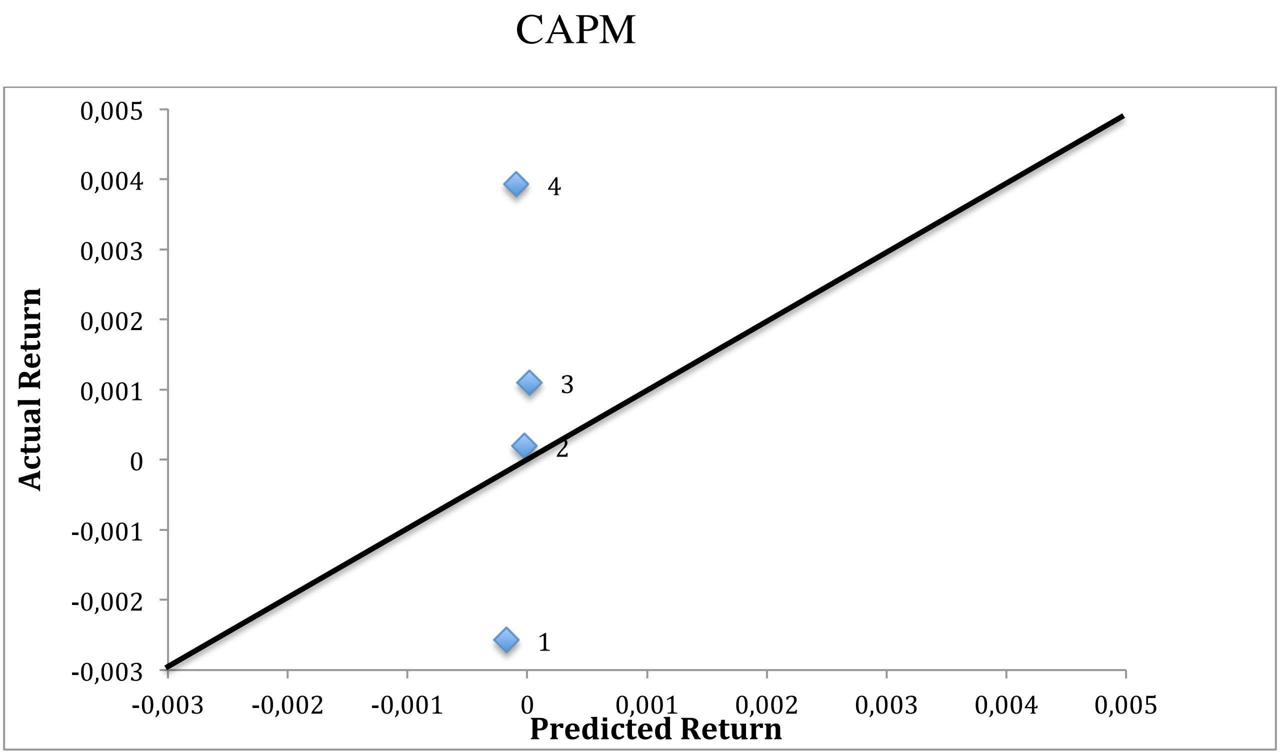

Fig. 9 Mean excess returns versus predicted excess returns for the unconditional capital asset pricing model (CAPM).

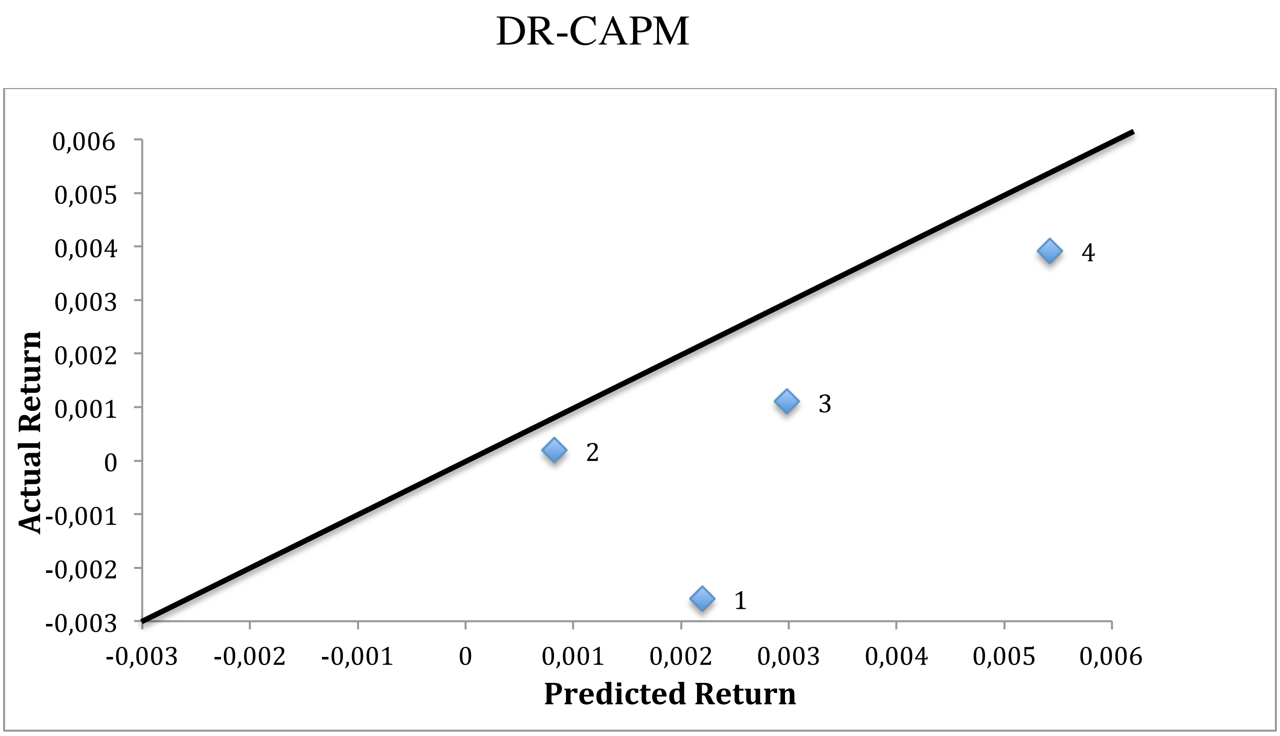

Fig. 10 Mean excess returns versus predicted excess returns for the downside risk capital asset pricing model (DR-CAPM).

Pricing errors are defined as the difference between the actual and the model-predicted excess return, so that a positive price error corresponds to an underprediction of the excess return by the model. DR-CAPM overpredicts excess returns for all portfolios while CAPM overpredicts only for Portfolio 1.
In absolute terms is evident the failure for both models in explaining the cross section of currency returns also if DR-CAPM better predicts the excess returns differentiation for the portfolios.
Finally, Table 7 resumes some important two-stage regression results:

	CAPM	DR-CAPM
Price of risk	-0,0130	-0,0130
Price of downside risk		-0,5383
R^2	0,16	0,56
RMSPE	0,0024	0,0026
Number of observations	168	168

Table 7. Estimation of linear pricing models.

Table 7 reports prices of risks, number of observations, root mean squared pricing errors (RMSPE) and the cross sectional R^2's for the unconditional capital asset pricing model and the downside risk CAPM.
The coefficient of determination R^2, statistical measure about the model goodness of fit, is very low for CAPM, while for DR-CAPM is equal to 0,56, denoting a better performance in explaining the cross-sectional variation in mean returns.
Conversely, the root mean squared pricing errors, which represents the sample standard deviation of the differences between predicted values and observed values, is very similar for both models.

Conclusion

I find that Euro currency returns are not associated with aggregate market risk, thus not supporting a risk-based view of forward discount.
However, as for Dollar currency, I find that unconditional CAPM cannot explain the cross section of currency returns because the beta associated with the portfolio with the lowest mean excess return is higher than the unconditional beta associated with the portfolio with the highest mean excess return (in Lettau, Maggiori and Weber analysis concerning Dollar-based portfolios there is a positive relation between

CAPM betas and portfolios' mean return, but the increase in CAPM beta going from the low- excess return portfolio to the high- excess return portfolio is small compared to the increase in average returns).

Focusing on downstate market periods, the resulting portfolios' downstate betas presents an inverse relation with portfolios' mean excess return: Portfolio 1 shows the highest sensibility to market downturns. Moreover, Portfolio 4 reports a negative downstate beta, meaning an inverse movement of portfolio's returns with respect to the market during bad market conditions.

Relative downside betas, calculated in order to apply the DR-CAPM, are negative for all portfolios, because unconditional betas are all higher than downstate betas, showing an opposite behaviour of Euro portfolios with respect to Dollar portfolios: Portfolio 4 shows the lowest relative downside beta, indicating a greater correlation with aggregate market during "normal" times than during market downturns, while, in Lettau, Maggiori and Weber analysis, Dollar-based portfolio with the highest mean excess return shows the highest relative downside beta confirming that the difference between downstate and unconditional beta is associated with contemporaneous returns.

However, while CAPM predicts almost identical returns for the four portfolios, DR-CAPM prediction presents a higher mean return differentiation between portfolios, with a higher coefficient of determination.

Based on this observations, DR-CAPM, which explicitly distinguishes states of the world in which the market return is falling, is not successful in explaining excess returns on Euro currency portfolios, rejecting the economic rationale of loss aversion, i.e. investors tend to value the disutility of a certain loss of wealth more than the utility of an equally high gain.

The link between downside risk and average excess returns for Euro-based cross-sectional strategies is not verified, confirming Burnside (2011) cautioning against the weak connection between currency excess returns and standard risk factors.