Dollar carry timing

by

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Abstract

Dollar carry trade risk premiums – unlike dollar-neutral or foreign exchange carry risk premiums – are positively correlated with firm-level dispersions in investment, profitability, and book-to-market in addition to the Treasury-bill rate, long term bond yield, term spread, and default spread. Several forecasting models pin down the few periods responsible for the entire premium, based on these proxies for the latent risk and price of risk states in the U.S. (and its business cycle). This predictability is also statistically and economically significant out of sample: It generates Sharpe ratios as large as 1.37 (compared to 0.44 unconditionally), for example.

JEL Codes: G11, G12, G15, F31, E32, D25.

Keywords: Carry trade, risk premium, business cycle, microeconomic dispersion, foreign exchange.

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1 Introduction

"Dollar carry" trade goes long in a basket of foreign currency forwards and short in the dollar when the average forward discount (AFD) on foreign currency (on the basket) is positive, and does the opposite otherwise. "Dollar-neutral" carry trade only goes long (short) in the foreign currencies with the largest (smallest) forward discounts each period, without any dollar exposure. Dollar carry risk premiums are large, uncorrelated with traditional risk factors, have minimum negative skewness and large Sharpe ratios. Dollar-neutral risk premiums are smaller, highly negatively skewed, correlated with traditional risk factors, and yield lower Sharpe ratios (Lustig et al., 2014; Daniel et al., 2017; Hassan and Mano, 2018).

A possible explanation for these differences is that dollar carry returns are related to the state of the U.S. business cycle, while dollar-neutral returns are not (Lustig et al., 2014). But the evidence is limited: Even the predictive return regressions for portfolios of currencies of developed countries in Lustig et al. (2014) have insignificant coefficients for inflation volatility, consumption volatility, and industrial production growth in all frequencies, except for the latter two variables in annual frequency (marginally and in sample).[1] Hence, the evidence is mostly restricted to the fact that the AFD on foreign currency is correlated with a few macro-economic variables and that it forecasts foreign exchange carry returns unconditionally. However, this empirical evidence is not very robust either: Conditioned on being positive, the AFD is essentially uncorrelated with future foreign exchange carry returns, and it is just above statistical significance when negative (Table 7, Section 5.2).

The present paper contributes to this discussion by comprehensively documenting a new stylized fact: Increases in two sets of observable variables are pervasively correlated with increases in future realized returns on *dollar carry portfolios* (as opposed to foreign currency carry portfolios) both in sample and out of sample.[2] The main set are the dispersions (spreads), in the cross-section of U.S. firms, of investment, iv_{sp}, profitability, op_{sp}, and

[1] Tables 9 and 10 in Lustig et al. (2014), controlling for finite sample properties ("VAR").

[2] For example, this is a fundamental difference relative to Lustig et al. (2014), who aim at forecasting foreign currency carry trade returns (from going long on foreign currency forwards).

book-to-market (BM), bm_{sp}, as defined by Fama and French (2015). The second group are four U.S. interest-rate variables (in levels or spreads): The long-term government bond yield, lty, the Treasury-bill rate, tbl, the term spread, tms, and the default spread, dfy.

Based on these seven state variables, I estimate 29 forecasting models of dollar carry annual returns, with one to three regressors, in January 1976 to September 2020. From a total of 59 slope coefficients estimated, 36 are significant, and all 59 have positive point estimates: Dollar carry return realizations tend to be large following economic states of large dispersion in investment, BM, and profitability, and after periods of large interest-rate spreads or levels, measured by the other variables. In addition, for a wide range of split dates, the out-of-sample (OOS) R^2 of the (in-sample) significant models are usually positive and the recursive forecasts are also significant out of sample, according to the forecast encompassing test of Clark and McCracken (2001).

In fact, the OOS recursive predictions of high and low returns are also economically significant: Realized returns (and Sharpe ratios) following above average return predictions are indeed higher than average from January 1992 (with a minimum 15-year training period) to September 2020. This holds for all models that are significant in sample (Table 4, Section 4.2.1). Furthermore, several models identify precisely the few periods responsible for the entire dollar carry premium. One example is the model based (jointly) on the the BM, investment, and default spreads. Out of sample, this model only predicts above average returns in 86 months. The realized mean annual return in these months is 8.64% (1.83% standard error) and the Sharpe ratio is 1.22 (0.26). In the remaining 247 months, the insignificant annual mean return is 1.94% (1.20%), and the insignificant Sharpe ratio is 0.28 (0.18).

These results also add to the list of documented empirical differences between dollar-neutral and dollar carry risk premiums: None of the 59 coefficients is significant in equivalent forecasting models of dollar-neutral returns – even at the 10 percent level. This supports the conjecture in Lustig et al. (2014) that dollar-neutral returns are unaffected by the state of the U.S. economy (and only depend on global state variables). Finally, foreign currency carry returns are not forecastable by these state variables, either. Even after I include the AFD in the models (Table 8, Section 5.2).

1.1 Theoretical background

Under the assumptions that the multifactor model of Fama and French (2015) statistically describes returns, that the investment and profitability characteristics used in Fama and French (2015) are risk proxies (according to *any* theory), and that book equity is a proxy for the expected cash flows of individual firms (de Oliveira Souza, 2020c; Berk, 1995), de Oliveira Souza (2020b) formally proves that the (observable) iv_{sp}, op_{sp}, and bm_{sp} are theoretically correlated with certain (unobservable) risk states of the economy, while the bm_{sp} is also theoretically correlated to the (unobservable) general price of risk state. Hence, the empirical evidence that I present fits the theory in de Oliveira Souza (2020b) very closely. Fundamentally, de Oliveira Souza (2020b) bridges macro-finance theories (as in Cochrane, 2011, 2017) and asset pricing theories consistent with the statistical description in Fama and French (2015). However, the derivation ignores the idiosyncrasies in these theories that are not clearly testable, which generates theoretically robust implications, instead.

Indeed, a growing literature also explicitly relates the business cycle and the dispersion of firm- (or plant-) level variables – similar to these three spreads. Some (especially productivity dispersion, Bloom et al., 2018) are claimed to be counter-cyclical, but others (especially investment dispersion, Bachmann and Bayer, 2014) are claimed to be pro-cyclical.[3] Hence, it is also possible to interpret the empirical results that I provide from this perspective, although less directly.

Regarding the interest-rate variables, apart from a general relation with the business cycle, the motivation is two-fold: (i) The variables in levels, tbl and lty, forecast fixed income returns (Campbell, 1987; Hodrick, 1992), so they represent the opportunity cost

[3] A few other examples are Berger and Vavra (2013), Bachmann and Bayer (2013), Vavra (2014), Jurado et al. (2015), Kehrig (2015), and Decker et al. (2016).

("required premium") for holding currency instead of bonds, (ii) the spread variables, dfy and tms are also related to the aggregate (risk or price of risk) state of the U.S. economy, since they forecast the returns on multiple assets (Fama and French, 1989).

Finally, the evidence that I document suggests that foreign currencies provide hedge for U.S. investors in some economic states, while being risky in others. This is why foreign currency carry returns are not forecastable by the same state variables that forecast dollar carry returns (Table 8, Section 5.2).

Section 3 provides a simple no-arbitrage framework to interpret all the empirical findings in the paper after Section 2 describes the data, variables and carry trade portfolios. Section 4 contains the main results: It provides the in sample and OOS evidence involving dollar carry return forecasts and the performance of the dollar carry timing strategy. Section 5 complements these results, in line with framework in Section 3, by showing that the state variables do not forecast dollar-neutral returns, nor do they forecast the returns on foreign currency carry trades. Section 6 concludes.

2 Data and variables

2.1 Foreign currency and carry trade returns

I follow Lustig et al. (2014) and use quoted spot and forward prices of currency contracts to calculate carry trade returns, and assume that the contracts are rolled monthly. The spot exchange rate in units of foreign currency per U.S. dollar (FCU/USD) at time t is s_t, and the (one-month) forward exchange rate in FCU/USD is f_t. Since s_t is the price of a dollar, an increase in s_t is an appreciation of the dollar. Equivalently, the foreign currency is at a forward discount (and the dollar is at a forward premium) when f_t is larger than s_t, so that a dollar is worth more of the foreign currency at the forward maturity than in t.

In a long position, the investor enters a forward contract, it time t, to buy the foreign currency (sell the dollar) at price $f_{i,t}$, in time $t+1$, when the spot price (of the dollar) is $s_{i,t+1}$. At maturity, the realized return on this position is

$$r_{i,t+1} = \frac{f_{i,t}}{s_{i,t+1}} - 1. \tag{1}$$

In addition, the forward discount on this currency, in time t, is given by[4]

$$f/s_{i,t} \equiv \frac{f_{i,t}}{s_{i,t}} - 1. \tag{2}$$

I build end-of-month series of returns and forward discounts from January 1976 until September 2020 using daily spot and forward exchange rates in U.S. dollars. All data are from Datastream, as detailed in Appendix A. The U.S. dollar spot rate quotes since 1990 are mid prices (they are bid prices between 1983 and 1990). In addition, U.S. dollar quotes are calculated from British Pound quotes between 1976 and 1983. For the reasons stated in Daniel et al. (2017), I only consider the (G10) currencies from Australia, Canada, Japan, New Zealand, Norway, Sweden, Switzerland, United Kingdom, and the Euro (Germany before 1999) against the (U.S.) dollar: I explicitly exclude the European currencies other than the Euro and the German Mark to avoid the peso problems associated with "convergence trade". I also exclude emerging market currencies to isolate the foreign currency risk premiums that I want to investigate from sovereign risk premiums (Daniel et al., 2017).

Foreign currency returns and the AFD: I often denote "foreign currency returns" (or foreign currency carry returns) as the returns from buying an equal-weighted basket of foreign currency (one month) forwards and then selling the foreign currencies in the spot

[4]Under typical conditions of covered interest rate parity, this is equal to the interest rate differential between the two countries, $f/s_{i,t} \approx r_t^{f*} - r_t^f$, where r^{f*} and r^f are the foreign and domestic risk-free rates in monthly frequency.

market (after one month).These returns are simply the average of the returns on each individual currency in Eq. (1),

$$fx_{t+1} = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{f_{i,t}}{s_{i,t+1}} - 1\right), \tag{3}$$

where i indicates each currency in the basket and N is the total number of currencies. Likewise, the AFD in time t is the equal weighted average of Eq. (2),

$$AFD_t = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{f_{i,t}}{s_{i,t}} - 1\right). \tag{4}$$

Dollar carry returns: The dollar carry strategy of Lustig et al. (2014), as implemented by Daniel et al. (2017), goes long all G10 foreign currency forwards when the foreign currencies are at forward discounts on average, and short all foreign currency forwards otherwise. Hence, the dollar carry monthly return, USD_m, is the average of all individual foreign currency returns – given by Eq. (3) – following periods when the average forward discount is positive, and it is the negative of this average return after periods when the average forward discount is negative,[5]

$$USD_{m,t} = sign(AFD_{t-1})fx_t. \tag{5}$$

Naturally, the annual dollar carry return, denoted simply USD, is the cumulative return in monthly frequency,

$$USD_t = \prod_{s=t-11}^{t}\left(1 + USD_{m,s}\right) - 1. \tag{6}$$

Dollar-neutral returns: The dollar neutral strategy is similar to the HML of Lustig et al. (2014), as implemented by Daniel et al. (2017). It only takes positions in foreign currencies. The dollar neutral strategy has equal positive (negative) weights on all currencies whose forward discounts are above (below) the median, with no position in the median currency.

[5] Given that I use discrete returns, in contrast to the continuous returns in Lustig et al. (2014), this return average is the return on the equal-weighted portfolio of those currencies, in fact.

Hence, the dollar neutral return, labeled $0D$, is the difference between the average return on the top and bottom forward discount currencies. This long-short portfolio has no direct dollar exposure.

Table 1 shows summary statistics for the returns on both strategies in the full 1976-2020 sample; in 1992-2020, which is when the recursive estimates of the forecasting models that I implement are available; and before 2010, which is similar to the period used in previous research. The main conclusion from Table 1 is that the Sharpe ratios since 1992 are substantially smaller than in the full sample, especially compared to the values in Daniel et al. (2017). Otherwise, the conclusion is similar to what Lustig et al. (2014) and Daniel et al. (2017) find: Dollar carry returns are larger, less negatively skewed, less fat tailed, and have larger Sharpe ratios relative to dollar neutral returns. Fig. 3 in Appendix A.1 displays the returns on the USD and $0D$ strategies over time, as well as the AFD.

Table 1: Descriptive statistics of monthly dollar carry, USD, and dollar neutral returns, $0D$, in January 1976–September 2020 and subperiods.

	μ	σ	γ_1	α_4	SR_y	Months
$0D$	0.22	2.06	-0.49	4.76	0.37	536
USD	0.40	2.27	-0.10	3.84	0.61	536
$0D_{92^+}$	0.14	1.90	-0.41	4.12	0.25	345
USD_{92^+}	0.28	2.20	-0.05	3.95	0.44	345
$0D_{10^-}$	0.26	2.18	-0.54	4.65	0.41	419
USD_{10^-}	0.49	2.32	-0.05	3.82	0.73	419

Monthly mean, μ, standard deviation, σ, skewness, γ_1, and kurtosis, α_4; annualized Sharpe ratios SR_y; and number of months. The values are for the years after 1992, 92^+, for the years before 2010, 10^-, or in the full sample.

Summary: Relative to dollar-neutral, dollar carry returns are larger, less negatively skewed, less fat tailed, and have larger Sharpe ratios. Returns and Sharpe ratios are markedly lower since 1992 and higher before 2010.

2.2 State variables

I follow de Oliveira Souza (2020b) exactly: Each spread (iv_{sp}, op_{sp}, bm_{sp}) is the difference between the 70^{th} and 30^{th} NYSE cross-sectional percentiles of the respective characteristic,

$$\kappa_{sp,t} \equiv \kappa_{0.7,t} - \kappa_{0.3,t}, \quad \kappa = \{bm, op, iv\}, \tag{7}$$

which is in logs for the BM spread, $\ln\left(bm_{0.7,t} - bm_{0.3,t}\right)$, so that the series is stationary in the full sample. The data to construct these variables come from their respective breakpoint files in Kenneth French's data library. They are available from June 1963 (June 1926 for the BM) until December 2019 and change yearly.[6] These are the **macro-finance state variables**.

The **interest-rate state variables**, which Welch and Goyal (2008) describe in detail, are from Amit Goyal's website: The treasury-bill rate, tbl; the long term yield, lty; the term spread, tms (difference between lty and tbl); and the default spread, dfy (difference between BAA- and AAA-rated corporate bond yields). All data are from June 1926 until December 2019.[7] Fig. 1 plots the state variables and show that eventual trends in these ratios are not persistent.[8]

3 A no-arbitrage framework

This section presents a simplified version of the framework in de Oliveira Souza (2020b) to help in the interpretation of the results that will follow. The main theoretical restriction is the absence of arbitrage, so that a stochastic discount factor (SDF) exists.

[6] I do not consider the period after 2019 because the remaining variables end in 2019.

[7] I use the 30-year treasury constant maturity rate (DGS30), from the St. Louis FED to complete Goyal's lty series in 2019.

[8] Indeed, the augmented Dickey-Fuller tests (Table 9a in Appendix B) formally reject the null hypotheses of unit roots (at least marginally) for most series, except for the op_{sp} and the lty in the full sample. In contrast, there is much less statistical evidence against the unit roots in the shorter sample (Table 9b in Appendix B). Fig. 4 in Appendix A.1 shows these values only for the period 1976-2020.

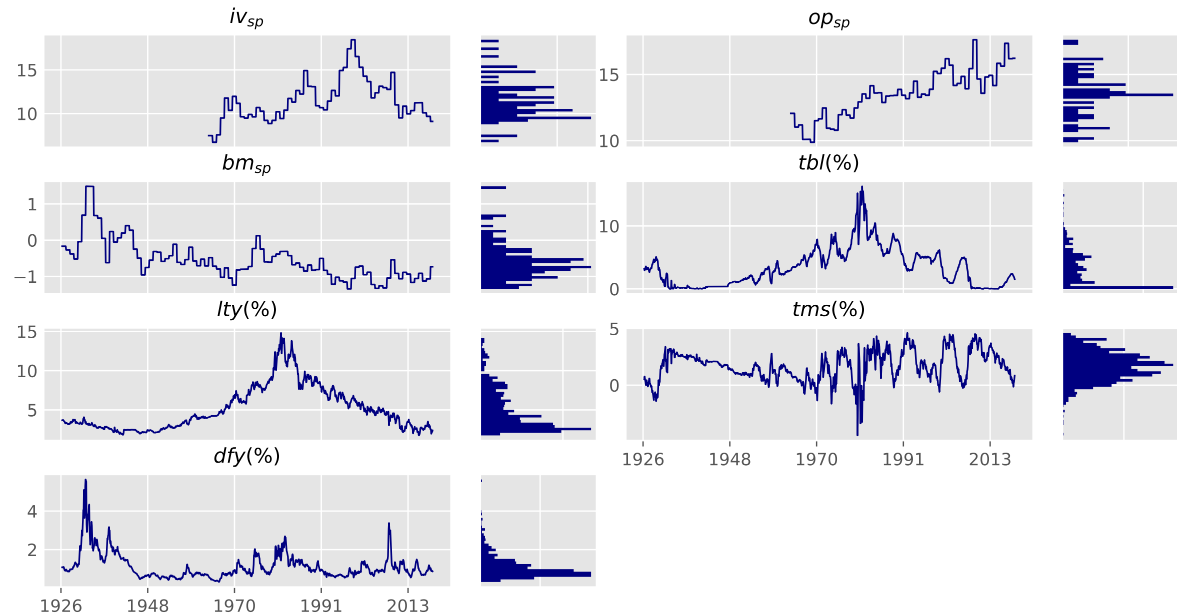

Figure 1: State variables in June 1926 (1963)–December 2019.
Summary: All variables have temporary trends. But since they are essentially ratios, the trends are short lived in all graphs, except for the op_{sp} (for which a longer sample is unavailable).

Let $P_i = (P_{i,t})$ be the price process for an asset i, such that

$$dP_{i,t} = P_{i,t}\left[\mu_{i,t}\,dt + \sigma_{i,t}dzt + \tilde{\sigma}_{i,t}\,d\tilde{z}_t\right], \tag{8}$$

where $z = (z_t)$ and $\tilde{z} = (\tilde{z}_t)$ are independent one-dimensional standard Brownian motions, respectively, representing "domestic" economic shocks, z, and "international" economic shocks, $\tilde{z}$; $\mu_{i,t}$ is a one-dimensional stochastic process representing expected returns; $\sigma_{i,t}$ and $\tilde{\sigma}_{i,t}$ are, respectively, price sensitivities to domestic and international economic shocks.

Definition 1 *With the fundamental uncertainty represented by z and $\tilde{z}$ and a locally risk-free asset with return r_t^f traded at all times, the **domestic price of risk**, $\lambda = (\lambda_t)$, and the **international price of risk**, $\tilde{\lambda} = (\tilde{\lambda}_t)$, are one-dimensional processes satisfying*

$$\mu_{i,t} - r_t^f = \sigma_{i,t}\lambda_t + \tilde{\sigma}_{i,t}\tilde{\lambda}_t \tag{9}$$

*for all assets $i = 1, ..., I$, where $\sigma_{i,t}$ is interpreted as the **domestic risk** of asset i and $\tilde{\sigma}_{i,t}$ is its **international risk**.*

Indeed, this already defines the SDF (as formally proven by Munk, 2013, pp. 109-112):

Proposition 1 *Under technical conditions, a process $\zeta = (\zeta_t)$ is a SDF if and only if*

$$d\zeta_t = -\zeta_t \left[r_t^f \, dt + \lambda_t dz_t + \tilde{\lambda}_t d\tilde{z}_t \right], \quad \zeta_0 = 1. \tag{10}$$

3.1 Economic assumptions and implications for latent variables

I incorporate two economic assumptions in the model, while simplifying the calculations in the proofs later on. The fist, in Eq. (11), is that shocks that affect the U.S. economy ("domestic" shocks) have similar effects on all foreign currencies. And these effects change over time: A positive AFD indicates that all foreign currency forwards are risky; a negative AFD indicates that all of them provide hedge against these domestic shocks instead. The second, in Eq. (12), is that some currencies are risky and others offer hedge with respect to the global business cycle, as in Christiansen et al. (2011) or Ranaldo and Soderlind (2010), for example. The ones with forward discounts below the median in a given period provide hedge against these "international" shocks. The other half is risky from this perspective.

Assumption 1 *The domestic and international risk parameters for each foreign currency forward, i, are given by the same functions:*

$$\sigma_{i,t} = \begin{cases} +\sigma_d, & if \;\; AFD_t > 0 \\ -\sigma_d, & if \;\; AFD_t < 0, \end{cases} \tag{11}$$

$$\tilde{\sigma}_{i,t} = \begin{cases} +\sigma_{dn}, & if \;\; f/s_{i,t} > median(f/s_t) \\ -\sigma_{dn}, & if \;\; f/s_{i,t} < median(f/s_t), \end{cases} \tag{12}$$

where σ_d and σ_{dn} are positive constants, $f/s_{i,t}$ is the foreign currency's forward discount, $median(f/s_t)$ is the cross-sectional foreign currency forward discount median in time t, and the AFD_t is positive or negative with approximately the same probability,

$$P(AFD_t > 0) \approx P(AFD_t < 0) \approx 0.5. \tag{13}$$

Lemma 1 *Under Assumption 1, the risk premium of a equal-weighted long portfolio on foreign currency forwards, μ_{fx}, is largely uncorrelated with the domestic price of risk, λ_t, in time-series, but it is positively correlated with the AFD (even if the AFD is uncorrelated with the domestic price of risk).*

Proof: *In time t, the risk of a equal-weighted long portfolio of foreign currency forwards is the conditional cross-sectional average of the risks of all such forwards. Eq. (12) implies $\tilde{\sigma}_{fx,t} = 0$ (meaning that the portfolio completely diversifies the international risk), and Eq. (11) implies $\sigma_{fx,t} = \sigma_{f,t}$ since all currencies have the same exposure to domestic shocks. Hence, the covariance with the domestic price of risk, based on Eq. (9), reduces to*

$$cov\left(\mu_{fx,t}, \lambda_t\right) = cov\left(\sigma_{fx,t}\lambda_t, \lambda_t\right) = \mathrm{E}\left[\sigma_{fx,t}\right] var\left(\lambda_t\right) \approx 0, \tag{14}$$

where Eqs. (11) and (13) imply,

$$\mathrm{E}\left[\sigma_{fx,t}\right] = \mathrm{E}\left[\sigma_{f,t}\right] \approx 0. \tag{15}$$

The covariance with the AFD (assumed uncorrelated with the domestic price of risk) is given by

$$cov\left(\mu_{fx,t}, AFD_t\right) = cov\left(\sigma_{fx,t}\lambda_t, AFD_t\right) = \mathrm{E}[\lambda_t] cov\left(\sigma_{fx,t}, AFD_t\right) > 0, \tag{16}$$

where (the price of risk is theoretically non-negative and) Eq. (11) implies

$$cov\left(\sigma_{fx,t}, AFD_t\right) = cov\left(\sigma_{f,t}, AFD_t\right) > 0. \tag{17}$$

■

Lemma 2 *Under Assumption 1, the risk premium of dollar carry portfolios, μ_{USD}, is positively correlated with the domestic price of risk, λ_t, in time-series.*

Proof: *Dollar carry portfolios are simply long (short) the portfolio of foreign currency forwards described in Lemma 1 when the AFD is positive (negative). Two conclusions follow: First, dollar carry portfolios also completely diversify the international risk, $\tilde{\sigma}_{USD,t} = 0$. Second, exposures to domestic shocks, by construction, are given by*

$$\sigma_{USD,t} = \begin{cases} +\sigma_{fx,t}, & AFD_t > 0 \\ -\sigma_{fx,t}, & AFD_t < 0 \end{cases} \implies \sigma_{USD,t} = \sigma_d \ \forall t. \tag{18}$$

This implies, based on Eq. (9), that

$$cov\left(\mu_{USD,t}, \lambda_t\right) = cov\left(\sigma_{USD,t}\lambda_t, \lambda_t\right) = \sigma_d \, var\left(\lambda_t\right) > 0, \tag{19}$$

where the inequality follows from σ_d being positive. ■

Lemma 3 *Under Assumption 1, the risk premium of dollar-neutral portfolios, μ_{0D}, is uncorrelated with the domestic price of risk, λ_t, as long as the international price of risk and the domestic price of risk are uncorrelated.*

Proof: *The zero-investment dollar-neutral portfolio is constructed by going long (short) portfolio H (L), which contains all currencies with forward discounts above (below) the median. The domestic and international risks of these two (unit) portfolios are, respectively,*

$$\sigma_{H,t} = \sigma_{f,t}, \quad \tilde{\sigma}_{H,t} = +\tilde{\sigma}_{dn}, \tag{20}$$

$$\sigma_{L,t} = \sigma_{f,t}, \quad \tilde{\sigma}_{L,t} = -\tilde{\sigma}_{dn}, \tag{21}$$

where $\sigma_{f,t}$ is given by Eq. (11) each period, while $\tilde{\sigma}_{H,t}$ and $\tilde{\sigma}_{L,t}$ are fixed over time due to how portfolios H and L are constructed and given Eq. (12). Without loss of generality, the risk of a *dollar-neutral portfolio is the difference between the risks in Eqs.* (20) *and* (21). *In particular, exposure to domestic and international shocks are given by*

$$\sigma_{0D,t} = \sigma_{H,t} - \sigma_{L,t} = 0 \quad \forall t, \tag{22}$$

$$\tilde{\sigma}_{0D,t} = \tilde{\sigma}_{H,t} - \tilde{\sigma}_{L,t} = 2\sigma_{dn} \quad \forall t. \tag{23}$$

Hence, the covariance with the domestic price of risk, based on Eq. (9)*, becomes*

$$cov\left(\mu_{0D,t}, \lambda_t\right) = cov\left(\tilde{\sigma}_{0D,t}\tilde{\lambda}_t, \lambda_t\right) = 2\sigma_{dn}cov\left(\tilde{\lambda}_t, \lambda_t\right) = 0, \tag{24}$$

where the equality follows from the assumption that the domestic price of risk is uncorrelated with the international price of risk. ■

3.2 State variables and observable implications

A parsimonious summary of de Oliveira Souza (2020b) is that – theoretically and empirically – the spreads in BM, investment, and profitability are positively correlated with the broad price of risk (in the U.S.). Indeed this is the definition that I use for state variable:

Definition 2 *An observable variable Λ_t is a state variable if and only if the variable is positively correlated with the (latent) one-dimensional price of risk,*

$$cov\left(\Lambda_t, \lambda_t\right) > 0. \tag{25}$$

In fact, de Oliveira Souza (2020b) relies on a multi-dimensional representation of the price of risk to show that the op_{sp} and the iv_{sp} are correlated with the price of specific economic shocks, while the bm_{sp} is correlated with all priced shocks. This distinction is not possible (nor relevant) within the simplified one-dimensional representation of the price of risk in this section. But de Oliveira Souza (2020b) offers an analogy to interpret the results involving interest-rate variables below.

In particular, the empirical results in Fama and French (1989) suggest that the term spread and the default spread (like the bm_{sp}) are also positively correlated with the prices of multiple risks, given that the two variables positively forecast returns on multiple assets. In contrast, the interest-rate variables in levels (T-bill, tbl and long term yield, lty) are positively correlated with future fixed income returns (Campbell, 1987; Hodrick, 1992), but are also mildly *negatively* correlated with future stock returns. Hence, the tbl and lty are not the same type of variable as the bm_{sp}. Nevertheless, these variables represent the opportunity cost ("required premium") for holding currency as opposed to bonds: The tbl and lty should also be positively correlated with the price of (currency) risk. This is the interpretation that I follow.

Based on the discussion above, the seven variables that I consider in the paper fit Definition 2. Hence, the observable implications/corollaries of Lemmas 1, 2, and 3 (respectively numbered) apply to each of the variables and can be used to understand the empirical findings in the next sections:

Corollary 1.1: *Future returns on foreign currency forwards, fx_{t+h}, are uncorrelated with state variables given by Definition 2, Λ_t, but positively correlated with the AFD, AFD_t.*

Corollary 2.1: *Future dollar carry returns, USD_{t+h}, are positively correlated with state variables given by Definition 2, Λ_t.*

Corollary 3.1: *Future dollar-neutral returns, $0D_{t+h}$, are uncorrelated with state variables given by Definition 2, Λ_t.*

4 Dollar carry return forecasts

4.1 In sample evidence

This section presents 23 valid forecasting models of annual dollar carry returns based on the state variables described in the previous sections. I estimate 59 slope coefficients in a total of 29 models. All of them have positive point estimates and 36 are significant (with Newey and West (1987) standard errors with 12 lags), consistent with the hypothesis in Lemma 2 (and Corollary 2.1) that the regressors are proxy variables for the risk and price of risk states of the U.S. economy.[9]

Models (1) to (7) in Table 2 report estimates for univariate regressions of the form

$$USD_{t+12} = \beta_0 + \beta_1 x_t + \epsilon_{t+12}, \tag{26}$$

where USD_{t+12} is the 1-year return of the dollar carry trade strategy, ϵ_{t+12} is an error term, and x_t is one of the seven state variables. The majority of the variables is significant in this formulation: The bm_{sp}, tbl, lty, and dfy, with R^2's of 8.5%, 4.2%, 8.7%, and 11.6%, respectively, for example.

Models (8) to (19) in Table 2 combine each macro-finance variable, as x_1, with each interest-rate variable, as x_2, in bivariate regressions of the form

$$USD_{t+12} = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \epsilon_{t+12}. \tag{27}$$

Models (10), (14), and (17) in Table 2 are the "invalid" models (by only having insignificant regressors). The tms remains insignificant in every model, including models (10) and (14) joined by the risk proxies iv_{sp} and op_{sp}. Model (17) combines two highly significant regressors (lty and bm_{sp}), but they become insignificant. In contrast, models (11), (12) and (13) only have significant regressors. They are highly significant in model (13), which also has the largest R^2 of 16.4% – based on the op_{sp} and the lty. Indeed, all

[9] Appendix C shows the results in monthly frequency, but those are substantially less significant.

Table 2: Predictive regressions for annual dollar carry returns in February 1976–September 2020.

	USD_{t+12}																		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
$iv_{sp,t}$	0.5							0.5	0.6	0.4	0.7*								
	(1.31)							(1.59)	(1.74)	(1.27)	(2.26)								
$op_{sp,t}$		0.2										1.5*	2.1***	0.1	0.3				
		(0.38)										(2.56)	(3.57)	(0.18)	(0.64)				
$bm_{sp,t}$			7.5**													6.5*	4.4	7.4**	4.4
			(3.10)													(2.27)	(1.52)	(2.97)	(1.82)
tbl_t				0.5*				0.5*				0.8***				0.2			
				(2.04)				(2.21)				(3.75)				(0.60)			
lty_t					0.8**				0.8**				1.4***				0.5		
					(3.02)				(3.06)				(4.80)				(1.46)		
tms_t						0.6				0.6				0.6				0.5	
						(0.99)				(0.92)				(0.98)				(1.05)	
dfy_t							6.0**				6.7**				6.1**				4.6**
							(3.26)				(3.16)				(3.13)				(2.70)
Constant	-0.5	1.9	11.4***	3.0	-0.09	3.8*	-1.4	-3.7	-7.2	-1.5	-11.0*	-20.1*	-34.0***	2.4	-6.4	9.9**	5.6	10.2***	3.8
	(-0.11)	(0.24)	(5.11)	(1.94)	(-0.04)	(2.54)	(-0.67)	(-0.86)	(-1.57)	(-0.32)	(-2.13)	(-2.29)	(-3.60)	(0.29)	(-0.77)	(2.77)	(1.28)	(4.16)	(1.18)
$\bar{R}^2$(%)	1.6	-0.1	8.5	4.2	8.7	1.0	11.6	6.4	11.2	2.4	15.7	8.2	16.4	0.8	11.8	8.7	10.3	9.3	13.8
t-ols(β_1)	3.06	0.85	7.03	4.89	7.13	2.48	8.35	3.67	3.98	2.98	5.14	4.88	7.04	0.39	1.42	5.16	3.22	6.98	3.81
t-ols(β_2)								5.29	7.59	2.38	9.41	6.92	10.21	2.36	8.43	1.46	3.40	2.35	5.79
Months	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525

The univariate [bivariate] regressions have the form

$$USD_{t+12} = \beta_0 + \beta_1 x_{1,t} + \left[\beta_2 x_{2,t}\right] + \epsilon_{t+12},$$

where USD_{t+12} is the 1-year return of the dollar carry trade strategy. In the bivariate regressions, x_1 is one of the macro-finance state variables: The cross-sectional spreads in investment, iv_{sp}, profitability, op_{sp}, or BM, bm_{sp}; and x_2 is one of the interest-rate state variables: The T-bill, tbl, long-term yield, lty, term spread, tms, or default spread, dfy. In the univariate regressions, the regressor is from either group x_1 or x_2. The coefficients have Newey and West (1987) t statistics in parentheses, with 12 lags, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The lower panel shows the uncorrected t statistics of the respective coefficients, t-ols(β_1) and t-ols(β_2), the number of months, and the adjusted R^2.

Summary: There is pervasive evidence in line with Lemma 2 (and Corollary 2.1) that dollar carry risk premiums covary positively with the price of risk in the U.S.: Most of the slopes in the table are significant; all point estimates are positive; and the R^2's can be above 16%.

models that include the dfy or the lty (half of the models) have R^2 above 10%. More generally, half of the estimated slopes in these models is significant.

In Table 3, all models include the proxy variable for the price of risk, bm_{sp}, in addition to x_1, a proxy variable for the (quantity of) risk (iv_{sp} or op_{sp}), in multivariate regressions of the form

$$USD_{t+12} = \beta_0 + \beta_{bm}\, bm_{sp,t} + \beta_1\, x_{1,t} + \left[\beta_2\, x_{2,t}\right] + \epsilon_{t+12}. \tag{28}$$

Models (3) to (10) also includes a third regressor x_2 – one of the four interest-rate state variables (tbl, lty, tms, dfy).

Only eight slope coefficients are insignificant among the 28 in Table 3: Three are for the op_{sp} and two for the tms. All R^2's are above 10% and all models have at least one significant coefficient. The iv_{sp} is significant in all models, and the bm_{sp} is only insignificant in the presence of the lty and op_{sp}, in model (8), which otherwise has the second largest R^2, 17.8% (model (6) has the largest R^2, 20.7%).

In summary, Tables 2 and 3 provide pervasive in-sample evidence that dollar carry risk premiums covary positively with the state variables. This fits Lemma 2 (and Corollary 2.1) in which these variables are proxies for the price of risk in the U.S..

4.2 Recursive OOS evidence

This section follows de Oliveira Souza (2020b) and analyzes the recursive OOS performance of the significant models from Section 4.1. In particular, the fitness of the recursive OOS forecast implementation of the model is important for actual investment purposes – discussed in more detail in Section 4.2.1 – and to eliminate any possible finite sample bias in the estimated coefficients (Stambaugh, 1999). The main idea is to run all regressions on training samples that exclude the return that is ultimately forecast, as in Welch and Goyal (2008), for example.

Table 3: Multivariate predictive regressions for annual dollar carry returns in February 1976–September 2020.

	USD_{t+12}									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$bm_{sp,t}$	9.9***	9.1***	9.4**	7.6*	9.8***	6.8**	7.0*	4.1	8.9***	6.0*
	(3.61)	(3.62)	(3.01)	(2.32)	(3.49)	(2.61)	(2.58)	(1.47)	(3.49)	(2.49)
$iv_{sp,t}$	0.9*		0.9*	0.9*	0.9*	1.0**				
	(2.47)		(2.42)	(2.29)	(2.44)	(2.79)				
$op_{sp,t}$		1.0					1.7**	2.1***	0.9	0.8
		(1.60)					(2.68)	(3.43)	(1.48)	(1.38)
tbl_t			0.09				0.5*			
			(0.35)				(2.02)			
lty_t				0.3				1.1**		
				(1.02)				(3.14)		
tms_t					0.5				0.4	
					(0.92)				(0.74)	
dfy_t						4.9**				4.3*
						(2.79)				(2.58)
Constant	2.2	-1.7	1.5	-1.2	1.3	-6.2	-14.8	-28.2**	-1.4	-6.4
	(0.55)	(-0.20)	(0.33)	(-0.24)	(0.33)	(-1.33)	(-1.61)	(-2.86)	(-0.16)	(-0.75)
$\bar{R}^2$(%)	14.7	10.9	14.7	15.5	15.3	20.7	13.5	17.8	11.1	15.3
t-ols(β_{bm})	9.04	8.07	7.18	5.26	8.95	5.84	5.73	3.10	7.84	4.81
t-ols(β_1)	6.28	3.88	6.15	5.78	6.18	6.81	5.48	6.98	3.45	3.23
t-ols(β_2)			0.81	2.41	2.09	6.35	4.09	6.71	1.57	5.35
Months	525	525	525	525	525	525	525	525	525	525

The regressions have the form

$$USD_{t+12} = \beta_0 + \beta_{bm}\, bm_{sp,t} + \beta_1\, x_{1,t} + \left[\beta_2\, x_{2,t}\right] + \epsilon_{t+12},$$

where USD_{t+12} is the 1-year return of the dollar carry trade strategy; bm_{sp} is the BM spread; x_1 is a second macro-finance state variable – the spread in investment, iv_{sp}, or profitability, op_{sp}; and x_2 is an interest-rate state variable – the T-bill, tbl, long-term yield, lty, term spread, tms, or default spread, dfy. The coefficients have Newey and West (1987) t statistics in parentheses, with 12 lags, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The lower panel shows the uncorrected t statistics of the respective coefficients, t-ols(β_{bm}), t-ols(β_1) and t-ols(β_2), number of months, and adjusted R^2.
Summary: There is pervasive evidence in line with Lemma 2 (and Corollary 2.1) that dollar carry risk premiums covary positively with the price of risk in the U.S.: All but 8 slope coefficients are significant, all point estimates are positive, and the R^2's can be above 20%.

I only report OOS statistics for the significant bivariate models based on the investment spread, in Fig. 2, because the conclusions are similar for the other models.[10] For each model, I split the full February 1976–September 2020 sample into training and evaluation subsamples each month. The statistics are always calculated exclusively in the evaluation sample. And each point in the horizontal axis in the graphs corresponds to a different date used to split the full sample into training and evaluation. This confirms the robustness of the findings in different test samples.

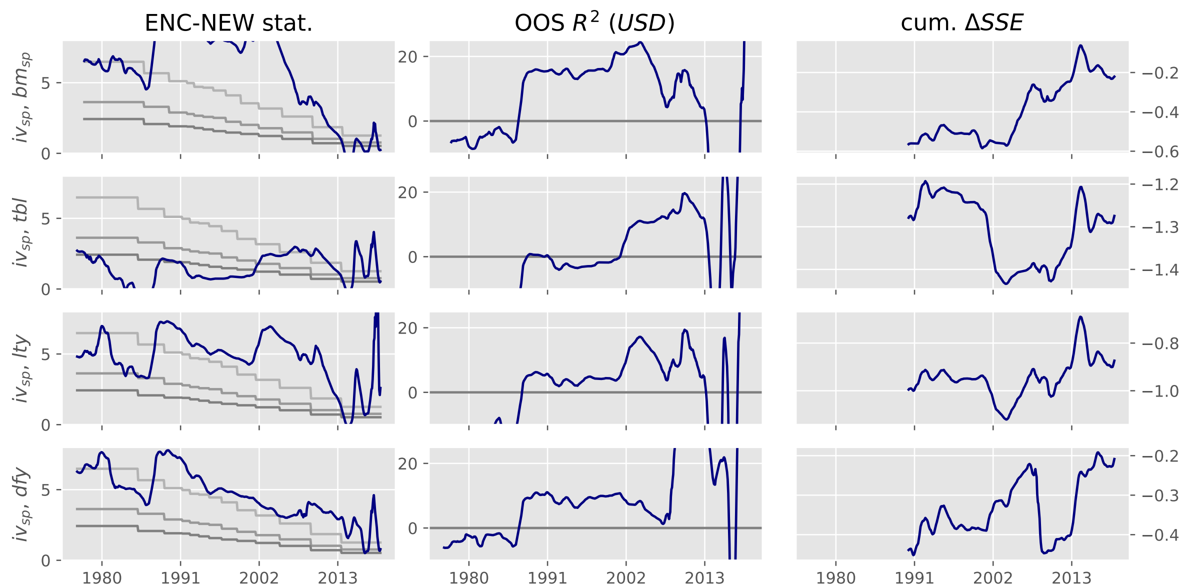

Figure 2: Out-of-sample statistics by sample split date for recursive bivariate forecasts of the dollar carry risk premium based on the investment spread and additional variables in January 1976 (1991)–September 2020.

For each model (per row), the columns show (i) the ENC-NEW encompassing test statistic of Clark and McCracken (2001), where the kinked gray lines are the critical values at 1, 5, and 10 percent (from the highest/lightest line to the lowest/darkest); (ii) OOS R^2 by sample split date; and (iii) the cumulative sum of squared forecasting errors of the historical mean minus the one from each model starting in 1991, ΔSSE: An increase between two points in ΔSSE indicates that the model outperforms the historical mean. There are often more extreme values outside the bounds in the graphs (for scaling reasons). The (pair of) regressors are shown in the graphs.

Summary: The same pervasive in-sample evidence exists OOS for a wide range of sample split dates: The models are often significant at 1 percent, in (i); with positive OOS R^2's, in (ii); and positive overall drift in ΔSSE, in (iii).

[10]These extra results in annual frequency are in Appendix E, while Appendix D.1.1 contains similar results in monthly frequency.

Quantitative inference: I assess predictability based on the forecast encompassing test for nested models in Clark and McCracken (2001), ENC-NEW, with Newey and West (1987) standard errors with 12 lags, as in Kelly and Pruitt (2013). I report the test statistics along with their respective critical values over a wide range of alternative split dates between 1976 and 2020. The critical values depend on the size of the training and evaluation samples: I display these values in the graphs for 1, 5, and 10 percent (the kinked gray lines from the highest/lightest line to the lowest/darkest).

Two models are nested if one of them contains all the terms of the other, plus at least one additional term. Hence we can define the model proposed as the "larger" model and the historical mean (only the intercept) as the "reduced" model. The null hypothesis in the ENC-NEW test is that the extra regressors in the larger models have no predictive content. Hence, the test is one-sided and a rejection indicates that the regressors in the models are, indeed, valid.

The ENC-NEW graphs in Fig. 2 show that all models are significant at least at 5 percent – and often at 1 percent – for almost every split date. The exception is model (iv_{sp}, tbl), which is only significant for split dates around 2007. The results for the remaining significant models from Section 4.1 are only included in Appendix E, but they are similar. The similarities include the fact that the models that rely on the tbl tend to be insignificant for many split dates.

Qualitative information in the OOS R^2: The ENC-NEW test is not exactly based on comparing the mean squared error (MSE) of the forecasts from the two models. For this type of qualitative OOS analysis, I also report the predictive OOS R^2 of the models,

$$OOS\,R^2 = 1 - \frac{MSE_m}{MSE_h}. \tag{29}$$

The OOS R^2 increases with the ratio between the mean squared forecasting error of the model, MSE_m, based on the vector of rolling OOS errors from the model and the one associated with the historical average, MSE_h, calculated from the vector of rolling OOS errors based on the historical mean at each point in time. The OOS R^2 can take any value below 1, and negative values mean that the forecast of the model is less accurate than simply using the historical mean return.

In finite samples, the OOS R^2 is negative under the null hypothesis of no predictability, **not** zero (Clark and West, 2006). Hence, a negative OOS R^2 is not the same as no predictability (which I test as in Clark and McCracken, 2001). The OOS R^2 is simply about forecasting accuracy. Nevertheless, all models have mostly positive OOS R^2 in Fig. 2. This includes model (iv_{sp}, tbl). The difference is that model (iv_{sp}, tbl) only has positive performance for sample split dates after 2002, compared to earlier than 1990 for the remaining models in these graphs. Again, the results are similar for the unreported models (in Appendix E).

Qualitative information in ΔSSE: A further qualitative tool to evaluate the forecasting performance of the models is the cumulative sum of squared forecasting errors of the historical mean minus the one from each model, the cumulative ΔSSE, as in Welch and Goyal (2008). Increases in the line imply that the model in question predicts better than the historical mean in that time interval. Otherwise, the mean is a better prediction. Hence, it is possible to adjust starting and ending dates and check the performance of the models in different subperiods.

For example, models (iv_{sp}, bm_{sp}) and (iv_{sp}, dfy) seem more robust from this perspective: Almost any value in the ΔSSE graph after 2002 is above any value before 2002 for model (iv_{sp}, bm_{sp}), which shows that the model outperforms the historical mean for many different ending dates as well (not only for different split/starting dates). In fact, this is a general pattern in all graphs, even if it is less clear in some graphs. The biggest difference is model (iv_{sp}, tbl), in which the positive drift starts later.

4.2.1 Returns and Sharpe ratios out of sample

Finally, this section shows that a recursive OOS implementation of the models generates economically significant results. Again, I consider all models that have at least one significant coefficient in sample in Tables 2 and 3.[11] The recursive predictions of each model, individually, partition the sample into periods of above or below average risk premium forecasts. And I calculate the performances over those months.

For a given model, the "high premium" strategy, "+", invests $\omega_{+,t} = 1$ dollar in the dollar carry portfolio **for one year** whenever the expected dollar carry premium for the next year is "high", above its prevailing historical mean given by

$$\overline{USD}_t = \frac{1}{t}\sum_{s=1}^{t} USD_s, \tag{30}$$

where USD_t is given by Eq. (6). The strategy invests nothing otherwise,

$$\omega_{+,t} = \begin{cases} 1, & \mathrm{E}_t[USD_{t+12}] > \overline{USD}_t \\ 0, & \mathrm{E}_t[USD_{t+12}] \leq \overline{USD}_t. \end{cases} \tag{31}$$

For the calculations, I assume that all returns only happen in annual frequency: The realized annual return each month is either 0 or the accumulated return from implementing the dollar carry trade for all previous 12 months,

$$USD_{+,t} = \omega_{+,t-12}\, USD_t. \tag{32}$$

For the same model, the opposite, "low premium", strategy has return

$$USD_{-,t} = \left(1 - \omega_{+,t-12}\right) \times USD_t. \tag{33}$$

Hence, every model generates a "high premium" and a "low premium" strategy. The relevant question is whether the model *identifies* high and low premium periods (reflected by the difference in performance of the two strategies).

[11] The online appendix A considers all models, and Appendix D.1 shows the results in monthly frequency.

Table 4: Average realized annual dollar carry returns and Sharpe ratios in periods recursively predicted (OOS) to have above or below average risk premiums – in January 1992–September 2020.

			$\overline{USD}_-$		$\overline{USD}_+$		SR_-		SR_+		N_-	N_+
		bm_{sp}	3.25	(1.18)	7.56	(2.09)	0.45	(0.18)	0.83	(0.25)	300	33
		tbl	3.67	(1.19)	-	(-)	0.48	(0.18)	-	(-)	333	-
		lty	3.67	(1.19)	-	(-)	0.48	(0.18)	-	(-)	333	-
		dfy	2.35	(1.15)	8.22	(2.00)	0.34	(0.20)	1.00	(0.23)	258	75
	iv_{sp}	bm_{sp}	3.01	(1.27)	6.62	(1.90)	0.41	(0.20)	0.87	(0.13)	272	61
		tbl	3.67	(1.36)	3.69	(1.71)	0.46	(0.22)	0.77	(0.29)	290	43
		lty	3.65	(1.19)	-	(-)	0.48	(0.18)	-	(-)	332	-
		dfy	1.76	(1.16)	8.33	(1.46)	0.27	(0.20)	1.06	(0.16)	236	97
	op_{sp}	bm_{sp}	2.08	(1.49)	5.26	(1.68)	0.30	(0.25)	0.66	(0.29)	166	167
		tbl	3.62	(1.55)	3.76	(1.40)	0.45	(0.20)	0.55	(0.23)	212	121
		lty	3.08	(1.27)	7.65	(1.02)	0.40	(0.17)	1.37	(0.40)	290	43
		dfy	1.81	(1.28)	6.21	(1.80)	0.28	(0.25)	0.76	(0.26)	192	141
	bm_{sp}	tbl	3.59	(1.23)	4.98	(2.41)	0.48	(0.19)	0.56	(0.30)	314	19
		lty	3.58	(1.22)	6.08	(3.16)	0.47	(0.19)	0.78	(0.01)	321	12
		tms	3.65	(1.32)	3.80	(2.03)	0.48	(0.20)	0.51	(0.24)	277	56
		dfy	2.62	(1.16)	7.01	(2.36)	0.38	(0.18)	0.81	(0.30)	253	80
bm_{sp}	iv_{sp}	tbl	3.36	(1.35)	5.27	(1.48)	0.43	(0.21)	0.85	(0.00)	278	55
		lty	3.43	(1.30)	5.63	(2.18)	0.45	(0.20)	0.81	(0.22)	296	37
		tms	2.58	(1.32)	7.19	(1.86)	0.35	(0.19)	1.04	(0.15)	254	79
		dfy	1.94	(1.20)	8.64	(1.83)	0.28	(0.18)	1.22	(0.26)	247	86
	op_{sp}	tbl	1.94	(1.44)	6.53	(1.45)	0.26	(0.20)	0.93	(0.22)	207	126
		lty	2.71	(1.35)	6.67	(1.70)	0.36	(0.19)	0.99	(0.30)	252	81
		tms	2.33	(1.42)	5.24	(1.85)	0.35	(0.25)	0.63	(0.31)	179	154
		dfy	1.50	(1.30)	6.67	(1.52)	0.23	(0.23)	0.85	(0.18)	193	140

The forecasting models (from Tables 2 and 3) are based on up to 3 regressors (in the first columns): The spreads in BM, bm_{sp}, investment, iv_{sp}, or profitability, op_{sp}; the T-Bill, tbl, long-term yield, lty, term spread, tms, or default spread, dfy. $\overline{USD}$ is the average realized return of the dollar carry strategy and SR is the Sharpe ratio (both annualized). The subscripts +/- indicate the periods in which the premium was predicted (recursively, OOS) to be above/below the prevailing average. N is the number of months that fall in each of these groups. Standard errors (in parentheses) are Newey and West (1987) with 12 lags (dropping missing values) for returns, and for the Sharpe ratios they are given by the delta method (with Andrews (1991) covariance matrix, and dropping missing values). **Summary:** All models correctly forecast risk premiums and Sharpe ratios OOS. Eight models pin down the small number of months responsible for the entire premium (ten models, if based on Sharpe ratios). For example, model (bm_{sp}, iv_{sp}, dfy) identifies a small group of 86 months with mean return of 8.64% and Sharpe ratio of 1.22. The premium and Sharpe ratio in the remaining 247 months are insignificant.

For the period between January 1992 and September 2020, Table 4 shows the average return, $\overline{USD}$, Sharpe ratio, SR, and the number of months, N, (with $\omega \neq 0$) in which the strategy has a long dollar carry position. For example, the high premium strategy has

$$N_{+} = \sum_{s=1}^{T} \omega_{+,s-12}, \tag{34}$$

where T is the total number of months in the sample (the low premium strategy has N_{-} based on $1-\omega_{+,s-12}$, instead). And the average return (or Sharpe ratio) is calculated only over these months,

$$\overline{USD}_{+} = \frac{1}{N_{+}} \sum_{s=1}^{T} USD_{+,s}. \tag{35}$$

For mean returns, I report Newey and West (1987) standard errors with 12 lags, after dropping missing values. For Sharpe ratios, I report standard errors given by the delta method, with covariances corrected by Andrews (1991) and also dropping missing values.[12]

Table 4 displays the results for 24 models with up to three regressors, shown in the first columns. In all of them, the high premium strategy delivers larger average returns, $\overline{USD}_{+}$, and Sharpe ratios, SR_{+} (naturally, when $N_{+} \neq 0$). The largest of these Sharpe ratios is 1.37 and several are above 1. For the same models, the Sharpe ratios of the low premium strategy, SR_{-}, are always lower than 0.5, and are usually less than half of their high premium counterparts. A similar pattern exists for returns.

In eight models, the low premium strategy – which accounts for most of the sample – delivers insignificant returns, $\overline{USD}_{-} \approx 0$. And in ten models, its Sharpe ratio is insignificant, $SR_{-} \approx 0$. This is especially true for the multivariate models that include a proxy variable for the price of risk (the bm_{sp}); another for risk (the iv_{sp} or op_{sp}); and an interest-rate state variable, especially the dfy. All these models accurately pin down a few high premium periods responsible for the entire dollar carry premium.

[12]These adjustments tend to inflate the standard errors relative to the uncorrected values. However, a few of them can be deflated because the returns are not consecutive (in time-series). Indeed, this happens in Table 4 with the standard errors of the Sharpe ratios of models (bm_{sp}, iv_{sp}, tbl) and (bm_{sp}, lty).

In two models, the high premium strategy delivers insignificant returns, $\overline{USD}_+ \approx 0$: Model ($bm_{sp}$, lty), in which only 12 months are "high premium" ($N_+ = 12$); and model (bm_{sp}, tms), with $N_+ = 56$. Nevertheless, even these models have significant Sharpe ratios for the high premium strategy, $SR_+ > 0$.

Finally, only a small fraction of the return predictions tends to be above average. This reflects the fact that dollar carry trade risk premiums have decreased over time in the sample.

5 Other carry trade risk premiums

The predictability documented above is restricted to dollar carry risk premiums: It does not extend to dollar-neutral carry nor to foreign currency carry risk premiums. While the former result is consistent with the model of Lustig et al. (2014), the later is difficult to conciliate with the hypothesis that the AFD is directly proportional to the price of risk in the U.S. (and that this would determine the risk premium of foreign currencies). Section 3 offers an alternative reduced-form model that can rationalize the findings that I present. Overall, the evidence partially supports Lustig et al. (2014) and partially challenges the model, similar to the conclusions in Daniel et al. (2017), for example.

5.1 Dollar-neutral risk premiums are independent of the state of the U.S. economy

This section supports the idea in Lustig et al. (2014) that the U.S. (risk or) price of risk states are uncorrelated with dollar-neutral carry risk premiums (which would be affected by global economic conditions, instead). Indeed, I find no evidence that dollar-neutral risk premiums are correlated with proxy variables for the (quantity of) risk and price of risk states of the U.S. economy: Each of the 59 coefficients investigated in the previous section is insignificant in predictive regressions of dollar-neutral returns.

Table 5: Predictive regressions for annual dollar-neutral carry returns in February 1976–September 2020.

	$0D_{t+12}$																		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
$iv_{sp,t}$	-0.2							-0.2	-0.2	-0.2	-0.2								
	(-0.51)							(-0.41)	(-0.41)	(-0.49)	(-0.42)								
$op_{sp,t}$		-0.5										-0.1	-0.08	-0.5	-0.5				
		(-0.80)										(-0.12)	(-0.09)	(-0.75)	(-0.76)				
$bm_{sp,t}$			3.6													2.5	2.4	3.6	3.8
			(1.17)													(0.69)	(0.62)	(1.19)	(1.08)
tbl_t				0.3				0.3				0.3				0.2			
				(1.32)				(1.28)				(0.99)				(0.70)			
lty_t					0.4				0.3				0.3				0.2		
					(1.30)				(1.25)				(0.90)				(0.59)		
tms_t						-0.3				-0.2				-0.2				-0.3	
						(-0.45)				(-0.44)				(-0.30)				(-0.52)	
dfy_t							0.9				0.7				0.8				-0.2
							(0.53)				(0.40)				(0.46)				(-0.11)
Constant	5.5	10.6	5.9*	1.5	0.5	3.4*	1.8	3.7	2.7	6.0	4.4	3.1	1.8	10.4	9.4	4.1	3.6	6.5*	6.3
	(1.02)	(1.03)	(2.10)	(1.24)	(0.28)	(2.02)	(0.78)	(0.70)	(0.51)	(1.06)	(0.67)	(0.23)	(0.12)	(1.03)	(0.85)	(1.12)	(0.77)	(2.18)	(1.31)
$\bar{R}^2$(%)	0.2	0.6	1.8	1.6	1.6	0.0	0.1	1.7	1.7	0.2	0.2	1.4	1.4	0.6	0.7	2.1	1.9	1.9	1.6
t-ols(β_1)	-1.48	-2.10	3.26	3.08	3.09	-1.10	1.23	-1.18	-1.18	-1.44	-1.25	-0.32	-0.25	-1.93	-2.03	1.90	1.65	3.30	3.02
t-ols(β_2)								2.94	2.96	-1.04	0.96	2.26	2.27	-0.72	1.11	1.59	1.30	-1.22	-0.27
Months	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525

The univariate [bivariate] regressions have the form

$$0D_{t+12} = \beta_0 + \beta_1 x_{1,t} + \left[\beta_2 x_{2,t}\right] + \epsilon_{t+12},$$

where $0D_{t+12}$ is the 1-year return of the dollar-neutral carry trade strategy. In the bivariate regressions, x_1 is one of the macro-finance state variables: The cross-sectional spreads in investment, iv_{sp}, profitability, op_{sp}, or BM, bm_{sp}; and x_2 is one of the interest-rate state variables: The T-bill, tbl, long-term yield, lty, term spread, tms, or default spread, dfy. In the univariate regressions, the regressor is from either group x_1 or x_2. The coefficients have Newey and West (1987) t statistics in parentheses, with 12 lags, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The lower panel shows the uncorrected t statistics of the respective coefficients, t-ols(β_1) and t-ols(β_2), the number of months, and the adjusted R^2.
Summary: There is no evidence that dollar-neutral risk premiums change with the state of the U.S. economy, in line with Lemma 3 (and Corollary 3.1): None of the 31 slope coefficients in the table is significant (or close to, even at the 10 percent level).

Table 6: Multivariate predictive regressions for annual dollar-neutral carry returns in February 1976–September 2020.

	$0D_{t+12}$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$bm_{sp,t}$	3.5	3.2	2.2	2.0	3.5	3.6	2.5	2.4	3.3	3.3
	(1.15)	(0.97)	(0.63)	(0.55)	(1.18)	(1.10)	(0.69)	(0.62)	(1.01)	(0.92)
$iv_{sp,t}$	-0.06		-0.09	-0.10	-0.05	-0.06				
	(-0.14)		(-0.20)	(-0.23)	(-0.11)	(-0.14)				
$op_{sp,t}$		-0.3					-0.05	-0.1	-0.2	-0.3
		(-0.37)					(-0.06)	(-0.11)	(-0.28)	(-0.37)
tbl_t			0.2				0.2			
			(0.72)				(0.55)			
lty_t				0.2				0.2		
				(0.64)				(0.38)		
tms_t					-0.3				-0.3	
					(-0.52)				(-0.45)	
dfy_t						-0.2				-0.1
						(-0.11)				(-0.06)
Constant	6.5	9.3	4.9	4.3	7.0	6.9	4.9	5.3	9.0	9.4
	(1.18)	(0.90)	(0.85)	(0.68)	(1.23)	(0.94)	(0.36)	(0.32)	(0.89)	(0.85)
$\bar{R}^2$(%)	1.6	1.8	2.0	1.8	1.7	1.5	1.9	1.8	1.8	1.6
t-ols(β_{bm})	2.92	2.65	1.58	1.29	2.97	2.76	1.88	1.65	2.76	2.41
t-ols(β_1)	-0.36	-0.95	-0.54	-0.60	-0.29	-0.37	-0.17	-0.32	-0.70	-0.92
t-ols(β_2)			1.64	1.38	-1.20	-0.29	1.28	0.93	-1.04	-0.14
Months	525	525	525	525	525	525	525	525	525	525

The regressions have the form

$$0D_{t+12} = \beta_0 + \beta_{bm}\, bm_{sp,t} + \beta_1\, x_{1,t} + \left[\beta_2\, x_{2,t}\right] + \epsilon_{t+12},$$

where $0D_{t+12}$ is the 1-year return of the dollar-neutral carry trade strategy; bm_{sp} is the BM spread; x_1 is a second macro-finance state variable – the spread in investment, iv_{sp}, or profitability, op_{sp}; and x_2, when included, is an interest-rate state variable – the T-bill, tbl, long-term yield, lty, term spread, tms, or default spread, dfy. The coefficients have Newey and West (1987) t statistics in parentheses, with 12 lags, $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$. The lower panel shows the uncorrected t statistics of the respective coefficients, t-ols(β_{bm}), t-ols(β_1) and t-ols(β_2), number of months, and adjusted R^2.
Summary: There is no evidence that dollar-neutral risk premiums change with the state of the U.S. economy, in line with Lemma 3 (and Corollary 3.1): None of the 28 slope coefficients in the table is significant (or close to, even at the 10 percent level).

Tables 5 and 6 are equivalent to Tables 2 and 3. However, the returns on dollar-neutral carry trade portfolios, $0D_{t+12}$, replace dollar carry returns, USD_{t+12}, as the forecasting target in the models in Eqs. (26), (27) and (28). Everything else is exactly the same. The result is that none of the coefficients in Tables 5 and 6 is even close to the 10 percent significance level. Indeed, several of them have negative point estimates, in opposition to the positive association between the same variables and the dollar carry risk premiums. Even the models in Table 6, which include a proxy variable for the price of risk, bm_{sp}; a proxy variable for risk, iv_{sp} or op_{sp}; and an interest-rate variable, generate insignificant coefficients.

5.2 Foreign currency carry risk premiums are not directly related the state of the U.S. economy

This section finds no evidence that the risk and price of risk states in the U.S. are directly correlated with the risk premiums of foreign currency carry portfolios, as opposed to being directly correlated to the risk premium of *dollar carry portfolios*. The difference is that dollar carry portfolios oscillate between exposures to dollars or to foreign currencies over time: Often, their risk premiums are exactly the *negative* of the risk premium on foreign currency carry portfolios, as Eq. (5) shows.

First, I investigate the information in the AFD about foreign currency carry premiums by running predictive monthly frequency regressions of the form

$$fx_{t+1} = \alpha + \beta AFD_t + \epsilon_{t+1}, \tag{36}$$

where fx_t and AFD_t are, respectively, the carry trade return on the basket of foreign currencies in Eq. (3), and AFD is given by Eq. (4). I estimate this equation unconditionally or conditioned on the AFD being negative or positive. In these last two cases, I also compute the conditional means of the AFD and the subsequent return on foreign currencies.

Table 7 shows that there is some information in the AFD about the risk premium of foreign currency carry, apart from its sign, but only when the AFD is negative (a little over 40% of the sample). Essentially, this happens because the AFD is a minor fraction of the total return of the dollar carry strategy: The conditional means of the foreign currency carry returns, in (3) and (6), are more than 2.5 times the ones for their respective AFD, in (4) and (7). The majority of the premium comes from subsequent changes in the exchange rate. These movements tend to amplify a negative AFD, which is just significant in model (5), but they are mostly uncorrelated with a positive AFD, in model (2). Hence, the significance of the slope and the R^2 in (1) are largely driven by the sign of AFD_t.[13]

Table 7: Conditional or unconditional predictive regressions of foreign currency carry returns, fx_{t+1}, on the AFD, AFD_t – and conditional means of both variables – in January 1976–September 2020.

	All	$AFD_t > 0$			$AFD_t < 0$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	fx_{t+1}	fx_{t+1}	fx_{t+1}	AFD_t	fx_{t+1}	fx_{t+1}	AFD_t
AFD_t	2.0***	0.2			2.6*		
	(3.99)	(0.18)			(2.05)		
Constant	0.08	4.6	4.9**	1.9***	-0.3	-4.7**	-1.7***
	(0.07)	(1.81)	(3.13)	(21.82)	(-0.11)	(-2.65)	(-18.51)
Months	536	306	306	306	230	230	230
R^2	0.029	0.000	0.000	0.000	0.018	0.000	0.000

The estimated equations (with returns in %) have the general form

$$fx_{t+1} = \alpha + \beta AFD_t + \epsilon_{t+1},$$

where α and β are the parameters reported, except in models (3) and (6) – conditional means of foreign currency carry returns – and in models (4) and (7) – conditional means of the (lagged) AFD, AFD_t. The coefficients in (1) are unconditional; in (2) to (4), they are conditional on a positive lagged AFD; and in (5) to (7), AFD_t is negative. The table shows the number of months, R^2, and coefficients with t statistics in parentheses, $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$.

Summary: The significant slope and R^2 in (1) are mostly driven by the sign of AFD_t, while its magnitude is important when negative: The slope in (2) is insignificant, but not in (5). The AFD is a minor fraction of the risk premium (relative to currency movements): The conditional means in (3) and (6) are more than 2.5 times the ones in (4) and (7).

[13] Appendix F shows that the AFD (in absolute value) does not forecast the dollar carry trade return, either.

Finally, I investigate the relation between foreign currency carry premiums and the state variables in the previous sections. Table 8 is equivalent to Table 2 with two differences: (i) Foreign currency carry returns, fx_{t+12}, replace dollar carry returns, USD_{t+12}, as the forecasting target in the models in Eqs. (26) and (27); and (ii) I include the AFD as a single regressor in Eq. (26), or as a third regressor in Eq. (27). The result are models of the form

$$fx_{t+12} = \beta_0 + \beta_1 x_{1,t} + \left[\beta_2 x_{2,t} + \beta_{fs} AFD_t\right] + \epsilon_{t+12}, \tag{37}$$

where only models (9) to (20) contain the regressors in brackets.

Table 8 shows that the AFD is significant in all models, which confirms the original results in Lustig et al. (2014). However, the evidence fits the interpretation in Lemma 1 (and Corollary 1.1) more closely: Foreign currency carry returns are largely uncorrelated with the state variables that proxy for the economic states in the U.S.: None of the macro-finance state variables is significant. Indeed, the bm_{sp} has a negative point estimate in model (20). Only the tms is significant in the univariate regression (6), but insignificant in all multivariate regressions, (11), (15), and (19). And the coefficients of the other interest-rate variables also have negative point estimates in several cases.

6 Conclusion

In this paper we learn that dollar carry trade risk premiums are positively correlated, in sample and out of sample, with firm-level dispersions in investment, profitability, and book-to-market; and with interest-rate variables, tbl, lty, tms, and dfy. This fact is consistent with these variables being proxies for the latent (quantity of) risk and price of risk states – and the business cycle – in the U.S..

In addition, we learn that the correlations above are non-existent for dollar-neutral risk premiums. And we learn that foreign currency carry risk premiums are also distinct from dollar carry risk premiums in this respect: None of the variables above is directly correlated with foreign currency carry premiums either (except for a non-robust relation with the

Table 8: Predictive regressions for annual returns on foreign currencies in February 1976–September 2020.

	fx_{t+12}																			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
$iv_{sp,t}$	0.4								0.5	0.5	0.5	0.6								
	(0.73)								(0.98)	(0.99)	(1.00)	(1.19)								
$op_{sp,t}$		0.5											1.2	1.2	0.9	0.9				
		(0.61)											(1.31)	(1.35)	(1.33)	(1.48)				
$bm_{sp,t}$			1.1														1.7	1.6	0.2	-1.2
			(0.27)														(0.50)	(0.48)	(0.05)	(-0.38)
tbl_t				-0.5					-0.1				0.2				-0.2			
				(-1.39)					(-0.40)				(0.39)				(-0.66)			
lty_t					-0.3					-0.09				0.2				-0.2		
					(-0.54)					(-0.25)				(0.45)				(-0.52)		
tms_t						1.8**					0.4				0.1				0.4	
						(2.78)					(0.52)				(0.17)				(0.55)	
dfy_t							0.9					2.2				1.8				2.0
							(0.30)					(0.96)				(0.83)				(0.84)
AFD_t								21.5***	20.9***	21.4***	20.1***	21.9***	23.3***	22.8***	21.7***	22.5***	20.0***	20.9***	19.8***	21.9***
								(4.76)	(4.18)	(4.66)	(4.01)	(4.94)	(4.14)	(4.62)	(4.26)	(4.95)	(3.82)	(4.43)	(3.82)	(4.90)
Constant	-4.5	-6.6	1.8	3.1	2.6	-3.0	-0.10	0.2	-4.7	-4.8	-6.1	-8.9	-17.4	-18.7	-12.4	-15.3	2.7	3.1	-0.5	-3.0
	(-0.63)	(-0.53)	(0.46)	(1.64)	(0.86)	(-1.83)	(-0.03)	(0.18)	(-0.84)	(-0.81)	(-1.12)	(-1.40)	(-1.23)	(-1.23)	(-1.36)	(-1.64)	(0.68)	(0.62)	(-0.17)	(-0.73)
$\bar{R}^2$(%)	0.9	0.3	-0.1	2.9	0.4	7.2	-0.0	18.2	19.2	19.1	19.3	20.0	19.5	19.6	19.4	20.0	18.3	18.1	18.1	18.5
t-ols(β_1)	2.41	1.65	0.80	-4.11	-1.79	6.44	0.98	10.83	2.68	2.73	2.74	3.28	3.02	3.26	2.87	3.27	1.09	0.99	0.13	-0.85
t-ols(β_2)									-1.00	-0.67	1.13	2.53	1.06	1.33	0.36	2.13	-1.69	-1.37	1.27	2.07
t-ols(β_{fs})									10.12	10.81	8.63	11.16	10.42	11.24	8.99	11.38	9.22	10.35	8.44	10.98
Months	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525

The univariate [multivariate] regressions have the form

$$fx_{t+12} = \beta_0 + \beta_1 x_{1,t} + \left[\beta_2 x_{2,t} + \beta_{fs} AFD_t\right] + \epsilon_{t+12},$$

where fx_{t+12} is the 1-year return of foreign currencies. In the multivariate regressions, apart from the AFD, AFD_t, x_1 is one of the macro-finance state variables: The cross-sectional spreads in investment, iv_{sp}, profitability, op_{sp}, or BM, bm_{sp}; and x_2 is one of the interest-rate state variables: The T-bill, tbl, long-term yield, lty, term spread, tms, or default spread, dfy. In the univariate regressions, the regressor is any of these variables. The coefficients have Newey and West (1987) t statistics in parentheses, with 12 lags, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The lower panel shows the uncorrected t statistics of the respective coefficients, t-ols(β_1), t-ols(β_2) and t-ols(β_{fs}), the number of months, and the adjusted R^2.

Summary: There is no evidence that the return on foreign currencies is related to the macro-economic states in the U.S., in line with Lemma 1 (and Corollary 1.1): None of the state variable coefficients is significant, except for the tms only in the univariate regression. Only the AFD is significant.

tms). In fact, the evidence is consistent with foreign currencies being a hedge or a risky asset for U.S. investors in different states, while the AFD is an empirical indicator of these states, as I state within a simple no-arbitrage asset pricing framework.

Finally, we learn that several forecasting models pin down the few periods responsible for the entire dollar carry risk premium. And that this predictability generates economically significant investment strategies with strong OOS performance, and Sharpe ratios as large as 1.37, for example, in a sample in which the unconditional Sharpe ratio is 0.44.

Appendix

A Carry trade details

The currencies are the Australian dollar (AUD), the British pound (GBP), the Canadian dollar (CAD), the euro (EUR), which is preceded by the Deutsche mark (DEM), the Japanese yen (JPY), the New Zealand dollar (NZD), the Norwegian krone (NOK), the Swedish krona (SEK), the Swiss franc (CHF), and the U.S. dollar (USD).

The series CAD, DEM, JPY, SEK, CHF, NOK, and USD are denominated in GBP from 1976 until 1985 at the latest, for most currencies. For this period, I divide FCU/GBP quotes by USD/GBP to obtain FCU/USD. The mnemonics for forward rates denominated in GBP are: CNDOL1F, DMARK1F, JAPYN1F, SWEDK1F, SWISF1F, NORKN1F, USDOL1F. The spot rates are: CNDOLLR, DMARKER, JAPAYEN, SWEKRON, SWISSFR, NORKRON, USDOLLR. This is the auxiliary dataset that I use to complete the series of quotes in USD when needed.

I combine different series of quotes in USD (to increase the sample period). When two mnemonics for the same currency exist, the one with the most recent values is the main one (usually these mnemonics end with "1M"). The forward quotes in USD are: BBAUD1F, TDAUD1M, BBCAD1F, USEUR1F, BBDEM1F, TDJPY1M, BBJPY1F, BBSEK1F, TDSEK1M, BBCHF1F, TDCHF1M, BBNZD1F, TDNZD1M, TDNOK1M, BBNOK1F, and BBGBP1F. And the spot quotes are: TDAUDSP, BBCADSP, BBEURSP, BBDEMSP, BBJPYSP, TDSEKSP, BBCHFSP, TDNZDSP, TDNOKSP, BBGBPSP.

Forwards in USD start in 1983 for DEM, JPY, CHF, and GBP, and in 1984 for the other currencies (the EUR starts in 1999). The spot rates are mostly mid prices, but the spot AUD, SEK, NZD, and NOK before 1990 are bid prices.

A.1 Extra figures

Fig. 3 shows the performance of the two carry trade strategies investigated in the main body of the paper. Fig. 4 is the equivalent of Fig. 1, but only in the shorter sample that I use in the estimations.

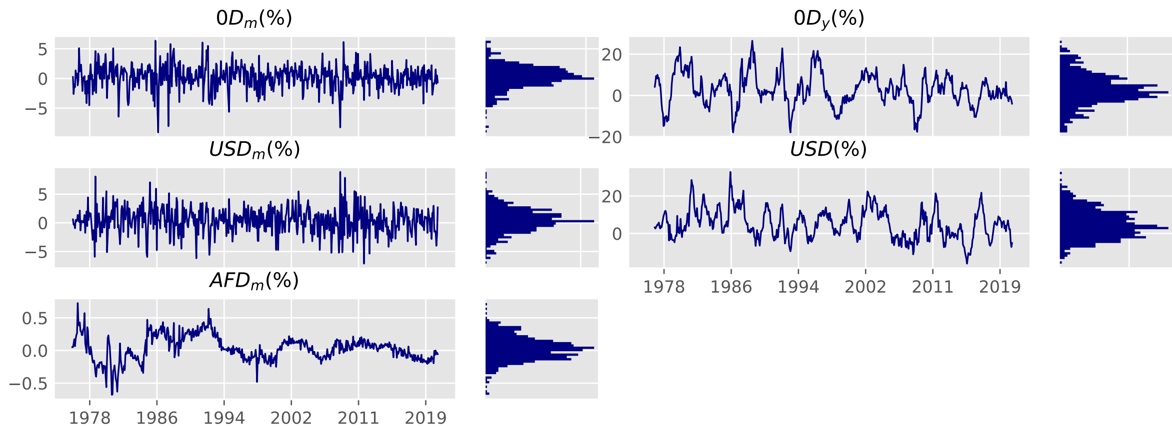

Figure 3: Returns on the dollar carry and dollar neutral portfolios and the AFD between January 1976 and September 2020. The graphs show monthly returns on the right-hand side and annual returns on the left-hand side for the dollar neutral strategy ($0D$, on top), the dollar carry (USD, in the middle). It also shows the (monthly) AFD in the bottom graph. The AFD values are close to one order of magnitude smaller than both monthly returns.

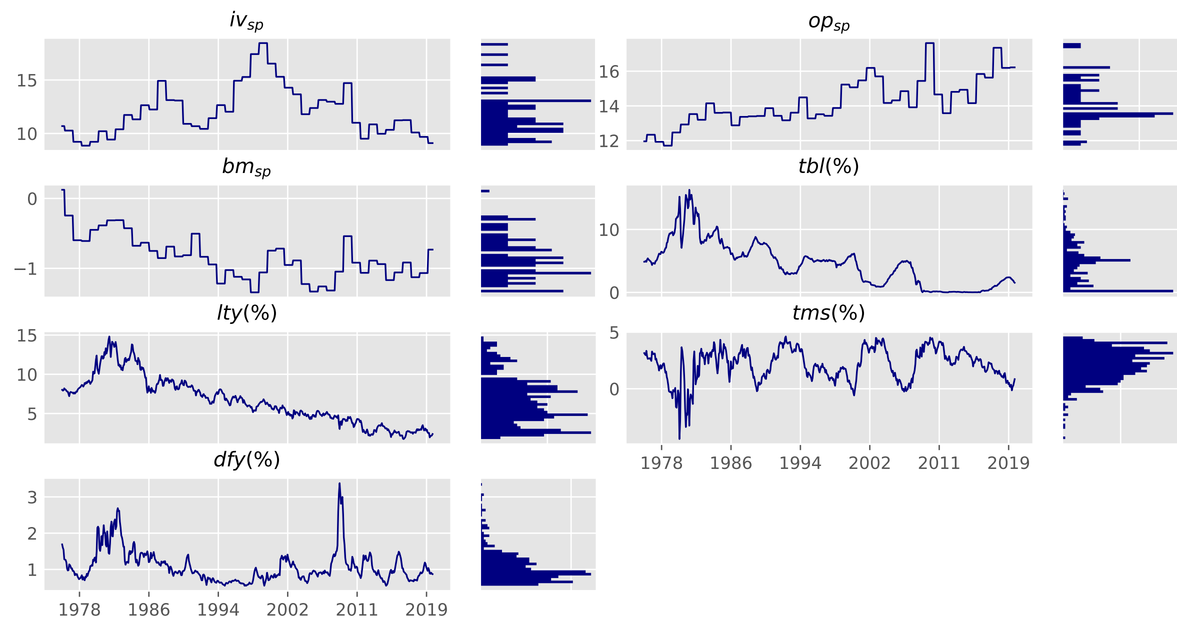

Figure 4: Time series and histogram for each state variable between January 1976 and December 2019. The graphs correspond to the cross-sectional median values of the BM among all NYSE stocks, and the cross-sectional spreads given by the difference in the breakpoints between the 70^{th} and 30^{th} percentiles for the BM, investment, and profitability within the same universe of stocks.

B Further statistical description

Table 9: Descriptive statistics of the state variables

(a) June 1926 (1963)–December 2019

	μ	σ	γ_1	α_4	ADF(lags)	Z_t	p	Obs
iv_{sp}	11.53	2.40	0.72	3.49	1	-2.52	0.11	55
op_{sp}	13.53	1.81	-0.01	2.58	1	-1.54	0.51	55
bm_{sp}	-0.56	0.54	1.45	5.90	1	-2.99	0.04	92
tbl	3.37	3.06	1.11	4.40	1	-2.72	0.07	1121
lty	5.06	2.78	1.12	3.68	1	-1.45	0.56	1121
tms	1.69	1.30	-0.26	3.30	1	-6.37	0.00	1121
dfy	1.12	0.68	2.52	12.17	1	-4.71	0.00	1121

(b) January 1976–December 2019

	μ	σ	γ_1	α_4	ADF(lags)	Z_t	p	Obs
iv_{sp}	12.08	2.33	0.82	3.11	1	-1.82	0.37	42
op_{sp}	14.24	1.34	0.52	2.93	1	-2.24	0.19	42
bm_{sp}	-0.86	0.30	0.29	2.23	1	-2.41	0.14	42
tbl	4.48	3.54	0.73	3.34	1	-2.04	0.27	525
lty	6.60	3.02	0.50	2.57	1	-1.00	0.75	525
tms	2.13	1.45	-0.75	3.88	1	-5.09	0.00	525
dfy	1.08	0.45	1.93	7.83	1	-4.42	0.00	525

Mean, μ, standard deviation, σ, skewness, γ_1, kurtosis, α_4, and Augmented Dickey-Fuller unit root test results: Number of lags, test statistic Z_t, p-value, and number of years/months. Macro-finance state variables – in annual frequency: Cross-sectional spreads in investment, iv_{sp}, profitability, op_{sp}, and BM, bm_{sp} (this one in logs) among NYSE stocks, as the differences between their 70^{th} and 30^{th} percentiles. The interest-rate variables – in monthly frequency – are the T-bill, tbl, the long-term yield, lty, the term spread, tms, and the default spread, dfy, all in percent.
Summary: The evidence against the unit root hypothesis is weak for almost all series from 1976 (Table 9b). But it is stronger for most series as the sample increases (Table 9a), where only the op_{sp} and lty remain (clearly) insignificant.

C Results from Section 4.1 in monthly frequency

Table 10: Equivalent to Table 2, but in monthly frequency (and Newey and West (1987) uses 1 lag).

	USD_{t+1}																		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
$iv_{sp,t}$	0.02							0.03	0.03	0.02	0.05								
	(0.56)							(0.72)	(0.77)	(0.53)	(1.13)								
$op_{sp,t}$		-0.02										0.07	0.1	-0.03	-0.004				
		(-0.24)										(0.81)	(1.31)	(-0.38)	(-0.05)				
$bm_{sp,t}$			0.5													0.4	0.2	0.5	0.2
			(1.87)													(1.42)	(0.73)	(1.83)	(0.54)
tbl_t				0.04				0.04				0.05				0.02			
				(1.21)				(1.27)				(1.36)				(0.53)			
lty_t					0.06				0.07				0.10^{*}				0.05		
					(1.80)				(1.86)				(2.10)				(1.13)		
tms_t						0.05				0.05				0.05				0.04	
						(0.63)				(0.61)				(0.68)				(0.59)	
dfy_t							0.6^{*}				0.6^{*}				0.6^{*}				0.5
							(2.22)				(2.29)				(2.20)				(1.67)
Constant	0.1	0.6	0.9^{**}	0.2	-0.004	0.3	-0.2	-0.1	-0.4	0.06	-0.8	-0.8	-1.9	0.7	-0.2	0.7	0.3	0.8^{*}	0.01
	(0.29)	(0.65)	(3.25)	(1.47)	(-0.02)	(1.69)	(-0.75)	(-0.21)	(-0.72)	(0.12)	(-1.26)	(-0.61)	(-1.28)	(0.68)	(-0.15)	(1.92)	(0.61)	(2.28)	(0.03)
$\bar{R}^2$(%)	-0.1	-0.2	0.3	0.2	0.5	-0.1	1.1	0.1	0.4	-0.2	1.2	0.1	0.6	-0.3	0.9	0.2	0.4	0.2	1.0
t-ols(β_1)	0.52	-0.22	1.68	1.37	1.94	0.71	2.66	0.65	0.70	0.49	1.07	0.76	1.27	-0.35	-0.05	1.12	0.57	1.66	0.54
t-ols(β_2)								1.42	2.00	0.68	2.81	1.55	2.31	0.76	2.64	0.56	1.13	0.66	2.12
Months	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528

Table 11: **Equivalent to Table 3, but in monthly frequency (and Newey and West (1987) uses 1 lag).**

	USD_{t+1}									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$bm_{sp,t}$	0.7*	0.6	0.6	0.4	0.7*	0.3	0.4	0.2	0.6	0.2
	(2.15)	(1.88)	(1.69)	(1.05)	(2.08)	(0.90)	(1.47)	(0.67)	(1.76)	(0.57)
$iv_{sp,t}$	0.06		0.05	0.05	0.05	0.06				
	(1.26)		(1.18)	(1.02)	(1.22)	(1.36)				
$op_{sp,t}$		0.03					0.08	0.1	0.03	0.01
		(0.45)					(0.87)	(1.28)	(0.32)	(0.18)
tbl_t			0.01				0.04			
			(0.39)				(0.87)			
lty_t				0.04				0.08		
				(0.89)				(1.62)		
tms_t					0.04				0.04	
					(0.52)				(0.52)	
dfy_t						0.5				0.5
						(1.71)				(1.65)
Constant	0.3	0.4	0.2	-0.06	0.3	-0.6	-0.5	-1.6	0.5	-0.2
	(0.67)	(0.41)	(0.43)	(-0.11)	(0.49)	(-0.81)	(-0.36)	(-1.07)	(0.44)	(-0.14)
$\bar{R}^2$(%)	0.4	0.2	0.3	0.4	0.3	1.1	0.2	0.5	0.1	0.8
t-ols(β_{bm})	2.00	1.72	1.46	0.91	1.96	0.91	1.18	0.52	1.65	0.56
t-ols(β_1)	1.20	0.44	1.14	1.00	1.16	1.29	0.85	1.24	0.31	0.17
t-ols(β_2)			0.42	0.92	0.58	2.17	0.91	1.62	0.58	2.08
Months	528	528	528	528	528	528	528	528	528	528

D Results from Section 5.1 in monthly frequency

Table 12: Equivalent to Table 5, but in monthly frequency (and Newey and West (1987) uses 1 lag).

	$0D_{t+1}$																		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
$iv_{sp,t}$	-0.02							-0.02	-0.02	-0.02	-0.02								
	(-0.65)							(-0.55)	(-0.56)	(-0.62)	(-0.59)								
$op_{sp,t}$		-0.07										-0.04	-0.05	-0.07	-0.07				
		(-1.09)										(-0.51)	(-0.56)	(-1.00)	(-1.06)				
$bm_{sp,t}$			0.3													0.2	0.2	0.3	0.3
			(1.02)													(0.57)	(0.53)	(1.04)	(0.92)
tbl_t				0.03				0.03				0.02				0.02			
				(1.07)				(1.03)				(0.55)				(0.64)			
lty_t					0.03				0.03				0.02				0.02		
					(1.02)				(0.98)				(0.47)				(0.48)		
tms_t						-0.03				-0.03				-0.02				-0.04	
						(-0.53)				(-0.50)				(-0.34)				(-0.56)	
dfy_t							0.06				0.04				0.04				-0.05
							(0.22)				(0.13)				(0.17)				(-0.15)
Constant	0.5	1.3	0.5	0.1	0.03	0.3*	0.2	0.4	0.3	0.6	0.5	0.8	0.8	1.2	1.2	0.3	0.3	0.6	0.6
	(1.12)	(1.29)	(1.73)	(0.74)	(0.13)	(1.97)	(0.58)	(0.76)	(0.60)	(1.18)	(0.75)	(0.57)	(0.57)	(1.27)	(1.11)	(0.80)	(0.56)	(1.81)	(0.98)
$\bar{R}^2$(%)	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.1	-0.1	-0.3	-0.3	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1	-0.2
t-ols(β_1)	-0.62	-1.06	1.06	1.09	1.03	-0.53	0.29	-0.52	-0.53	-0.60	-0.58	-0.50	-0.54	-0.98	-1.04	0.56	0.52	1.07	1.04
t-ols(β_2)								1.04	0.97	-0.50	0.17	0.57	0.47	-0.35	0.22	0.63	0.46	-0.57	-0.21
Months	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528

Table 13: Equivalent to Table 6, but in monthly frequency (and Newey and West (1987) uses 1 lag).

	$0D_{t+1}$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$bm_{sp,t}$	0.3	0.2	0.1	0.1	0.3	0.3	0.2	0.2	0.2	0.2
	(0.91)	(0.73)	(0.42)	(0.37)	(0.94)	(0.85)	(0.53)	(0.55)	(0.77)	(0.66)
$iv_{sp,t}$	-0.01		-0.01	-0.02	-0.010	-0.01				
	(-0.30)		(-0.38)	(-0.40)	(-0.26)	(-0.30)				
$op_{sp,t}$		-0.05					-0.04	-0.05	-0.05	-0.05
		(-0.78)					(-0.47)	(-0.58)	(-0.66)	(-0.78)
tbl_t			0.02				0.01			
			(0.68)				(0.29)			
lty_t				0.02				0.004		
				(0.55)				(0.08)		
tms_t					-0.03				-0.03	
					(-0.55)				(-0.42)	
dfy_t						-0.05				-0.03
						(-0.16)				(-0.09)
Constant	0.6	1.2	0.4	0.4	0.7	0.7	0.9	1.1	1.1	1.2
	(1.22)	(1.21)	(0.83)	(0.68)	(1.29)	(0.92)	(0.64)	(0.70)	(1.19)	(1.11)
$\bar{R}^2$(%)	-0.2	-0.1	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.2	-0.3
t-ols(β_{bm})	0.89	0.71	0.40	0.34	0.92	0.90	0.52	0.54	0.75	0.69
t-ols(β_1)	-0.26	-0.72	-0.34	-0.36	-0.23	-0.27	-0.46	-0.56	-0.62	-0.70
t-ols(β_2)			0.66	0.52	-0.55	-0.22	0.30	0.08	-0.43	-0.12
Months	528	528	528	528	528	528	528	528	528	528

D.1 OOS conditional mean returns and Sharpe ratios for the dollar carry strategy in monthly frequency

Table 14: Equivalent of Table 4 in monthly frequency, with (at least marginally) significant models in sample in monthly frequency.

			$\overline{USD}_{m,-}$		$\overline{USD}_{m,+}$		SR_-		SR_+		N_-	N_+
		bm_{sp}	0.28	(0.12)	0.44	(0.36)	0.13	(0.06)	0.21	(0.19)	300	41
		dfy	0.16	(0.12)	0.82	(0.28)	0.08	(0.07)	0.30	(0.11)	263	73
	iv_{sp}	bm_{sp}	0.29	(0.14)	0.35	(0.24)	0.13	(0.06)	0.17	(0.12)	265	76
		dfy	0.18	(0.14)	0.57	(0.22)	0.09	(0.07)	0.23	(0.09)	226	110
	op_{sp}	lty	0.31	(0.13)	0.25	(0.35)	0.14	(0.06)	0.11	(0.17)	290	46
		dfy	0.16	(0.14)	0.56	(0.21)	0.08	(0.07)	0.22	(0.08)	215	121
	bm_{sp}	dfy	0.17	(0.13)	0.63	(0.23)	0.08	(0.07)	0.25	(0.09)	233	103
bm_{sp}	iv_{sp}	tms	0.19	(0.15)	0.55	(0.20)	0.09	(0.07)	0.27	(0.10)	231	105
	op_{sp}	tms	0.15	(0.14)	0.52	(0.19)	0.08	(0.08)	0.21	(0.08)	196	140

D.1.1 OOS statistics in monthly frequency

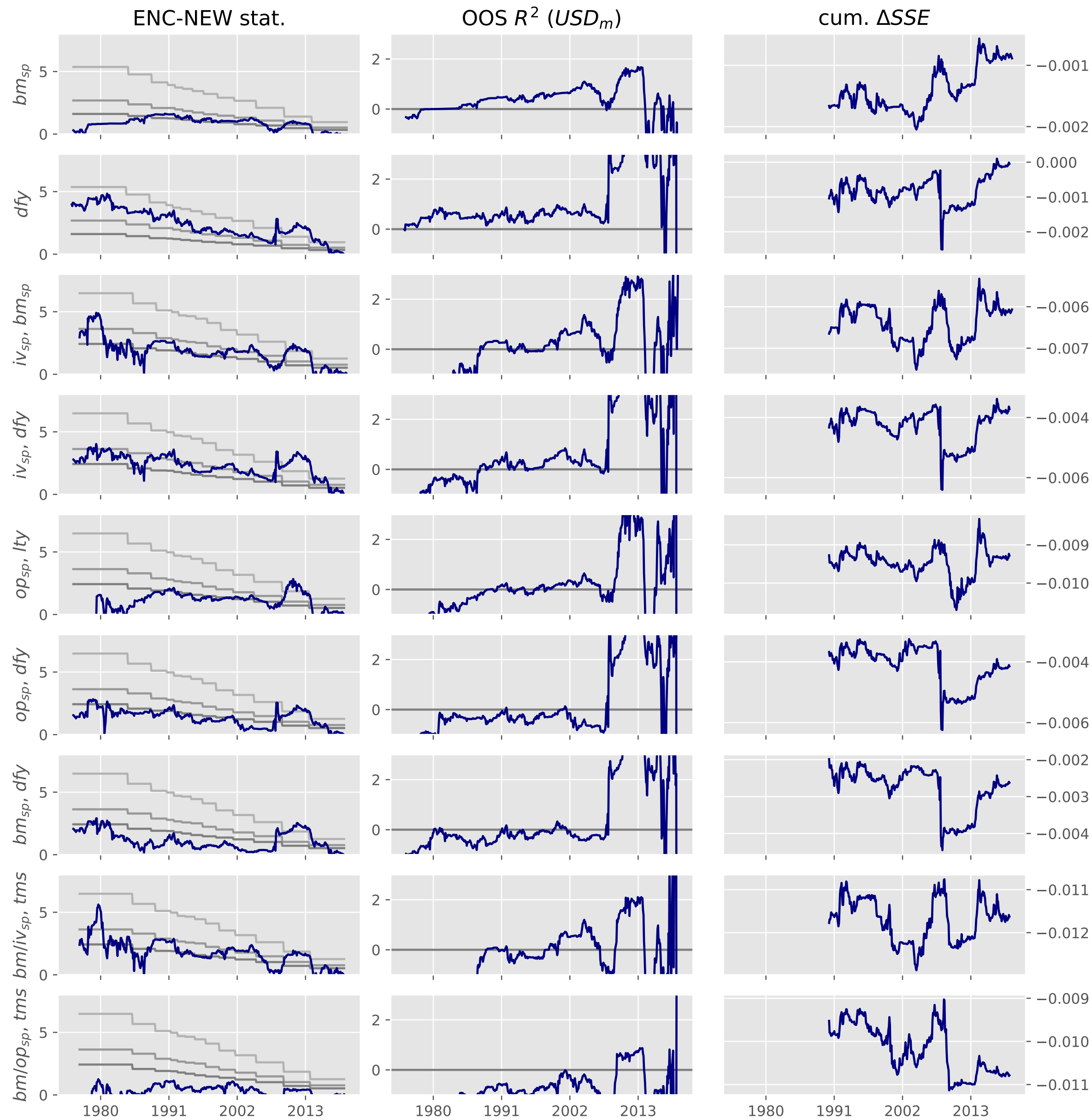

Figure 5: Equivalent of Fig. 2 for all significant or marginally significant models in monthly frequency.

E OOS statistics for the remaining significant models in annual frequency

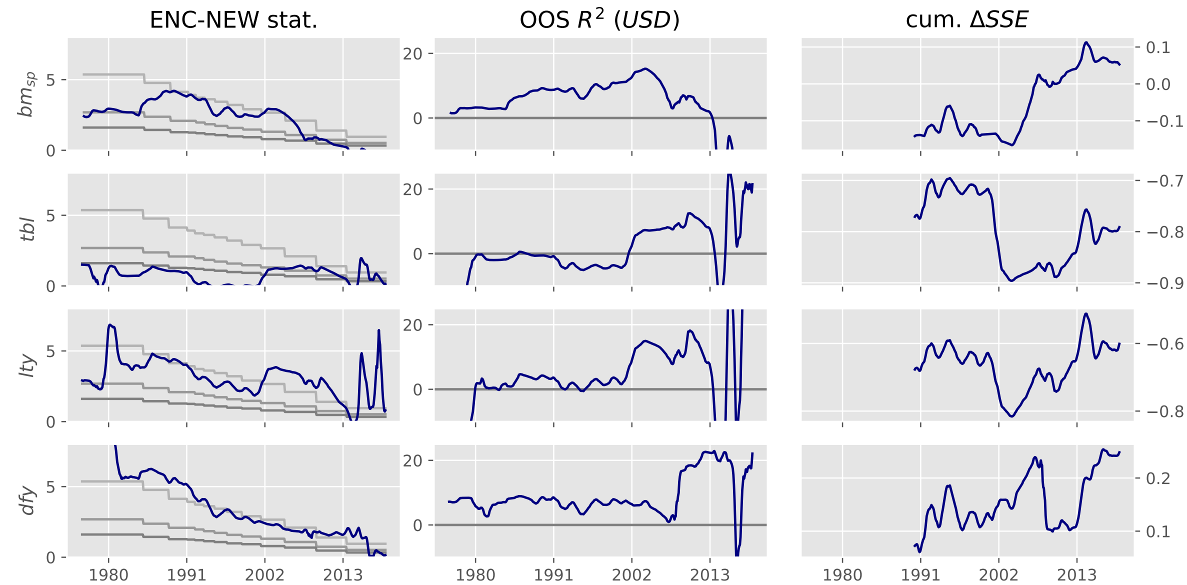

Figure 6: Equivalent of Fig. 2 for the univariate models in Table 2, which do not consider the dispersion in investment.

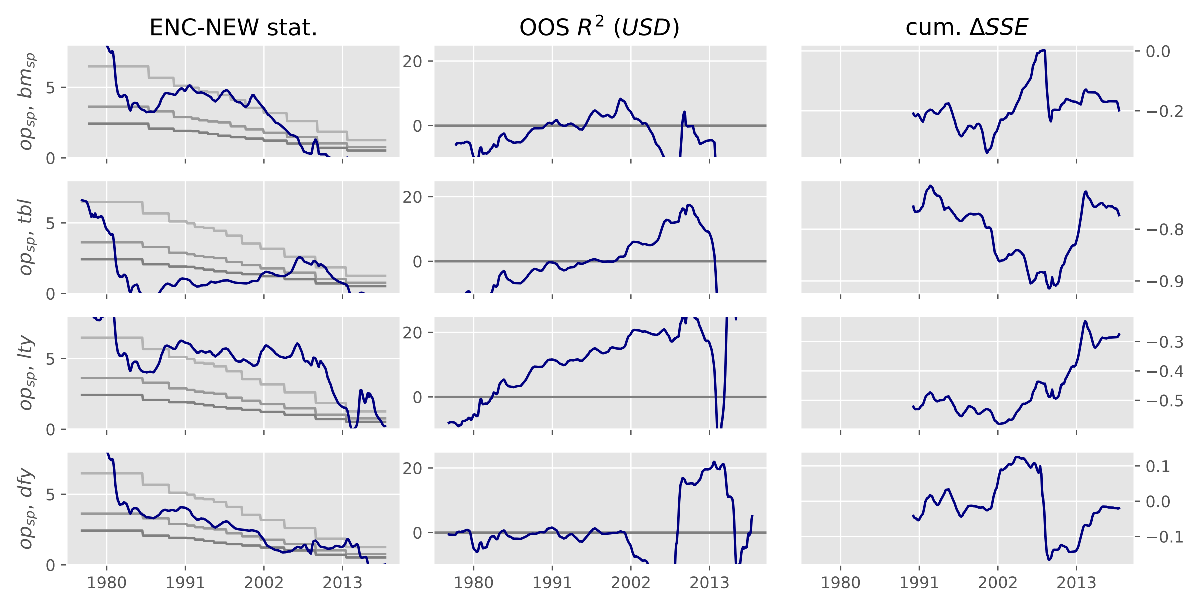

Figure 7: Equivalent of Fig. 2 for models based on dispersion in profitability instead of dispersion in investment in Table 2.

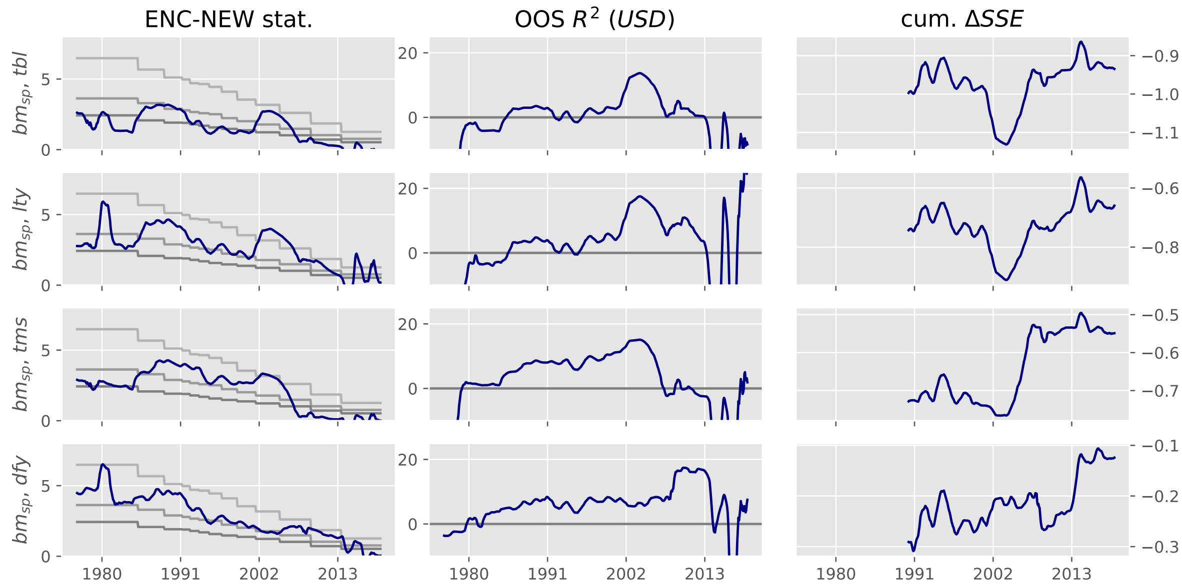

Figure 8: Equivalent of Fig. 2 for models based on dispersion in BM instead of dispersion in investment in Table 2.

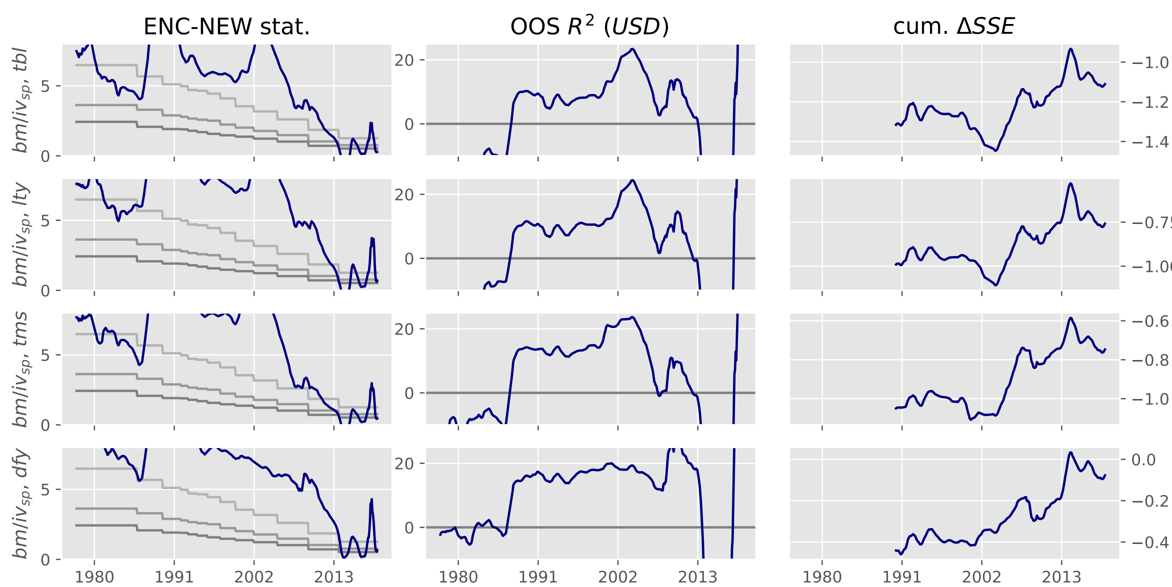

Figure 9: Equivalent of Fig. 2 for models with 3 regressors (Table 3), based on dispersion in BM in addition to dispersion in investment.

The reference lines with the ENC-NEW critical values (for only 2 regressors) are **not** valid for these models.

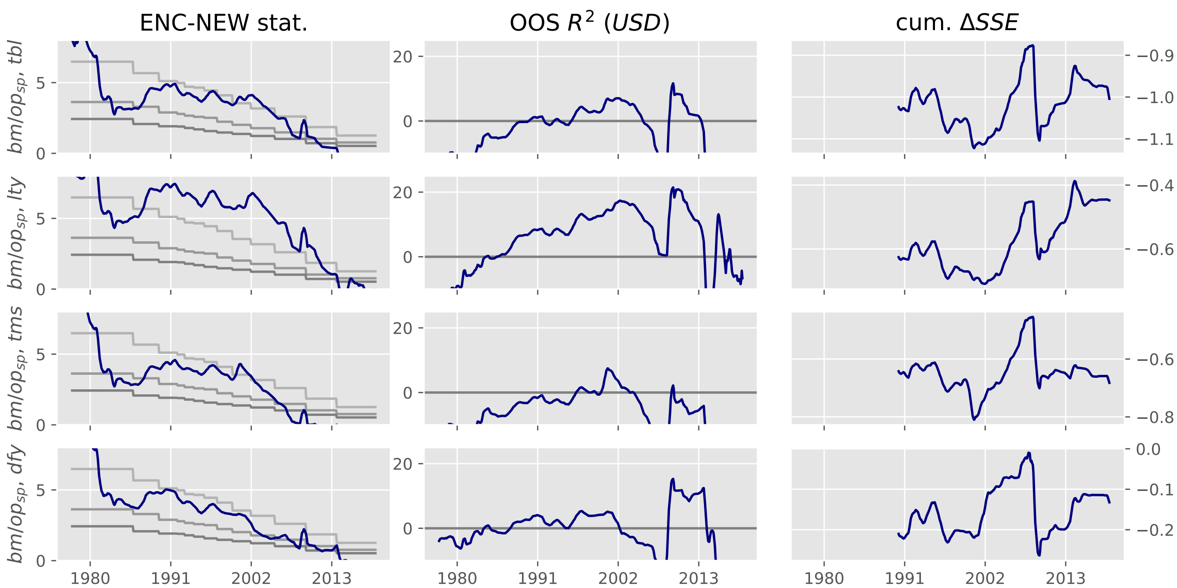

Figure 10: Equivalent of Fig. 2 for models with 3 regressors (Table 3), based on dispersions in BM and profitability, instead of dispersion in investment.

The reference lines with the ENC-NEW critical values (for only 2 regressors) are **not** valid for these models.

F The average forward discount does not forecast dollar carry returns

Table 15: Absolute value of the AFD as a predictor of annual dollar carry returns in February 1976–September 2020.

	USD_{t+12}												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
$\lvert AFD_t \rvert$	9.2	6.6	3.2	12.3	9.6	6.9	3.7	12.0	9.4	0.8	-0.8	2.8	3.3
	(1.52)	(1.06)	(0.56)	(1.84)	(1.85)	(1.16)	(0.65)	(1.83)	(1.69)	(0.14)	(-0.13)	(0.43)	(0.59)
$iv_{sp,t}$		0.6	0.6	0.6	0.8*								
		(1.70)	(1.76)	(1.67)	(2.57)								
tbl_t		0.4				0.7**				0.2			
		(1.64)				(3.20)				(0.55)			
lty_t			0.8**				1.3***				0.5		
			(2.76)				(4.56)				(1.49)		
tms_t				0.7				0.6				0.6	
				(1.11)				(1.06)				(1.05)	
dfy_t					6.5***				5.8**				4.7**
					(3.36)				(3.23)				(2.78)
$op_{sp,t}$						1.6**	2.2***	0.5	0.7				
						(2.78)	(3.71)	(0.99)	(1.23)				
$bm_{sp,t}$										6.4*	4.5	6.9**	3.8
										(2.25)	(1.52)	(2.70)	(1.50)
Constant	3.6**	-5.0	-7.7	-5.3	-13.5**	-22.5*	-35.0***	-5.4	-12.2	9.7**	5.7	9.3**	2.7
	(2.78)	(-1.09)	(-1.60)	(-1.05)	(-2.65)	(-2.56)	(-3.74)	(-0.68)	(-1.42)	(2.69)	(1.27)	(2.94)	(0.76)
$\bar{R}^2$(%)	1.9	7.1	11.2	5.8	17.7	8.9	16.5	3.7	13.5	8.5	10.1	9.2	13.9
t-ols(β_1)		4.03	4.11	3.90	5.82	5.21	7.16	1.85	2.58	4.95	3.21	5.95	3.03
t-ols(β_2)		3.92	6.35	2.85	9.20	6.07	9.36	2.55	8.12	1.33	3.34	2.46	5.86
t-ols(β_{fs})	3.35	2.20	1.07	4.44	3.73	2.32	1.30	4.09	3.36	0.27	-0.25	0.97	1.16
Months	525	525	525	525	525	525	525	525	525	525	525	525	525

The univariate [multivariate] regressions have the form

$$USD_{t+12} = \beta_0 + \beta_1 x_{1,t} + \left[\beta_2 x_{2,t} + \beta_{fs} \lvert AFD_t \rvert\right] + \epsilon_{t+12},$$

where USD_{t+12} is the 1-year dollar carry return. In the multivariate regressions, apart from the absolute value of the AFD, $\lvert AFD_t \rvert$, x_1 is one of the macro-finance state variables: The cross-sectional spreads in investment, iv_{sp}, profitability, op_{sp}, or BM, bm_{sp}; and x_2 is one of the interest-rate state variables: The T-bill, tbl, long-term yield, lty, term spread, tms, or default spread, dfy. In the univariate regressions, the regressor is the $\lvert AFD_t \rvert$. The coefficients have Newey and West (1987) t statistics in parentheses, with 12 lags, $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$. The lower panel shows the uncorrected t statistics of the respective coefficients, t-ols(β_1) and t-ols(β_2) t-ols(β_{fs}), the number of months, and the adjusted R^2.

Summary: There is no evidence that dollar carry risk premiums are related to the AFD, which has insignificant coefficients in all models.

A Conditional returns and Sharpe ratios for all models out of sample

Table 16: Extended version of Table 4: Includes insignificant models (in sample) and average indicator for long or short carry.

			$\overline{USD}_-$		$\overline{USD}_+$		SR_-		SR_+		$w_{t-1,-}$		$w_{t-1,+}$		N_-	N_+
		iv_{sp}	3.73	(1.58)	3.58	(1.38)	0.46	(0.22)	0.54	(0.22)	0.12	(0.20)	0.19	(0.20)	207	126
		op_{sp}	-1.03	(0.73)	3.85	(1.22)	-0.31	(0.37)	0.50	(0.18)	1.00	(0.00)	0.11	(0.16)	12	321
		bm_{sp}	3.25	(1.18)	7.56	(2.09)	0.45	(0.18)	0.83	(0.25)	0.13	(0.16)	0.26	(0.37)	300	33
		tbl	3.67	(1.19)	-	(-)	0.48	(0.18)	-	(-)	0.16	(0.16)	-	(-)	333	-
		lty	3.67	(1.19)	-	(-)	0.48	(0.18)	-	(-)	0.16	(0.16)	-	(-)	333	-
		tms	3.85	(1.82)	3.56	(1.33)	0.50	(0.27)	0.47	(0.21)	-0.09	(0.25)	0.32	(0.18)	129	204
		dfy	2.35	(1.15)	8.22	(2.00)	0.34	(0.20)	1.00	(0.23)	0.01	(0.18)	0.67	(0.14)	258	75
		bm_{sp}	3.01	(1.27)	6.62	(1.90)	0.41	(0.20)	0.87	(0.13)	0.17	(0.17)	0.01	(0.32)	272	61
		tbl	3.67	(1.36)	3.69	(1.71)	0.46	(0.22)	0.77	(0.29)	0.30	(0.16)	-0.81	(0.08)	290	43
	iv_{sp}	lty	3.65	(1.19)	-	(-)	0.48	(0.18)	-	(-)	0.16	(0.16)	-	(-)	332	-
		tms	4.13	(1.71)	3.24	(1.44)	0.52	(0.25)	0.45	(0.25)	-0.07	(0.21)	0.38	(0.19)	161	172
		dfy	1.76	(1.16)	8.33	(1.46)	0.27	(0.20)	1.06	(0.16)	0.09	(0.19)	0.34	(0.22)	236	97
		bm_{sp}	2.08	(1.49)	5.26	(1.68)	0.30	(0.25)	0.66	(0.29)	0.12	(0.20)	0.17	(0.22)	166	167
		tbl	3.62	(1.55)	3.76	(1.40)	0.45	(0.20)	0.55	(0.23)	0.42	(0.16)	-0.27	(0.22)	212	121
	op_{sp}	lty	3.08	(1.27)	7.65	(1.02)	0.40	(0.17)	1.37	(0.40)	0.15	(0.16)	0.20	(0.36)	290	43
		tms	0.40	(1.17)	4.20	(1.29)	0.08	(0.27)	0.54	(0.20)	-0.18	(0.35)	0.22	(0.16)	46	287
		dfy	1.81	(1.28)	6.21	(1.80)	0.28	(0.25)	0.76	(0.26)	0.02	(0.20)	0.36	(0.19)	192	141
		tbl	3.59	(1.23)	4.98	(2.41)	0.48	(0.19)	0.56	(0.30)	0.17	(0.16)	0.07	(0.31)	314	19
		lty	3.58	(1.22)	6.08	(3.16)	0.47	(0.19)	0.78	(0.01)	0.15	(0.16)	0.46	(0.11)	321	12
	bm_{sp}	tms	3.65	(1.32)	3.80	(2.03)	0.48	(0.20)	0.51	(0.24)	0.09	(0.17)	0.51	(0.20)	277	56
		dfy	2.62	(1.16)	7.01	(2.36)	0.38	(0.18)	0.81	(0.30)	0.09	(0.18)	0.40	(0.19)	253	80
		tbl	3.36	(1.35)	5.27	(1.48)	0.43	(0.21)	0.85	(0.00)	0.25	(0.17)	-0.31	(0.28)	278	55
		lty	3.43	(1.30)	5.63	(2.18)	0.45	(0.20)	0.81	(0.22)	0.22	(0.16)	-0.30	(0.36)	296	37
	iv_{sp}	tms	2.58	(1.32)	7.19	(1.86)	0.35	(0.19)	1.04	(0.15)	0.22	(0.17)	-0.04	(0.31)	254	79
bm_{sp}		dfy	1.94	(1.20)	8.64	(1.83)	0.28	(0.18)	1.22	(0.26)	0.13	(0.18)	0.25	(0.28)	247	86
		tbl	1.94	(1.44)	6.53	(1.45)	0.26	(0.20)	0.93	(0.22)	0.27	(0.18)	-0.02	(0.25)	207	126
		lty	2.71	(1.35)	6.67	(1.70)	0.36	(0.19)	0.99	(0.30)	0.15	(0.17)	0.19	(0.27)	252	81
	op_{sp}	tms	2.33	(1.42)	5.24	(1.85)	0.35	(0.25)	0.63	(0.31)	0.04	(0.20)	0.30	(0.21)	179	154
		dfy	1.50	(1.30)	6.67	(1.52)	0.23	(0.23)	0.85	(0.18)	0.14	(0.19)	0.19	(0.21)	193	140

The extra variable w_{t-1} is the average between 1 for long carry portfolios and -1 for short positions. It has a lag to indicate whether high (+) and low returns (-) are generated by long or short carry positions on average.

Table 17: Equivalent of Table 16 for dollar-neutral risk premiums.

			$\overline{0D}_-$		$\overline{0D}_+$		SR_-		SR_+		$w_{t-1,-}$		$w_{t-1,+}$		N_-	N_+
		iv_{sp}	1.02	(1.85)	2.27	(1.40)	0.14	(0.32)	0.33	(0.20)	0.27	(0.22)	0.07	(0.19)	129	204
		op_{sp}	1.52	(1.15)	8.79	(0.32)	0.22	(0.15)	4.36	(0.87)	0.11	(0.16)	1.00	(0.00)	321	12
		bm_{sp}	1.61	(1.08)	2.11	(2.41)	0.27	(0.19)	0.24	(0.26)	0.17	(0.19)	0.09	(0.23)	217	116
		tbl	2.04	(1.11)	-8.70	(1.69)	0.29	(0.16)	-1.75	(0.34)	0.14	(0.16)	1.00	(0.00)	325	8
		lty	2.87	(1.13)	-3.59	(2.07)	0.42	(0.18)	-0.59	(0.36)	0.20	(0.17)	-0.03	(0.39)	277	56
		tms	2.04	(1.25)	1.47	(1.78)	0.31	(0.25)	0.19	(0.25)	0.81	(0.07)	-0.61	(0.12)	182	151
		dfy	0.91	(1.27)	2.32	(1.48)	0.15	(0.21)	0.31	(0.21)	0.31	(0.24)	0.07	(0.19)	126	207
	iv_{sp}	bm_{sp}	2.77	(1.06)	1.09	(1.67)	0.54	(0.22)	0.13	(0.18)	-0.04	(0.22)	0.27	(0.18)	138	195
		tbl	2.43	(1.18)	0.18	(1.97)	0.35	(0.18)	0.02	(0.25)	0.12	(0.18)	0.26	(0.27)	238	95
		lty	4.40	(1.14)	-0.44	(1.46)	0.74	(0.18)	-0.06	(0.09)	0.01	(0.21)	0.29	(0.21)	153	180
		tms	2.11	(1.39)	1.56	(1.52)	0.33	(0.27)	0.21	(0.19)	0.60	(0.19)	-0.13	(0.19)	135	198
		dfy	2.33	(1.75)	1.51	(1.36)	0.34	(0.33)	0.21	(0.21)	0.19	(0.24)	0.15	(0.18)	111	222
	op_{sp}	bm_{sp}	2.14	(1.05)	0.79	(2.83)	0.34	(0.20)	0.09	(0.33)	0.17	(0.18)	0.07	(0.25)	246	87
		tbl	1.78	(1.13)	-	(-)	0.25	(0.15)	-	(-)	0.16	(0.16)	-	(-)	333	-
		lty	2.48	(1.09)	-6.11	(1.75)	0.36	(0.15)	-1.27	(0.45)	0.20	(0.16)	-0.33	(0.44)	306	27
		tms	2.16	(0.98)	0.34	(3.03)	0.35	(0.17)	0.04	(0.34)	0.36	(0.17)	-0.59	(0.13)	264	69
		dfy	2.03	(0.97)	0.91	(3.07)	0.33	(0.17)	0.09	(0.31)	0.15	(0.17)	0.19	(0.30)	261	72
	bm_{sp}	tbl	1.93	(1.01)	1.33	(3.42)	0.33	(0.21)	0.13	(0.31)	0.20	(0.18)	0.05	(0.29)	253	80
		lty	2.26	(1.12)	0.79	(2.40)	0.36	(0.23)	0.09	(0.30)	0.14	(0.19)	0.20	(0.24)	225	108
		tms	2.06	(1.08)	1.39	(2.13)	0.34	(0.21)	0.17	(0.25)	0.47	(0.17)	-0.27	(0.21)	196	137
		dfy	1.71	(1.14)	1.90	(2.18)	0.28	(0.21)	0.23	(0.26)	0.21	(0.19)	0.09	(0.23)	202	131
bm_{sp}	iv_{sp}	tbl	2.42	(1.11)	0.96	(2.07)	0.42	(0.22)	0.11	(0.20)	0.30	(0.20)	-0.02	(0.21)	188	145
		lty	3.35	(1.04)	0.69	(1.62)	0.63	(0.20)	0.09	(0.12)	-0.07	(0.23)	0.32	(0.19)	137	196
		tms	2.65	(1.07)	1.03	(1.66)	0.48	(0.22)	0.13	(0.21)	0.32	(0.21)	0.03	(0.20)	155	178
		dfy	2.22	(1.36)	1.46	(1.58)	0.35	(0.27)	0.19	(0.21)	-0.05	(0.23)	0.31	(0.18)	143	190
	op_{sp}	tbl	2.04	(0.99)	0.92	(3.37)	0.34	(0.20)	0.09	(0.16)	0.22	(0.18)	-0.04	(0.26)	257	76
		lty	2.32	(1.03)	0.26	(2.81)	0.37	(0.21)	0.03	(0.25)	0.19	(0.18)	0.06	(0.25)	247	86
		tms	2.00	(1.04)	1.38	(2.51)	0.34	(0.21)	0.15	(0.22)	0.36	(0.18)	-0.20	(0.22)	219	114
		dfy	2.26	(1.07)	0.57	(2.65)	0.36	(0.21)	0.06	(0.34)	0.21	(0.18)	0.04	(0.24)	240	93

Table 18: Monthly version of Table 16.

			$\overline{USD}_{m,-}$		$\overline{USD}_{m,+}$		SR_{-}		SR_{+}		$w_{t-1,-}$		$w_{t-1,+}$		N_{-}	N_{+}
		iv_{sp}	0.30	(0.17)	0.30	(0.16)	0.16	(0.10)	0.13	(0.07)	0.10	(0.10)	0.18	(0.09)	160	181
		op_{sp}	0.37	(0.21)	0.27	(0.14)	0.18	(0.10)	0.12	(0.07)	0.07	(0.13)	0.18	(0.08)	98	243
		bm_{sp}	0.28	(0.12)	0.44	(0.36)	0.13	(0.06)	0.21	(0.19)	0.13	(0.07)	0.26	(0.19)	300	41
		tbl	0.31	(0.12)	-	(-)	0.14	(0.06)	-	(-)	0.16	(0.07)	-	(-)	336	-
		lty	0.31	(0.12)	-	(-)	0.14	(0.06)	-	(-)	0.16	(0.07)	-	(-)	336	-
		tms	0.34	(0.16)	0.28	(0.16)	0.19	(0.09)	0.12	(0.07)	-0.08	(0.11)	0.32	(0.08)	133	203
		dfy	0.16	(0.12)	0.82	(0.28)	0.08	(0.07)	0.30	(0.11)	0.02	(0.08)	0.67	(0.10)	263	73
	iv_{sp}	bm_{sp}	0.29	(0.14)	0.35	(0.24)	0.13	(0.06)	0.17	(0.12)	0.27	(0.08)	-0.29	(0.14)	265	76
	iv_{sp}	tbl	0.28	(0.13)	0.43	(0.23)	0.12	(0.06)	0.23	(0.14)	0.35	(0.07)	-0.70	(0.10)	275	61
	iv_{sp}	lty	0.32	(0.13)	0.21	(0.27)	0.14	(0.06)	0.13	(0.17)	0.26	(0.07)	-0.93	(0.07)	307	29
	iv_{sp}	tms	0.25	(0.17)	0.35	(0.16)	0.14	(0.10)	0.14	(0.07)	-0.11	(0.11)	0.37	(0.08)	147	189
	iv_{sp}	dfy	0.18	(0.14)	0.57	(0.22)	0.09	(0.07)	0.23	(0.09)	0.15	(0.08)	0.18	(0.12)	226	110
	op_{sp}	bm_{sp}	0.25	(0.14)	0.40	(0.21)	0.12	(0.07)	0.17	(0.09)	0.08	(0.09)	0.25	(0.11)	216	125
	op_{sp}	tbl	0.36	(0.15)	0.21	(0.19)	0.16	(0.07)	0.10	(0.10)	0.35	(0.08)	-0.21	(0.12)	220	116
	op_{sp}	lty	0.31	(0.13)	0.25	(0.35)	0.14	(0.06)	0.11	(0.17)	0.11	(0.07)	0.47	(0.16)	290	46
	op_{sp}	tms	0.31	(0.18)	0.30	(0.15)	0.17	(0.11)	0.13	(0.06)	-0.12	(0.12)	0.30	(0.08)	110	226
	op_{sp}	dfy	0.16	(0.14)	0.56	(0.21)	0.08	(0.07)	0.22	(0.08)	0.07	(0.09)	0.32	(0.11)	215	121
	bm_{sp}	tbl	0.33	(0.12)	-0.16	(0.48)	0.15	(0.06)	-0.08	(0.24)	0.17	(0.07)	-0.02	(0.26)	318	18
	bm_{sp}	lty	0.31	(0.12)	-	(-)	0.14	(0.06)	-	(-)	0.16	(0.07)	-	(-)	334	-
	bm_{sp}	tms	0.27	(0.13)	0.45	(0.28)	0.13	(0.06)	0.18	(0.12)	0.07	(0.08)	0.53	(0.12)	267	69
	bm_{sp}	dfy	0.17	(0.13)	0.63	(0.23)	0.08	(0.07)	0.25	(0.09)	0.08	(0.08)	0.35	(0.11)	233	103
bm_{sp}	iv_{sp}	tbl	0.31	(0.14)	0.31	(0.22)	0.14	(0.06)	0.16	(0.12)	0.35	(0.07)	-0.53	(0.12)	264	72
bm_{sp}	iv_{sp}	lty	0.35	(0.13)	0.04	(0.29)	0.16	(0.06)	0.02	(0.15)	0.29	(0.07)	-0.59	(0.13)	287	49
bm_{sp}	iv_{sp}	tms	0.19	(0.15)	0.55	(0.20)	0.09	(0.07)	0.27	(0.10)	0.26	(0.08)	-0.05	(0.12)	231	105
bm_{sp}	iv_{sp}	dfy	0.24	(0.14)	0.45	(0.23)	0.12	(0.07)	0.18	(0.09)	0.19	(0.08)	0.11	(0.12)	233	103
bm_{sp}	op_{sp}	tbl	0.34	(0.14)	0.23	(0.24)	0.16	(0.07)	0.09	(0.10)	0.20	(0.08)	0.07	(0.14)	242	94
bm_{sp}	op_{sp}	lty	0.35	(0.13)	0.10	(0.33)	0.16	(0.06)	0.04	(0.14)	0.12	(0.08)	0.34	(0.15)	278	58
bm_{sp}	op_{sp}	tms	0.15	(0.14)	0.52	(0.19)	0.08	(0.08)	0.21	(0.08)	-0.02	(0.09)	0.42	(0.10)	196	140
bm_{sp}	op_{sp}	dfy	0.28	(0.14)	0.36	(0.21)	0.14	(0.08)	0.14	(0.08)	0.11	(0.09)	0.24	(0.11)	214	122

Table 19: Monthly version of Table 17.

			$\overline{0D}_{m,-}$		$\overline{0D}_{m,+}$		SR_-		SR_+		$w_{t-1,-}$		$w_{t-1,+}$		N_-	N_+
		iv_{sp}	0.09	(0.20)	0.19	(0.12)	0.04	(0.10)	0.11	(0.07)	0.25	(0.11)	0.08	(0.09)	133	208
		op_{sp}	0.22	(0.10)	-0.56	(0.49)	0.13	(0.06)	-0.20	(0.19)	0.09	(0.07)	0.73	(0.16)	311	30
		bm_{sp}	0.19	(0.12)	0.03	(0.25)	0.10	(0.06)	0.02	(0.13)	0.20	(0.08)	-0.04	(0.14)	266	75
		tbl	0.17	(0.11)	-	(-)	0.09	(0.06)	-	(-)	0.16	(0.07)	-	(-)	335	-
		lty	0.17	(0.11)	-	(-)	0.09	(0.06)	-	(-)	0.16	(0.07)	-	(-)	335	-
		tms	0.17	(0.16)	0.15	(0.14)	0.09	(0.09)	0.08	(0.07)	0.81	(0.05)	-0.61	(0.07)	182	154
		dfy	0.18	(0.12)	0.14	(0.19)	0.10	(0.07)	0.07	(0.10)	0.01	(0.09)	0.36	(0.10)	194	142
	iv_{sp}	bm_{sp}	0.19	(0.13)	0.08	(0.18)	0.10	(0.07)	0.04	(0.10)	0.07	(0.08)	0.28	(0.12)	224	117
		tbl	0.27	(0.12)	-0.43	(0.29)	0.14	(0.07)	-0.22	(0.15)	0.23	(0.07)	-0.22	(0.16)	285	51
		lty	0.18	(0.12)	0.07	(0.21)	0.09	(0.07)	0.04	(0.13)	0.16	(0.08)	0.17	(0.17)	278	58
		tms	0.10	(0.20)	0.20	(0.12)	0.05	(0.11)	0.11	(0.07)	0.53	(0.09)	-0.09	(0.09)	136	200
		dfy	0.29	(0.18)	0.09	(0.13)	0.15	(0.10)	0.05	(0.07)	0.06	(0.11)	0.22	(0.09)	124	212
	op_{sp}	bm_{sp}	0.20	(0.11)	-0.07	(0.30)	0.11	(0.06)	-0.03	(0.14)	0.14	(0.08)	0.15	(0.15)	277	64
		tbl	0.16	(0.11)	0.28	(0.56)	0.08	(0.06)	0.15	(0.38)	0.18	(0.07)	-0.60	(0.23)	326	10
		lty	0.18	(0.11)	-	(-)	0.10	(0.06)	-	(-)	0.16	(0.07)	-	(-)	334	-
		tms	0.20	(0.12)	0.07	(0.22)	0.11	(0.07)	0.03	(0.11)	0.32	(0.08)	-0.28	(0.12)	245	91
		dfy	0.18	(0.11)	0.11	(0.27)	0.10	(0.06)	0.05	(0.12)	0.11	(0.08)	0.32	(0.14)	256	80
	bm_{sp}	tbl	0.18	(0.11)	-0.02	(0.39)	0.10	(0.06)	-0.01	(0.18)	0.23	(0.07)	-0.46	(0.18)	303	33
		lty	0.17	(0.11)	0.05	(0.46)	0.09	(0.06)	0.02	(0.20)	0.21	(0.07)	-0.32	(0.21)	304	32
		tms	0.18	(0.12)	0.11	(0.23)	0.09	(0.06)	0.06	(0.13)	0.29	(0.08)	-0.27	(0.13)	260	76
		dfy	0.18	(0.12)	0.12	(0.23)	0.09	(0.07)	0.06	(0.13)	0.23	(0.08)	-0.05	(0.14)	254	82
bm_{sp}	iv_{sp}	tbl	0.25	(0.12)	-0.29	(0.27)	0.13	(0.06)	-0.15	(0.14)	0.23	(0.07)	-0.21	(0.17)	283	53
		lty	0.22	(0.12)	-0.10	(0.26)	0.12	(0.06)	-0.05	(0.13)	0.16	(0.08)	0.18	(0.16)	275	61
		tms	0.18	(0.14)	0.13	(0.17)	0.09	(0.07)	0.07	(0.09)	0.21	(0.09)	0.08	(0.11)	214	122
		dfy	0.14	(0.14)	0.21	(0.17)	0.07	(0.07)	0.11	(0.09)	0.09	(0.09)	0.29	(0.11)	213	123
	op_{sp}	tbl	0.18	(0.11)	0.05	(0.32)	0.10	(0.06)	0.02	(0.15)	0.21	(0.07)	-0.17	(0.17)	291	45
		lty	0.16	(0.11)	0.16	(0.35)	0.09	(0.06)	0.07	(0.17)	0.21	(0.07)	-0.14	(0.18)	292	44
		tms	0.20	(0.11)	-0.02	(0.31)	0.11	(0.06)	-0.01	(0.14)	0.22	(0.08)	-0.13	(0.14)	277	59
		dfy	0.19	(0.11)	0.05	(0.28)	0.10	(0.06)	0.02	(0.14)	0.14	(0.08)	0.23	(0.14)	265	71

B Detailed OOS statistics

B.1 Dollar neutral annual returns

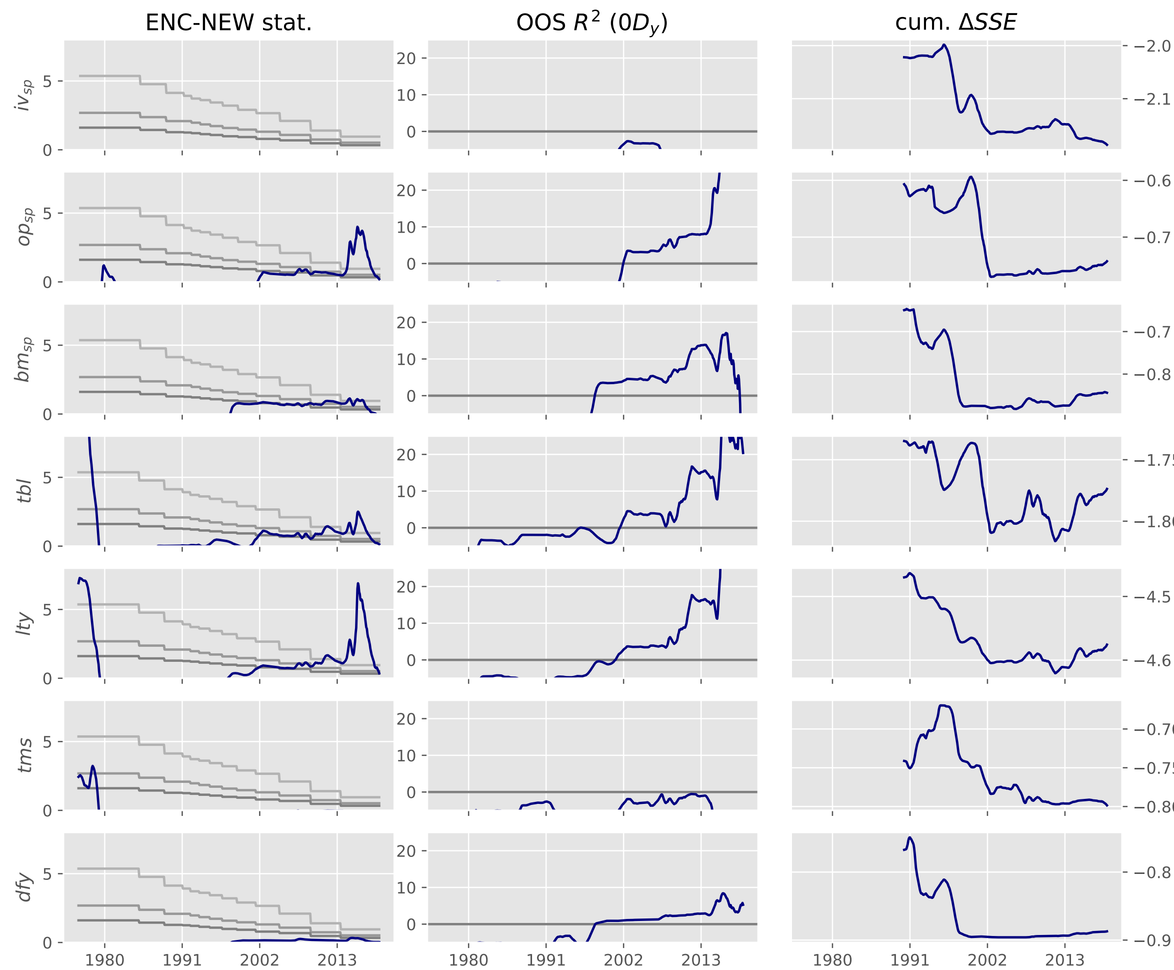

Figure 11: Recursive univariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

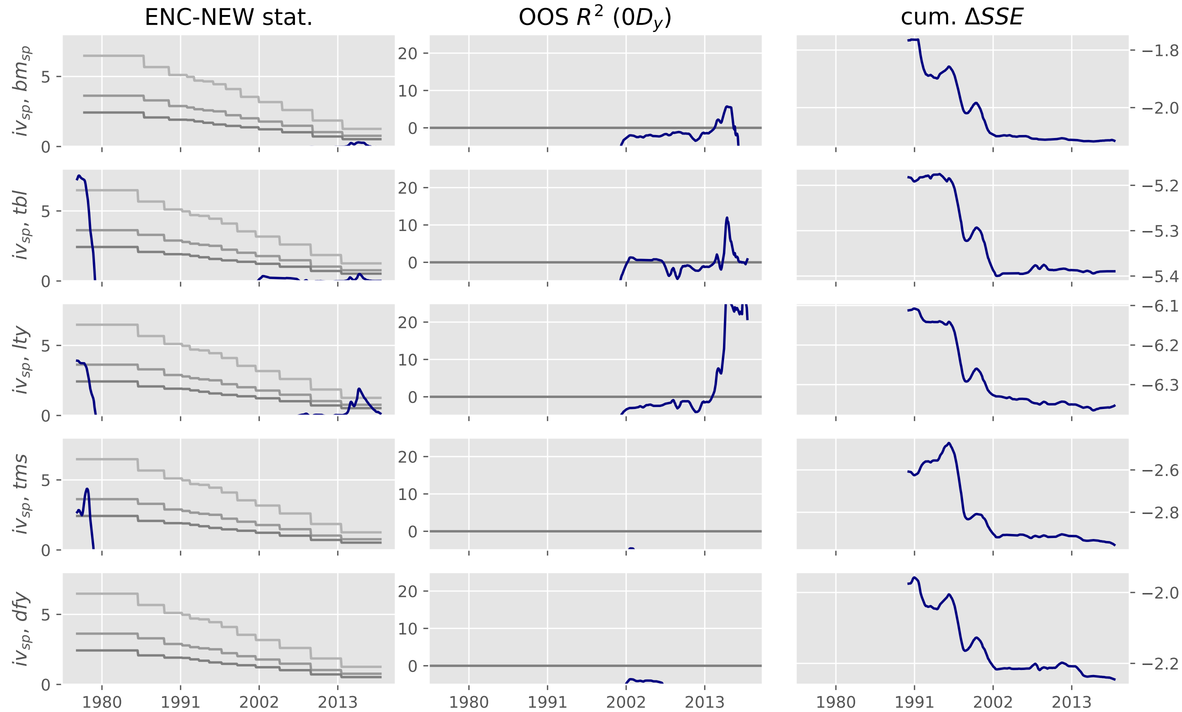

Figure 12: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

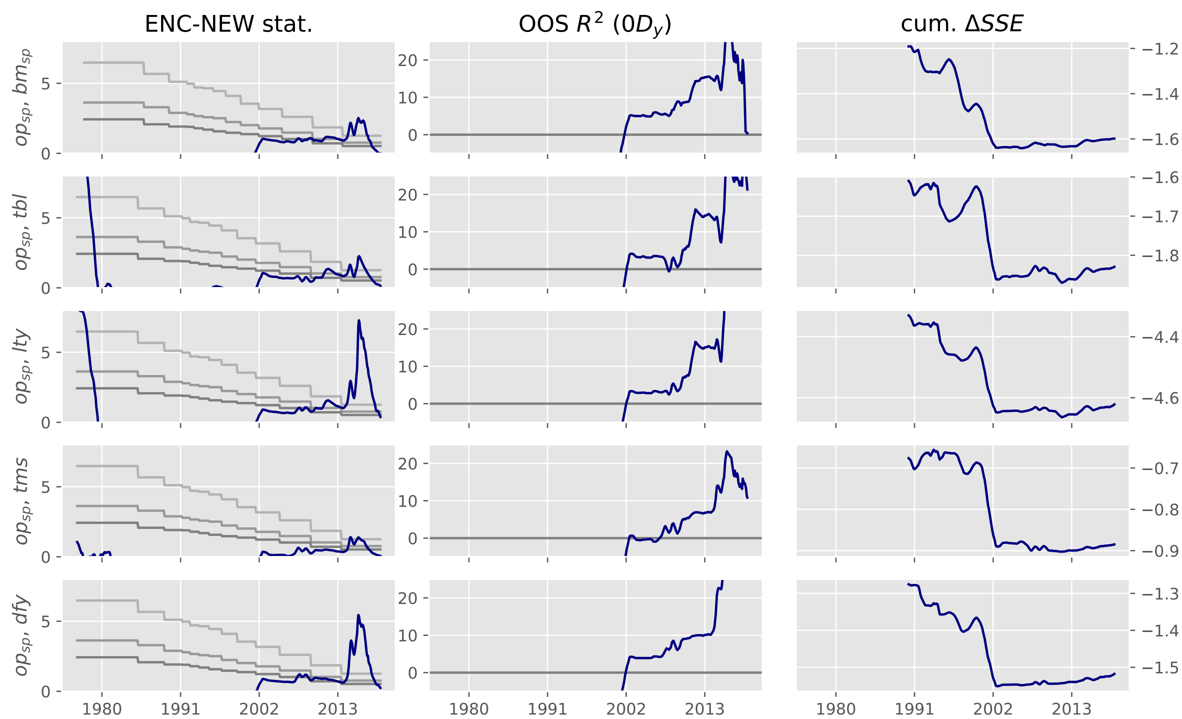

Figure 13: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

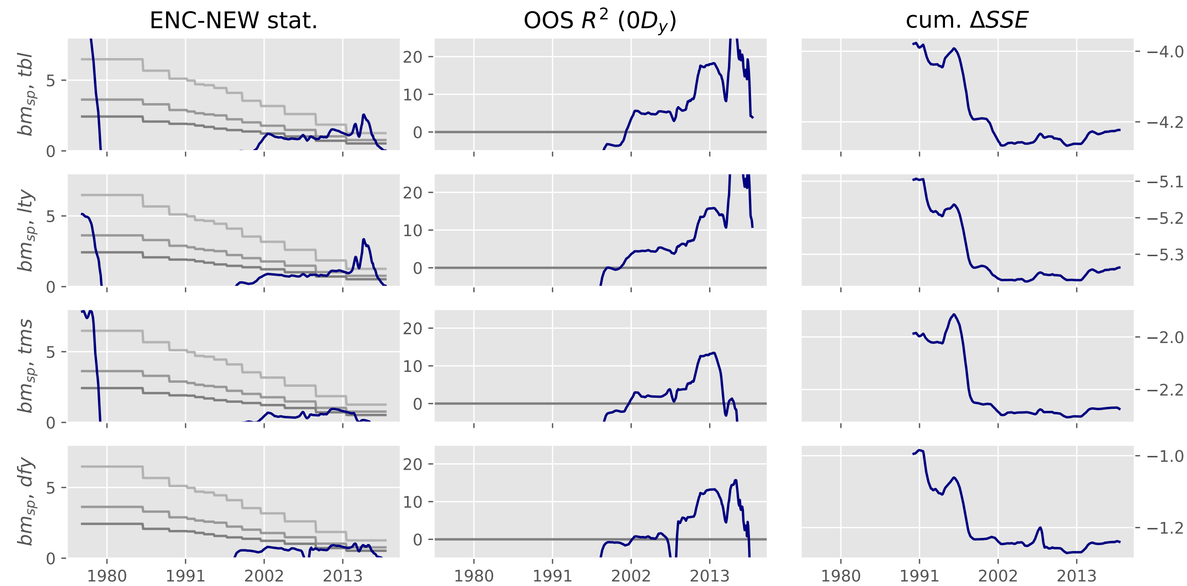

Figure 14: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

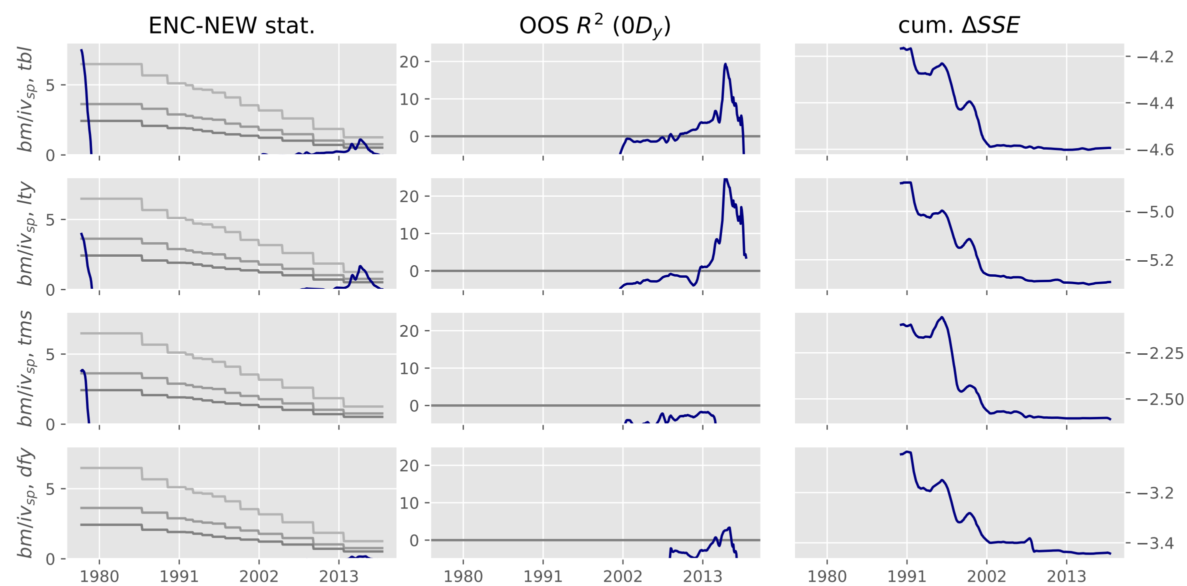

Figure 15: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

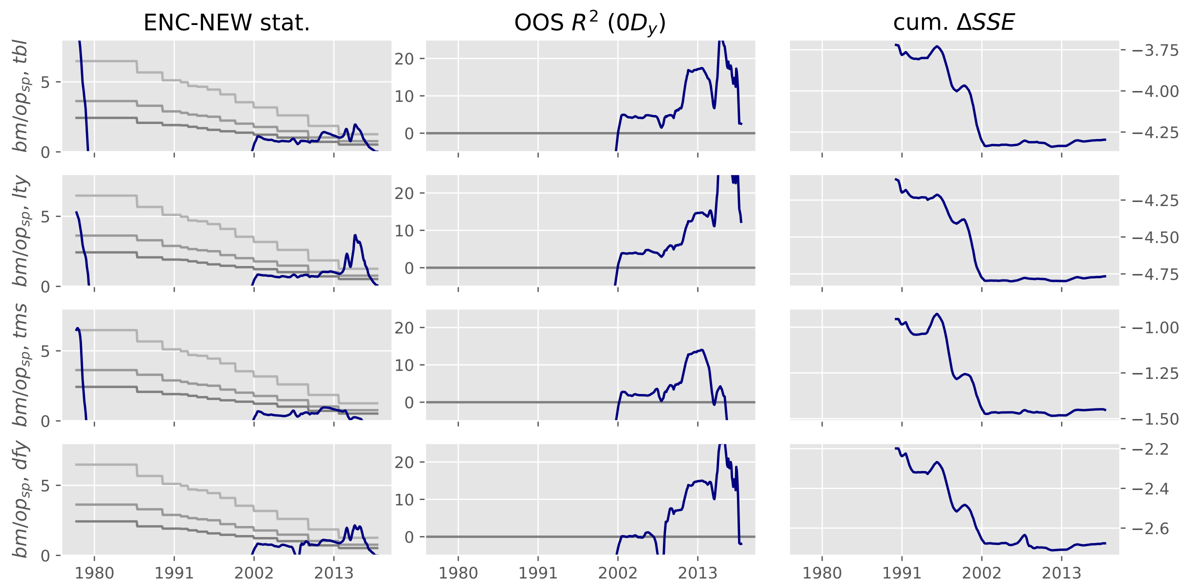

Figure 16: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

B.2 Dollar carry annual returns

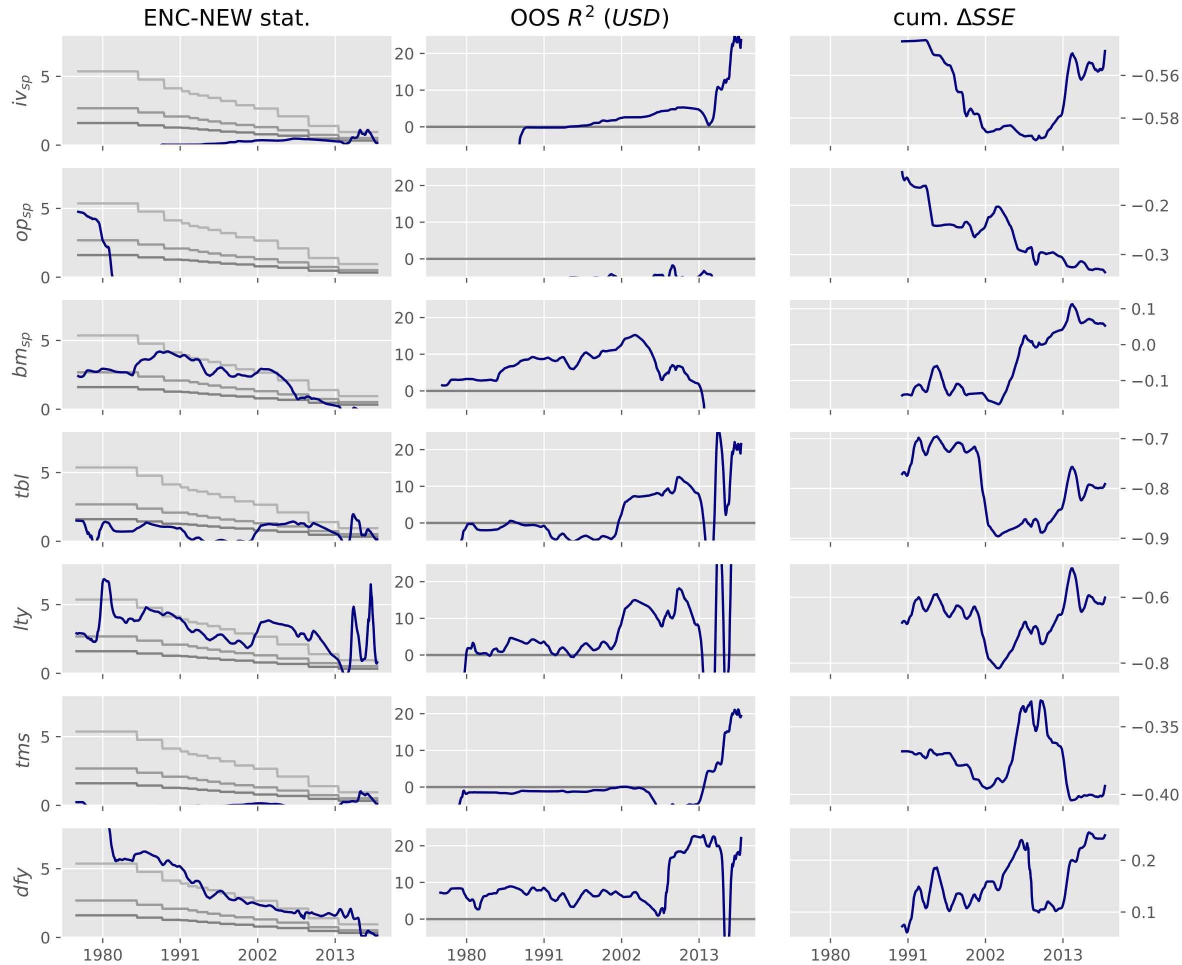

Figure 17: Recursive univariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

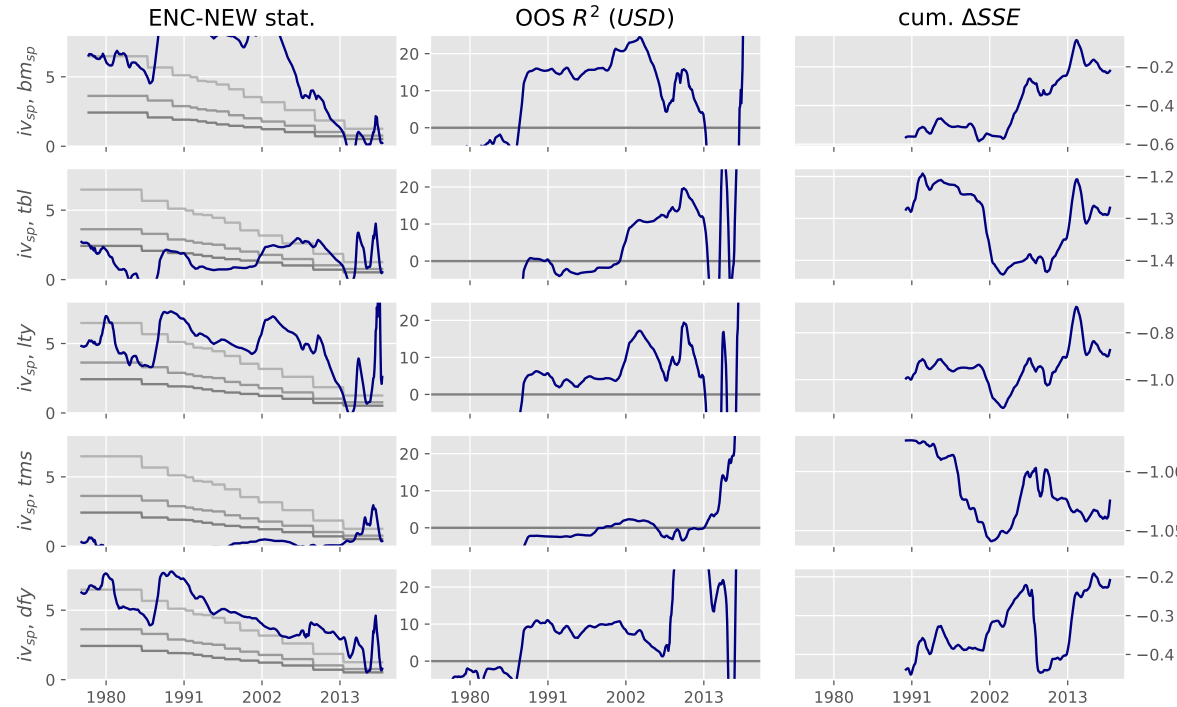

Figure 18: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

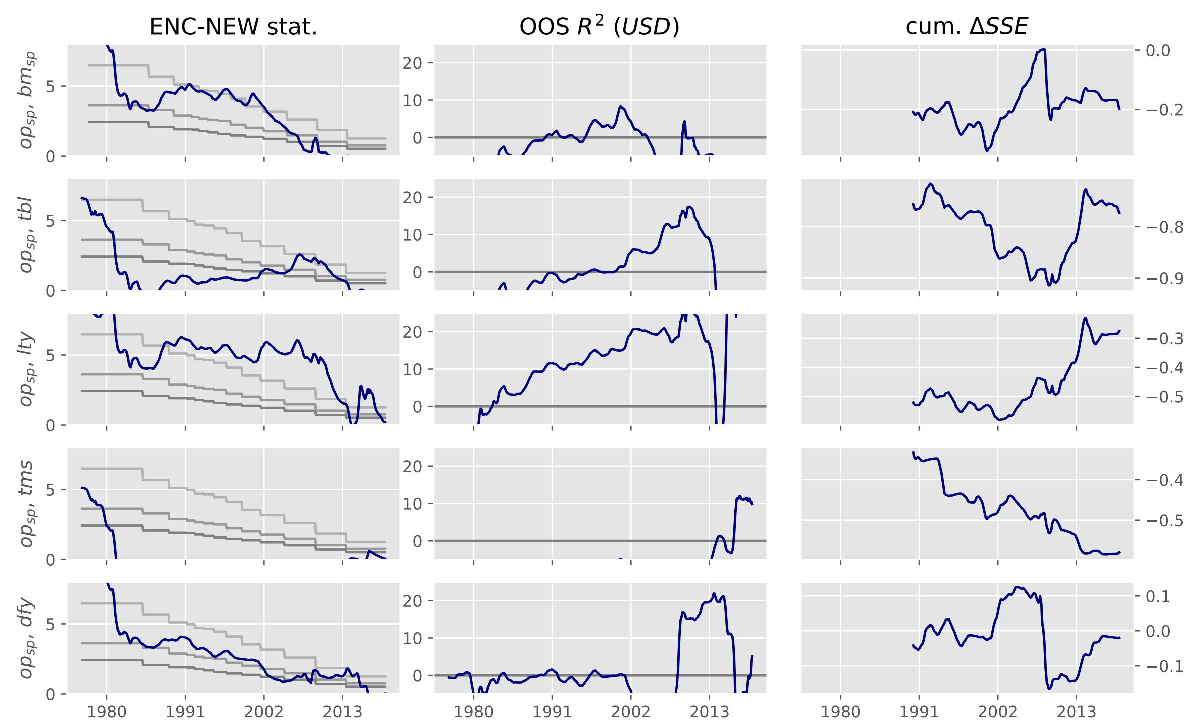

Figure 19: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

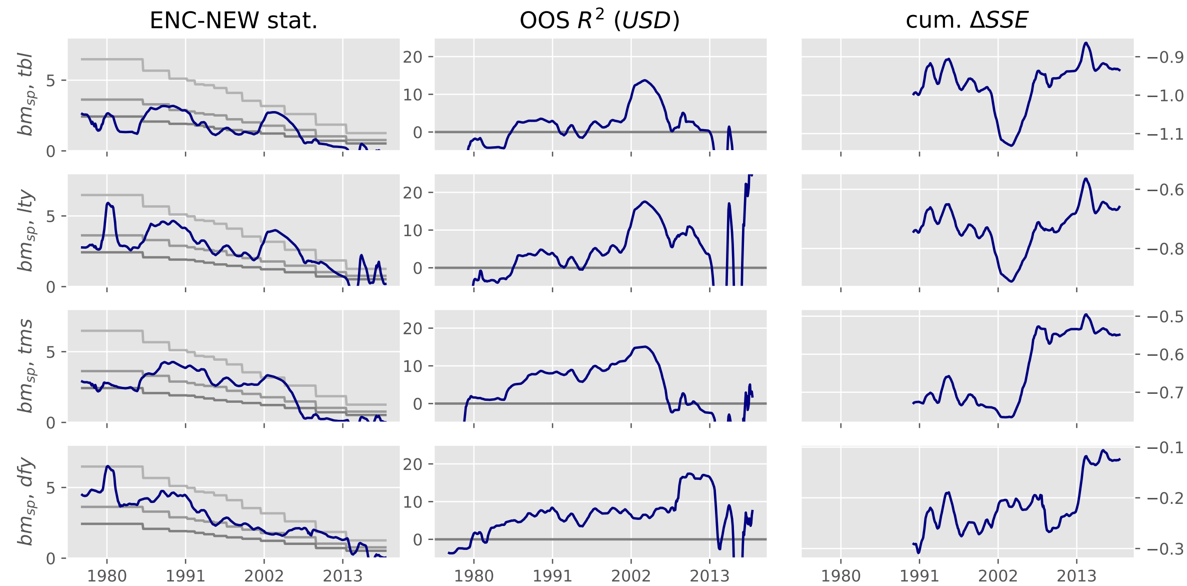

Figure 20: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

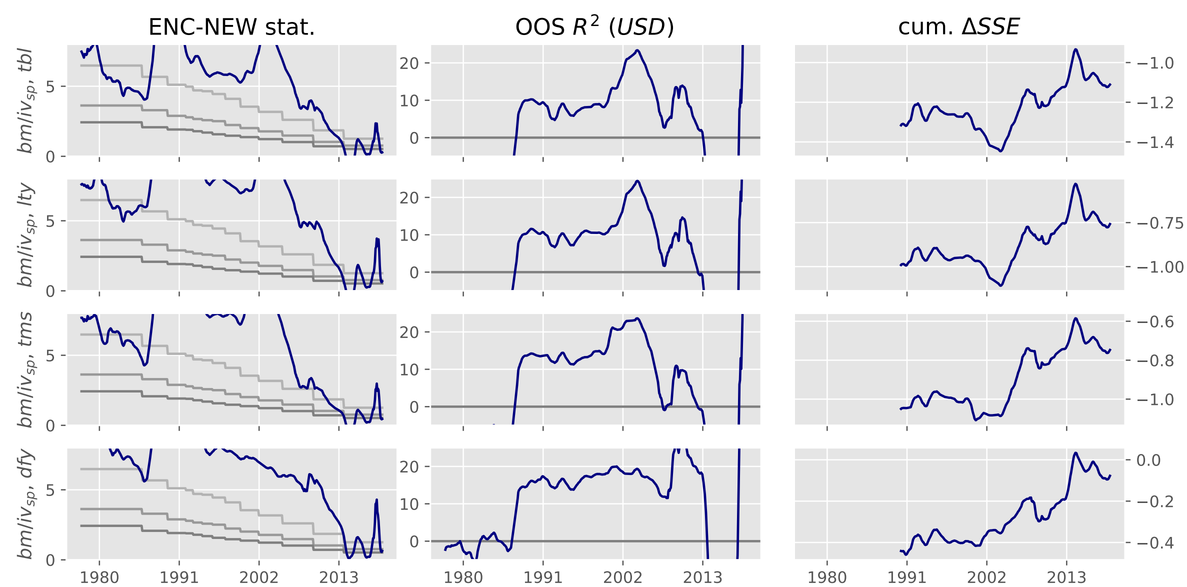

Figure 21: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

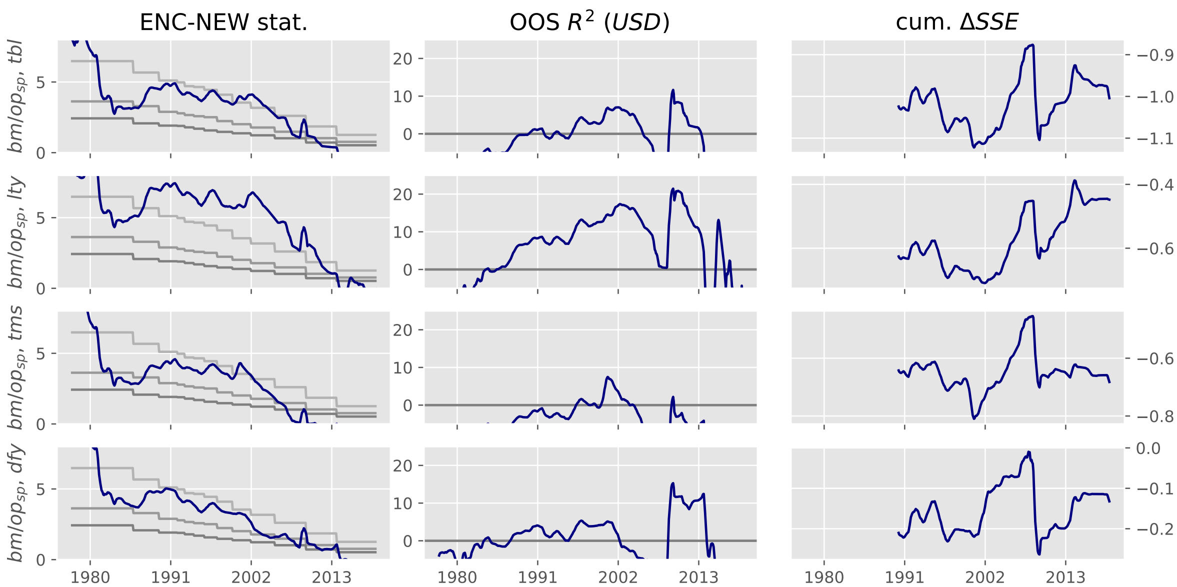

Figure 22: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

B.3 Dollar-neutral monthly returns

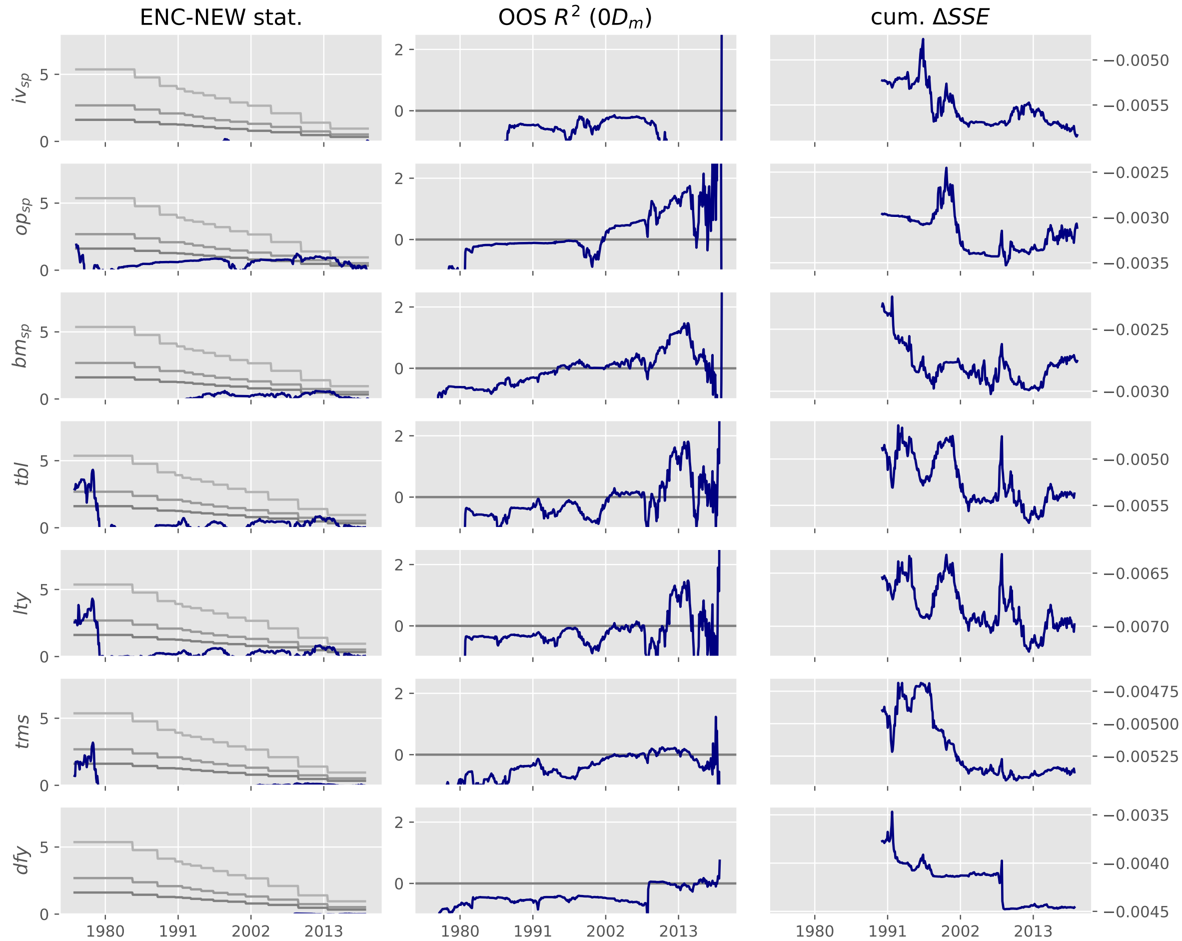

Figure 23: Recursive univariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

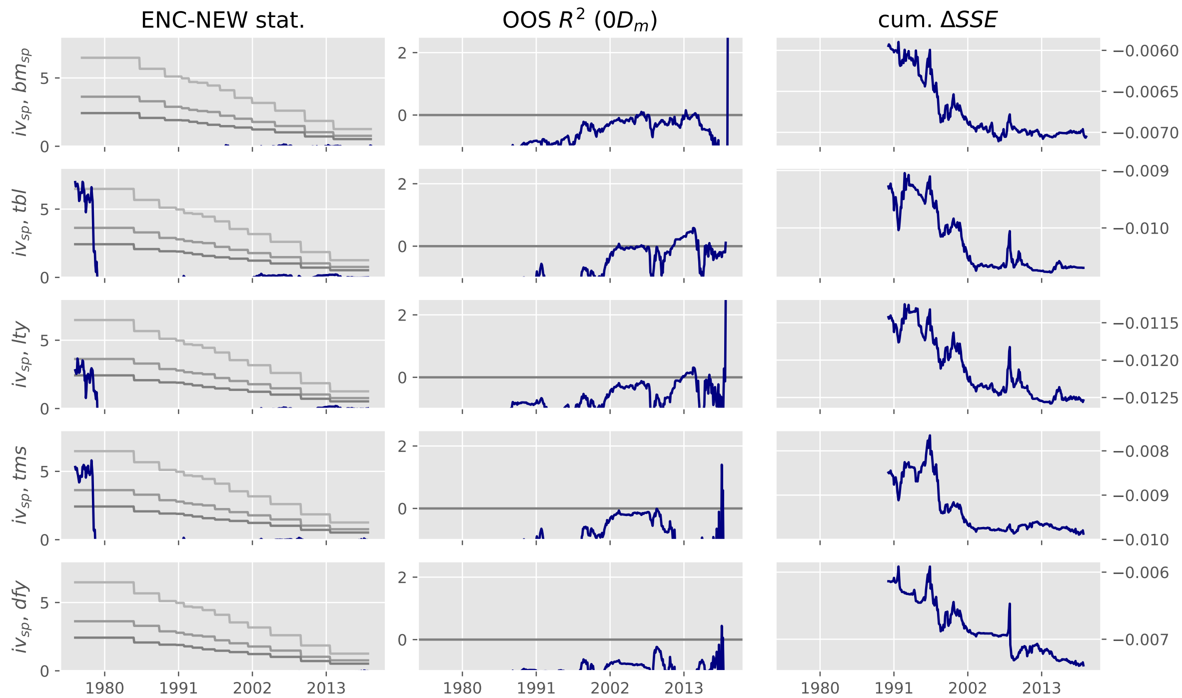

Figure 24: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

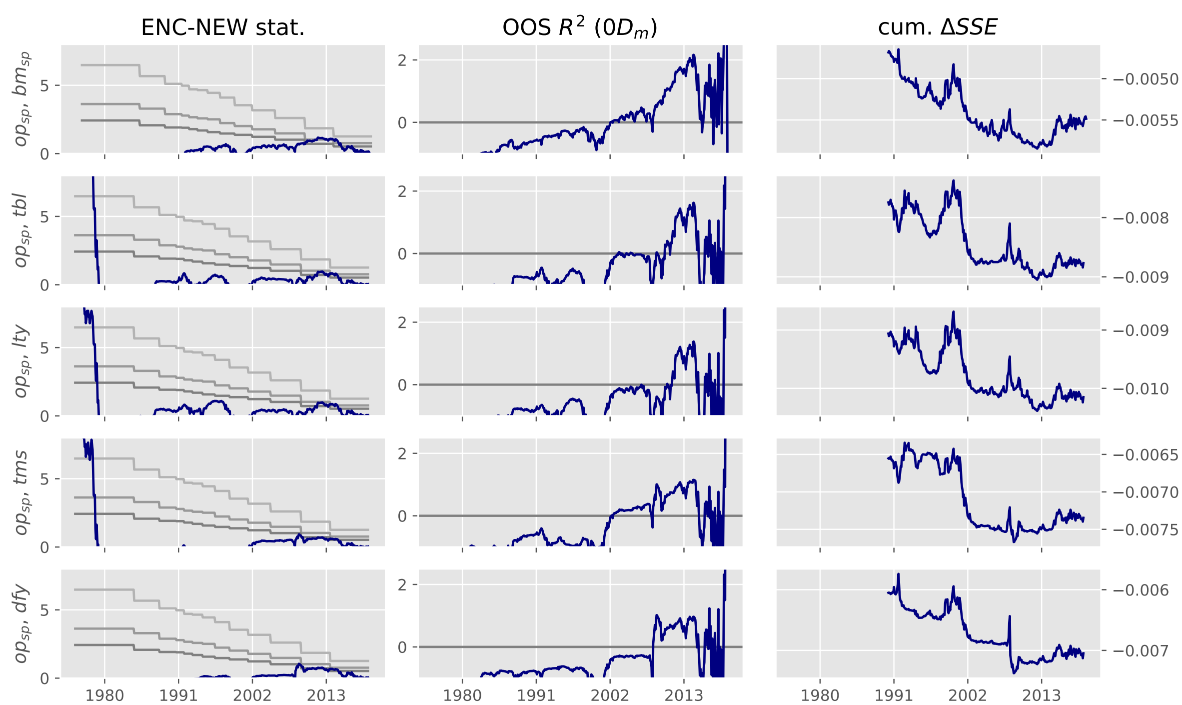

Figure 25: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

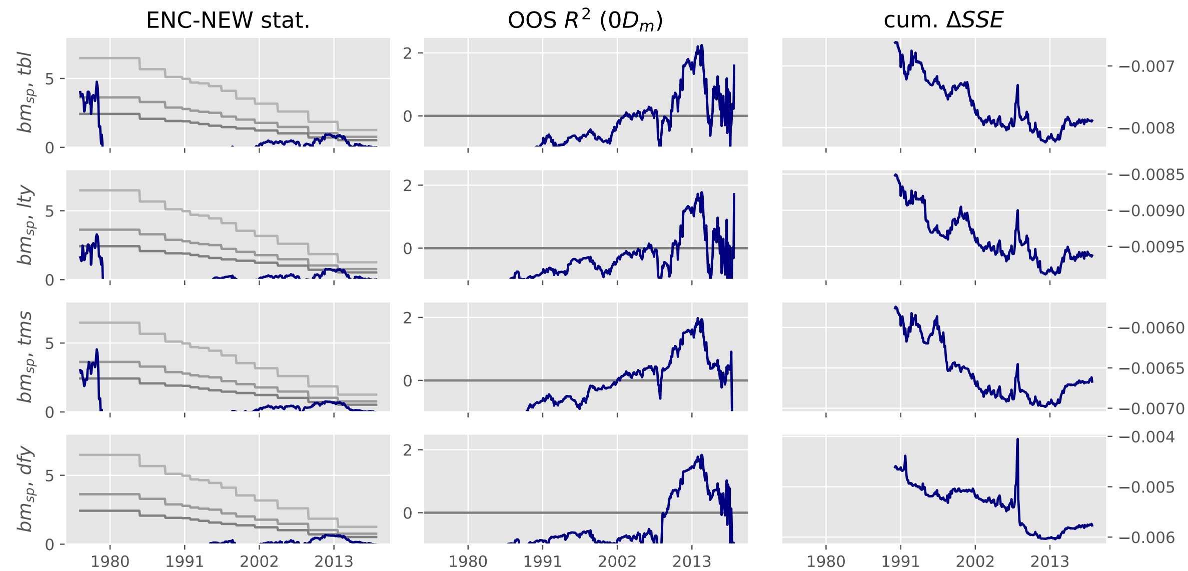

Figure 26: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

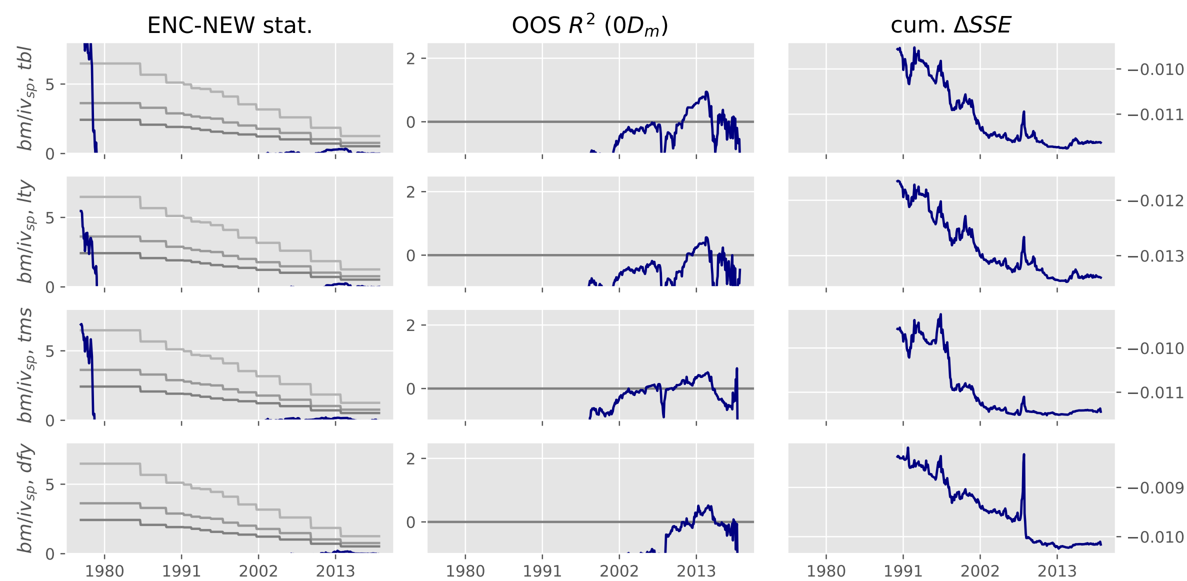

Figure 27: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

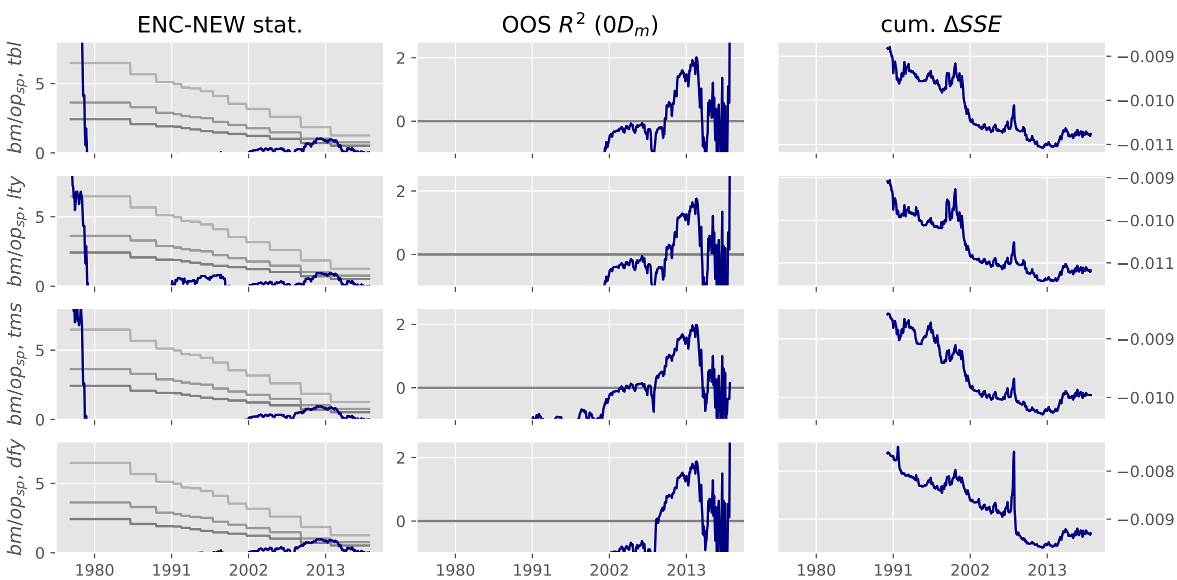

Figure 28: Recursive bivariate regressions of the equal-weighted dollar neutral carry trade strategy on selected regressors.

B.4 Dollar carry monthly returns

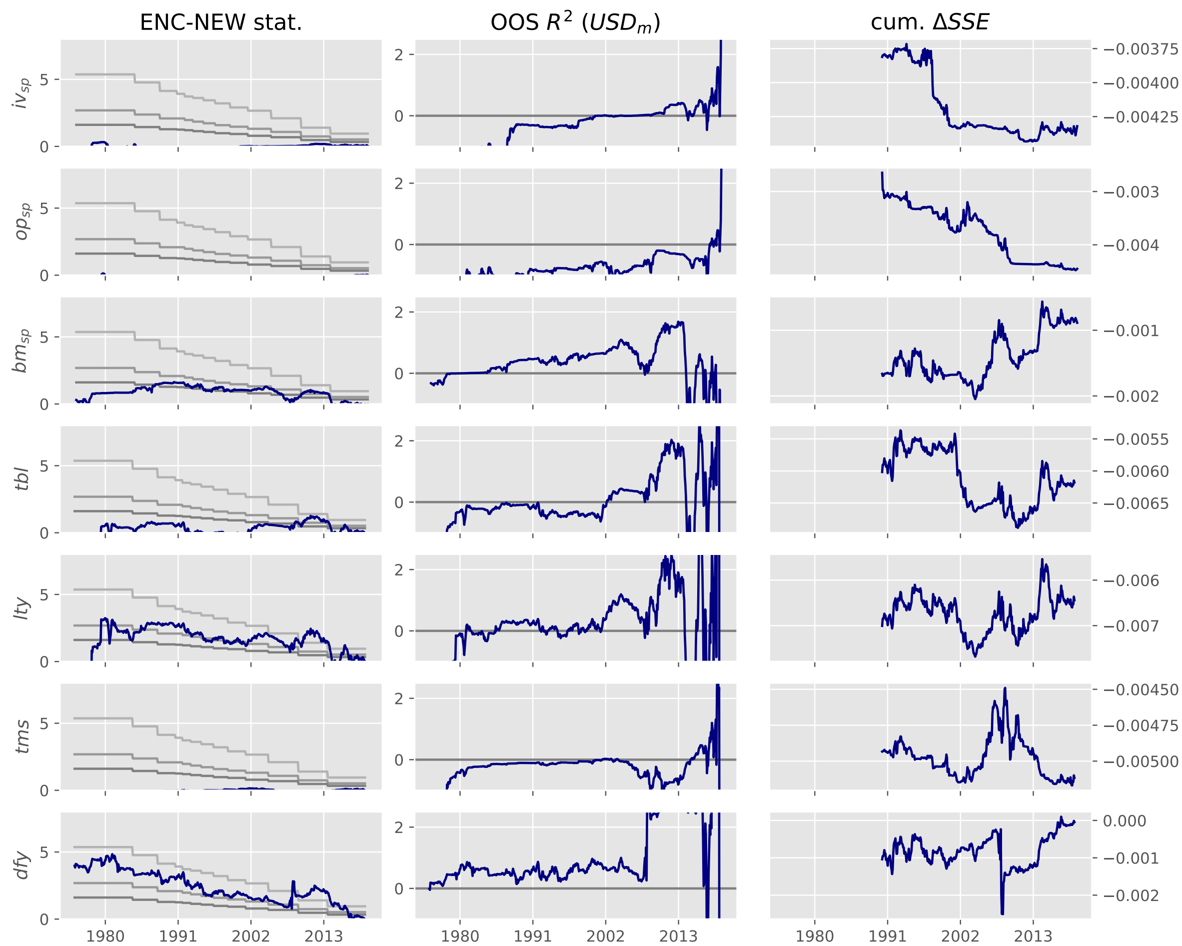

Figure 29: Recursive univariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

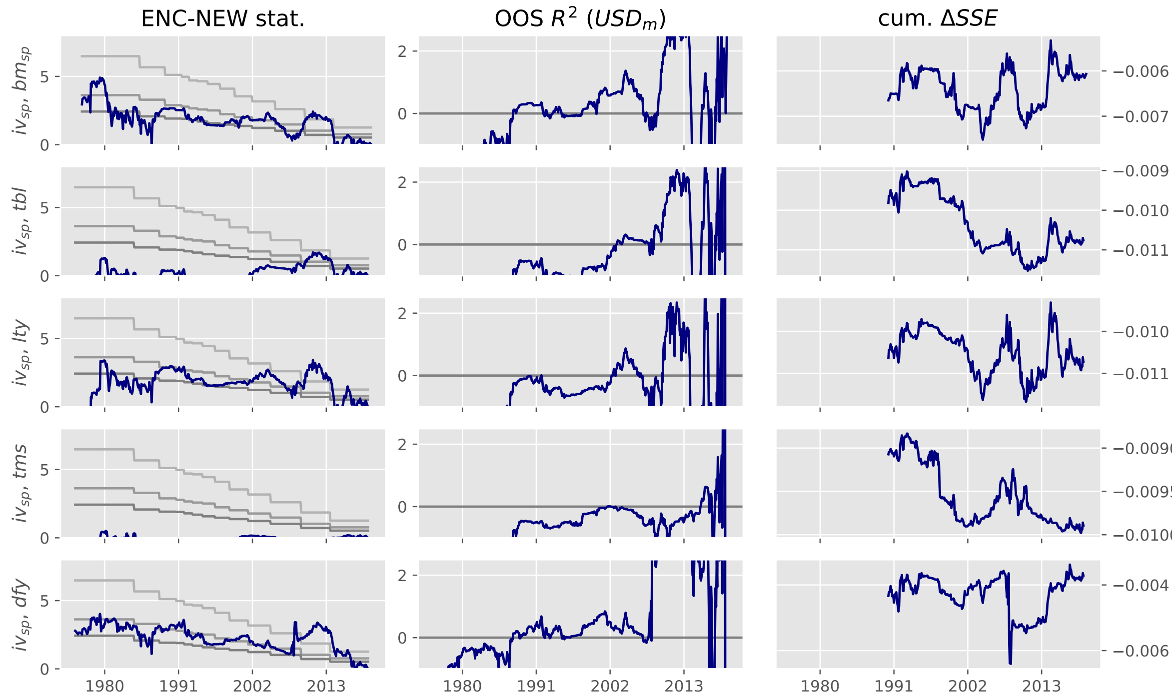

Figure 30: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

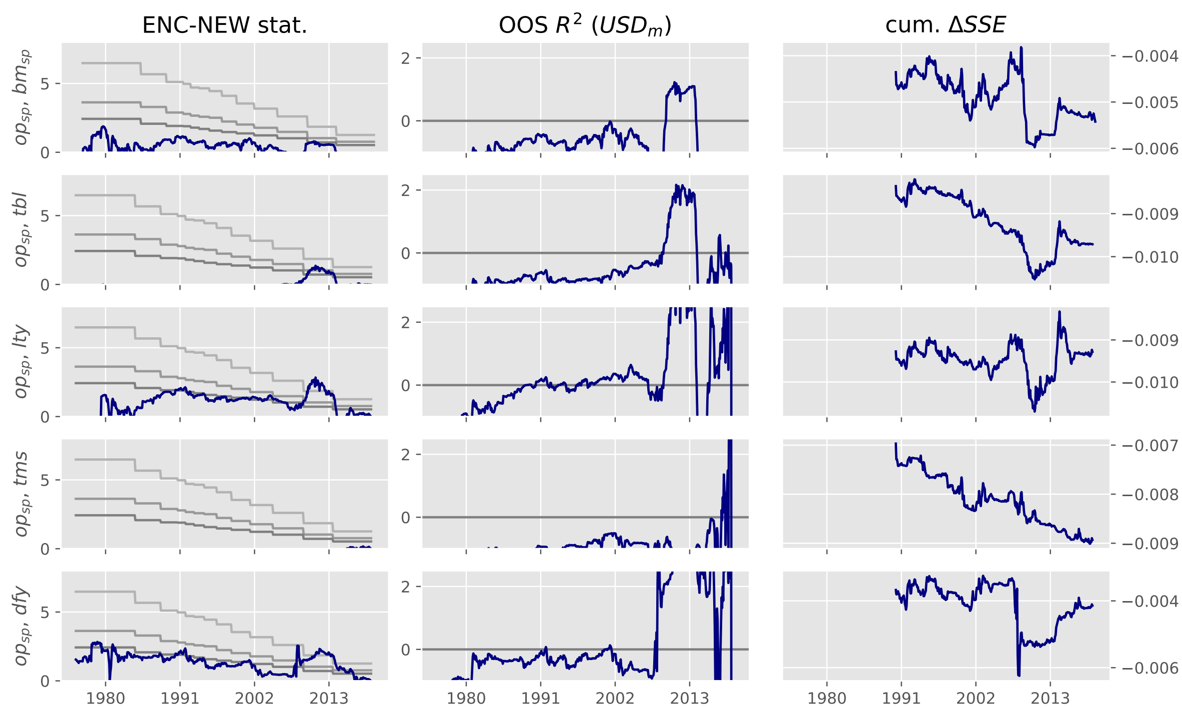

Figure 31: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

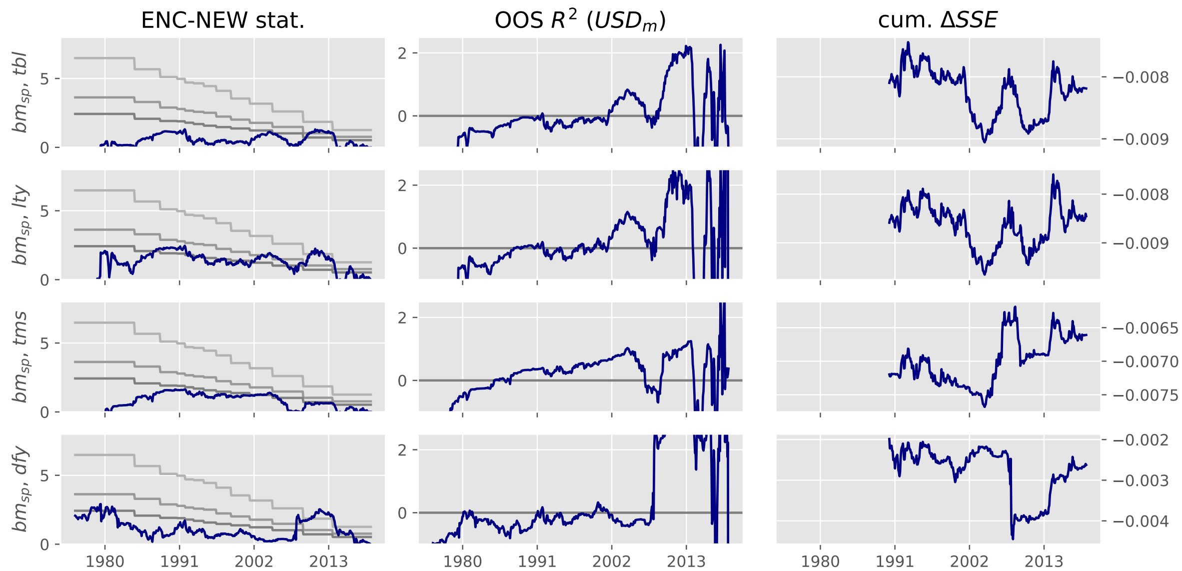

Figure 32: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

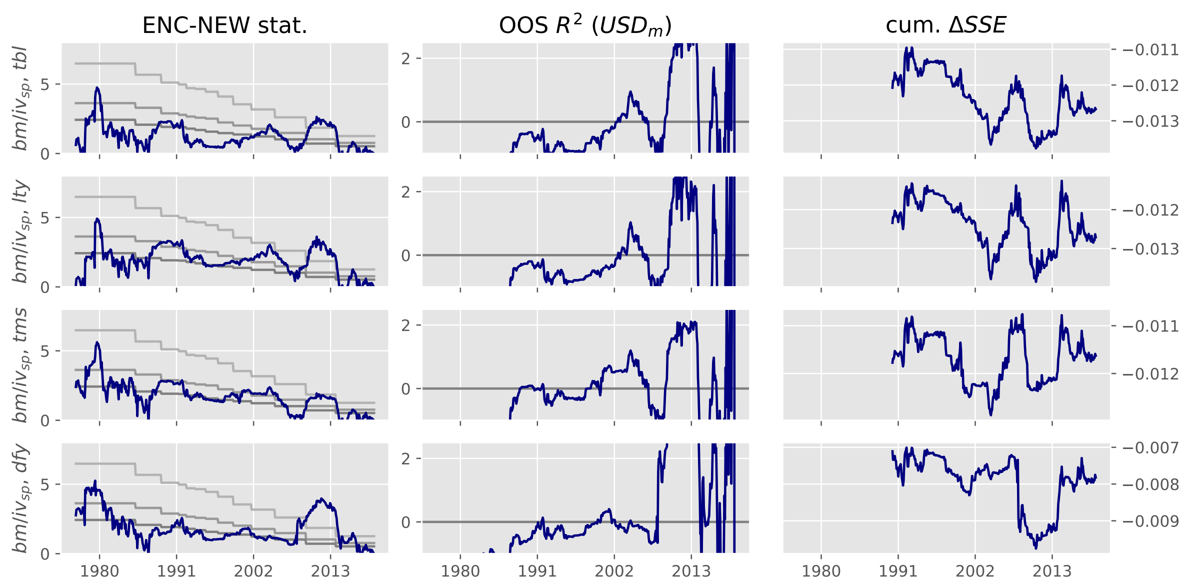

Figure 33: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

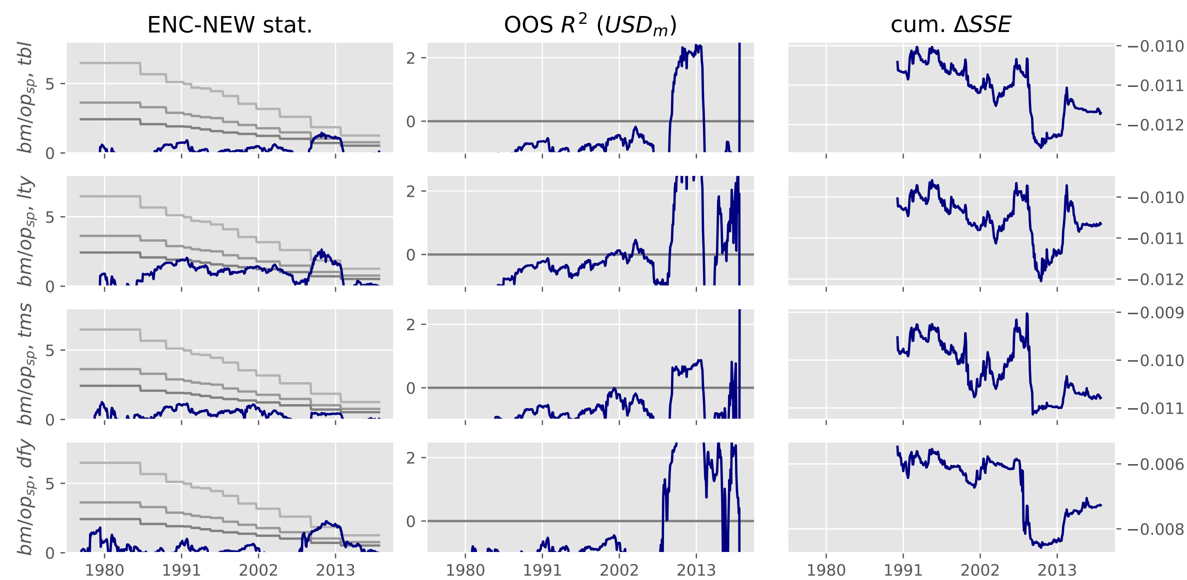

Figure 34: Recursive bivariate regressions of the equal-weighted dynamic dollar neutral carry trade strategy on selected regressors.

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