Why are some currencies viewed as benchmarks? The Roles of Interest rates, Economic Size, and Exchange-rate Regime

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First draft: December 2008
this version formatted at 16:13 on Friday 13th February, 2009

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Abstract

The forward puzzle is traditionally explained as the reflection of a covariance-risk premium, market friction or limits to arbitrage. Recently, Liu and Sercu (2009; henceforth LS), working on intra-ERM rates for the DEM, presented evidence consistent with career-risk considerations (portfolio managers shun assets with danger signals), or with investors otherwise assign fallen-angel status to such assets. In this paper, we test the external validity of this finding: we compare floating rates to band-regime ones, strong base currencies to weak ones, and large economies to small ones. We find that the exchange-rate regime seems to matter the least; but the bench-marking role can come from either a huge economy (the U.S.), a strong currency (Swiss Franc, Dutch Guilder), or good ratings on both counts (Japan and Germany). Consistent with the idea that these are slow-moving reputational effects, the evidence is especially present in the long-run-trend component of the forward premium. In the short-run, filtered part, other factors seem to be at work.

Keywords: forward puzzle, exchange rate regime, base-currency strength, nonstationarity, career-risk premium.

JEL-codes: G15, G32.

Introduction

The carry trade, *i.e.* the strategy of borrowing in a currency with a low interest rate and investing in a currency with a high interest rate, has been around for a long time. Its success is based on the empirical regularity that strong currencies appreciate by less, on average, than their (positive) forward premiums, and that weak currencies depreciate by less than their (negative) forward premiums. Figure 1, overleaf, shows numerical and graphical information on some long-term means for exchange-rate changes and premiums; the cross-sectional regression confirms that, on average, the exchange rate change is about 60% of the earlier 'prediction' by the forward premium. Implicitly, then, there would be a risk premium that is, on average, -40% of the forward premium, meaning that strong currencies earn a negative risk premium and vice versa. The phenomenon has been well documented since several decades[1] and the carry trade is well known among practitioners, so the phenomenon could be deemed to be an equilibrium one rather than an anomaly or just an unexpected windfall. In fact, the pattern of implied risk premiums fits in perfectly with what many people would think to be a normal risk premium: weak currencies are risky, strong ones not. This feeling is neatly reflected in a quote from *The Economist*,

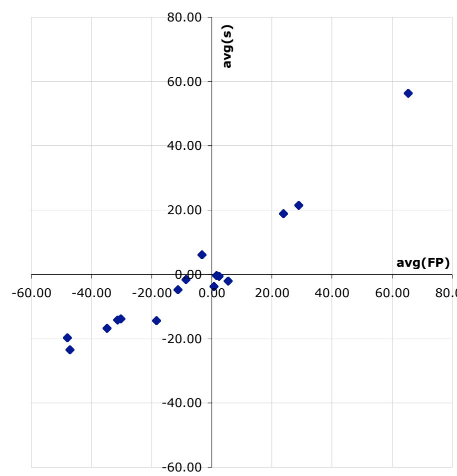
> [...] riskier currencies have lost ground to the relative security of the Japanese yen and the Swiss franc. (*The Economist*, January 26, 2008, p 68.)

Whether that notion of risk agrees with what finance theory thinks about it—a covariance with the market as a whole, for instance—is far from obvious. It certainly fits in with the more humdrum notions of risk like career perspectives. In fact, the most influential investors now play with money not of their own but of their customers or employers. These professional portfolio managers do not necessarily look for the best return, but for the best track record. The big, strong currencies do look safe and respectable. Paraphrasing the old saying about IBM's computers, one could state that "Nobody ever got fired for buying CHF". Getting fired for buying Turkish Lira is much easier to imagine. In the stock market there is a similar aversion to very small-capitalisation stocks or to shares that have done badly in the recent past ('fallen angels'): investors don't like them, so they're priced with big returns.

[1] Already as of the late seventies the carry-trade strategy was tested in academia and found to work; see e.g. Robinson and Warburton (1980), and Bell and Kettle (1983).

Figure 1: **Unconditional Tests of UIP**

	avg s	avg FP	s-FP	t	prob
ats	–14.20	–31.30	17.10	0.83	0.41
bef	–4.80	–11.20	6.40	0.31	0.75
cad	–1.60	–8.60	7.00	0.26	0.80
chf	–19.70	–48.00	28.30	1.20	0.23
dem	–16.80	–34.80	18.00	0.88	0.38
dkk	–3.80	0.75	–4.55	–0.22	0.83
esp	21.50	28.99	–7.49	–0.39	0.70
frf	6.05	–3.20	9.25	0.45	0.65
iep	–2.10	5.45	–7.55	–0.43	0.67
itl	18.90	23.90	–5.00	–0.24	0.81
jpy	–23.50	–47.20	23.70	0.84	0.40
nok	–0.60	2.41	–3.01	–0.16	0.87
nlg	–13.80	–30.20	16.40	0.82	0.41
pte	56.31	65.35	–9.04	–0.44	0.66
sek	–0.40	1.57	–1.97	–0.10	0.92
usd	–14.40	–18.40	4.00	0.14	0.89



$$s = \underset{(1.47)}{3.37} + \underset{(0.05)}{0.64}\, FP, \; R^2 = 0.92$$

Key We test the equality of mean monthly exchange-rate changes and one-monthly forward premiums against the GBP (quoted as HC/GBP, UK style), 1977-96. All means (and their differences) are expressed as basis points, i.e. percentages of percentages. The plot on the right visualizes the means. Means and t-tests kindly provided by Martina Vandebroek.

Another puzzling item, besides the nature of the risk premium, is the discrepancy between the above cross-sectional evidence, based on long-term means of the two variables, and the time-series evidence for every separate exchange rate. In time-series tests, there seems to be almost no connection, or surprisingly often even a negative connection, between exchange-rate changes and forward premiums. One possible explanation of the difference between the cross-sectional and longitudinal results might be that, while the time-series means are reasonably well related, the timing inside each time series is wrong—for instance, if forward premiums would fall after a depreciation (and vice versa), rather than at the beginning of the period of the depreciation. Another possibility is that the risk premium is quite unstable, as a fraction of the forward premium. Liu and Sercu (2009, henceforth LS), test a whole array of such non-linear models to intra-ERM exchange rates for the DEM, and find evidence consistent with the career-risk or fallen-angel hypothesis: increasingly negative premiums seem to come with fast-rising higher risk premiums, while increasingly positive premiums seem to be associated with more and more negative risk premiums. LS also split up the premiums into a long-term trend and short-term deviations, and find that their risk premium pattern mostly stems from the long-term component; while the short-term fluctuations around the trend do contain a similar premium, they also load much more on expectations.

In this paper we test the external validity of these findings. Our prior is that the pattern is not universal. Even if we see fairly isomorphic non-linearities in rates for the DEM, we cannot expect the same isomorphic relations among all possible cross-rates that can be generated from this data. Indeed, as far as we can see, there is only case of a universal, currency-independent behavioral equation: if there is a linear relation between expected log exchange-rate changes and log forward premiums relative to some base currency, with the same slope coefficient across all rates for this base, then also all cross rates follow the same model. In the LS case, the model is so nonlinear that the difference between, for example, the DEM/FRF and ITL/FRF equations would not generate a similar equation for the cross rate, DEM/ITL, even if the coefficients in the original equations were equal across the two rates. So, we can expect heteromorphism as a rule. Even for an inverse rate rather than a cross-rate, there exists heteromorphism. True, the pattern for the DEM/ITL data must be the same as that for the ITL/DEM, except for the effect of flipping the signs of the axes. But we cannot be sure the relation would be symmetric in the sense that a loss is just a negative gain. In the paper we call this asymmetry, and it should not be confused with heteromorphism.

Given that the patterns can be very different in different data or even in various rotations of the same data, the question arises whether the LS patterns arise elsewhere too, and which properties of the DEM seem to be crucial for LS's findings: the strength of the currency, the size of the economy, or the fact that all rates were part of an admissible-band regime. We test this by replicating their estimations on various sets of exchange rates. The USD indirectly quoted for HKD, for instance, is a band-regime rate, but refers to a much smaller economy relative to the DEM, and the base currency is actually relatively strong to the quoting currency. Likewise we study some ERM rates from smaller economies, having either weak base currencies (ITL, ESP) or a strong one (NLG); floating rates against a strong currency with either a rather small economy (CHF) or a bigger one (JPY); or floating rates against a half-strong base with a huge economy behind it (USD). We find that the LS pattern is present surprisingly often, and is patently absent in the ITL sample (which rather fits the transaction-cost/limits-to-arbitrage idea) and the HKD sample supports the Bansal's risk-premium theory in terms of the short-term filtered component. In addition, again like in LS, the pattern is coming from the trend component in the forward premium, the long-run numbers, while the short-term fluctuations around it do not seem to generate similarly changing risk premiums.

1 Models and Hypotheses

LS use cubic polynomials to model the relation between exchange-rate changes and forward premiums. These cubics can capture at least three very different theories about the risk premium, which are reviewed in the first subsection. Then we turn to the testable hypotheses.

1.1 The Competing Hypotheses

We review, in turn, the market-friction/limits-to-arbitrage hypothesis, the Bansal risk premium and the career-risk/fallen-angel view. In the appendix, we explore a behavioral extension as what prospect theory and mental accounting have to offer in this field; the testable predictions are somewhat meager though, as far as we can see, but the unsurprising conclusion is that the patterns proposed here could also be the result of a behavioral model.

The Market friction/Limits to arbitrage Hypothesis

Huisman *et al.* (1998) explain the forward puzzle as stemming from friction in the market, notably transaction costs. Because of such costs, uncovered interest arbitrage cannot perfectly align expected exchange rate changes and forward premiums. Market friction is especially likely to obscure the theoretical parity between the two when the expectation of the exchange rate change is small and diffuse, a description that may very well apply to most situations. In contrast, those observations where the forward premiums are larger may provide a much favorable signal-to-noise ratio than the small-sized observations. Huisman *et al.* (1998) accordingly let the Fama regression assume different coefficients depending on whether the cross-sectional variation of the daily forward premium is high or low, and they use panel techniques with a cross-currency constraint that ensures numeraire-invariance of the estimates. Their major finding is that large-variance observations generate Fama regression coefficients close to unity, and even substantially above unity if the definition of "large variance" is very strict.

The Limits-to-Arbitrage literature models, which has its origin in behavioral finance (see e.g. De Long *et al.*, 1990, or Schleifer and Vishny, 1997), is similar in spirit, pointing out that in reality so-called arbitrage is not cost- and risk-free. More recent tests would typically model the varying beta in a smoother and more flexible way rather than the abrupt switch between the large- and small-sized forward premiums of Huisman *et al.* But both the market-friction and the limit-to-arbitrage theories believe that the slope (beta) increases in the size of the forward premium — that is, the betas should exhibit a U-shaped pattern. Table 1 sums up

Table 1: **Overview of the competing theories**

Model	rp in terms of f	β in terms of f
Huisman *et al.* (1998) and limit-to-arbitrage	—	U-shaped or inverse bell pattern
Bansal (1997)	– (inverse) U-shaped pattern: – (inverse) V-shaped approximation:	β linear in f, changing sign β stepwise, changing sign
Fallen-angel hypothesis	Cotangent shape, possibly asymmetric	inverse U or inverse V, possibly asymmetric

Key: "rp" denotes the risk premium, "β" the Fama (1983) beta and "f" the forward premium.

the competing theories and their betas patterns.

Bansal's Risk Premium Hypothesis

Bansal (1997) takes a very different perspective, focusing on the risk premium instead of friction. He starts from a CCAPM equilibrium asset pricing model, and establishes that its currency risk premium is approximately quadratic in the forward premium. Thus, the entire relation between expected change and forward premium becomes quadratic. In his tests, Bansal approximates this by a piecewise linear relation, implying that the Fama β changes discretely around $f = 0$, from positive to negative or vice versa. With the original quadratic function for expected exchange-rate change, the beta is negatively or positively linear in the forward premium.[2]

The LS Career-risk/Fallen-Angel Hypothesis

Liu and Sercu (2009), lastly, discuss a new possible explanation, the Fallen-angel hypothesis or career-risk effect. They point out that the market is dominated by professional investors (traders or portfolio managers) rather than individuals who play with their own stakes. For a

[2]Bansal empirically observes a negative relation but this depends on the choice of the base currency: the Bansal patterns, with an inverse U for the expected change and a falling beta, get reversed if we look at the rate from the other currency's perspective. If $\mathrm{E}(\tilde{s}) = \alpha + \beta_1 f + \beta_2 f^2 + \beta_3 f^3$ and $s' := -s$ and $f' := -f$, then $\mathrm{E}(\tilde{s}') = -\alpha + \beta_1 f' - \beta_2 f'^2 + \beta_3 f^3$. That is, in a linear regression only the intercept flips sign; in a quadratic, a U gets inverted and vice versa; and the cubic coefficient does not change. In terms of beta we have $\beta' = \beta_1 - \beta_2 f' + \beta_3 f'^2$: a falling Bansal beta flips to a raising one, but a U- (or inverse-U-)shaped beta retains its shape, and only the vertex shifts from the positive to the negative domain of the forward premium or vice versa.

professional, the ultimate decision criterion is the portfolio manager's career and remuneration prospects. However, neither remuneration nor reputation is linear in the portfolio return, but depends on how and when any losses have occurred. For example, when bad news arises about a foreign currency, its spot value falls and its interest rates rise, implying that the forward exchange rate falls even more than the spot. The manager may then choose to liquidate the foreign positions, thus risking to miss a recovery; or she can act contrarian and stay long, risking a further drop in the spot rate. From the perspective of the manager, a cash loss from being contrarian (after there has been a clear and publicly observable bad initial signal) looks much worse than an opportunity loss from missing a rally that is unlikely anyway, judging by the initial forward premium. Any cash loss from going against the flow will be met with the comment that the trader "should have seen it coming", but the opportunity loss from heeding the danger signal will not. In short, when bad news hits the market, professional investors head for the exit even if there would be an expected gain from the subsequent recovery, because the expected gain from the recovery is counterbalanced by a dark matter, the potential damage to the contrarian professional investor's career if expectations turn out to be wrong. This view certainly fits well with the strong culture of loss-cutting among currency traders.

Liu and Sercu test the idea on ERM rates for its core currency, the DEM. One reason for choosing ERM data is that a clear band around the central parity rates makes the danger signals easier to recognize. In addition, in a band regime, political considerations often keep the accumulating tensions bottled up for longer times. LS find that the cubic model (where the beta is quadratic function of the forward premium) is the best specification in terms of goodness-of-fit; and the pattern of betas shows a clear inverse-U shape that fits with the career-risk premium. In addition, they decompose the nonstationary forward premium into a trend and a short-term component, and run the Fama regressions with either component as the regressor, instead of the total forward premium. When the regressor is the short-term component, the model generates higher betas than do the raw forward premium or the trend component. Thus, the filtered, stationary component picks up more of the expectations. Still, on top of the difference in general levels of the betas, there is an inverse-U shape pattern for both components, consistent with the idea that the career-risk premium is present in both components.

Career risk considerations may be privately rational behavior but lead to irrational prices. It is less obvious whether the fallen-angel phenomenon, as referred to in the stock market literature, is privately rational. It could just stem from the behavioral phenomenon of recency, where a recent event (a drop in prices) leads the agent to attach an excessive probability to similar events in future.

'Irrational' prices could also emerge under another branch of behavioral finance, prospect theory. It turns out that prospect theory has something to say on the forward bias but little, as far as we can see, about the relationship to the forward premium. We relegate the issue to Appendix A. We now move on to our tests. To prepare the ground we state the competing hypotheses as theories about a Fama beta that is nonlinear in the forward premium, f.

1.2 Testable Hypotheses in terms of the Fama Regression Slope

In this subsection, we present the beta patterns we expect under each of the competing models. From the review of Table 1, both the market-friction and limits-to-arbitrage theories suggest a U-shaped pattern: the large-sized forward premium provide higher betas than the small-sized forward premium; Bansal's risk premium hypothesis argues that the beta is negatively correlated with the forward premium; and the Fallen-angel Hypothesis proposes an inverse U-shaped pattern for the career-risk effect. All these theories regard the missing variable as a non-linear function of the forward premium. U-shapes suggest quadratics, but we noted that losses might be different from gains by more than just the sign. To allow for more asymmetries, Liu and Sercu (2009) approximate the relations by the cubic model,

$$\begin{aligned} \mathrm{E}_t(\tilde{s}_{t,\Delta}) &= \alpha + \beta_1 f_{t,\Delta} + \beta_2 f_{t,\Delta}^2 + \beta_3 f_{t,\Delta}^3, \\ &= \alpha + \beta(f) f_{t,\Delta} \\ \text{where } \beta(f) &= \beta_1 + \beta_2 f_{t,\Delta} + \beta_3 f_{t,\Delta}^2, \end{aligned} \tag{1.1}$$

in which the β_2 and β_3 are the coefficients of the higher-order items. By implication, the beta is a quadratic function of the forward premium. The possible shapes of β can be categorized as in Table 2.

From this overview, the crucial parameter to be watched is β_3, which makes the difference between the career-risk, limit-to-arbitrage, and Bansal hypotheses. All significance tests are based on Monte Carlo simulations as described in the Appendix, to simultaneously take into account the overlapping observations and the long memory in f.

Table 2: Summary of the possible shapes for betas

	$\beta_3 > 0$	$\beta_3 = 0$	$\beta_3 < 0$
$\beta_2 > 0$	regular U; min at $f < 0$ (limits-to-arbitrage)	monotone rise (Bansal)	inverse U; max at $f > 0$ (career-risk)
$\beta_2 = 0$	regular and symmetric U (limits-to-arbitrage)	constant standard model	inverse and symmetric U (career-risk)
$\beta_2 < 0$	regular U; min at $f > 0$ (limits-to-arbitrage)	monotone fall (Bansal)	inverse U; max at $f < 0$ (career-risk)

2 Research Questions

In this section, we discuss how the characteristics of the currency regime, base currency strength and economic size could affect the relationship between exchange-rate changes and premiums.

The potential relevance of the band regime is easiest to argue. In the ERM the admissible range for exchange rates is well-defined, and positions can be very clearly classified from excellent all the way down to highly risky. There even was an official summary measure that provided a synthetic view of the currency's position vis-a-vis each of the other member currencies, the divergence indicator[3]. In contrast, there is no such clear 'good'/'bad' standard for floating rate, nor does a falling rate associate with a peso-type risk of a discrete, big realignment. In the presence of a band, in fact, the notion of a danger zone is quite clear. In addition, intervention could lead to a build-up of pressure and to a drastic devaluation later on. The combination of clear danger signals and possibly disastrous consequences from ignoring these signals may be vital for the validity of the career-risk idea and related behavioral phenomena. Thus, we apply the LS tests to mainstream floating rates against the USD, JPY, and CHF to see whether the phenomenon also has any validity outside a pegged-rate system. We also present additional results for band regimes, notably the USD/HKD rate and the intra-ERM rates for the ITL, NLG and ESP.

Currency strength and economic size are the features that could induce asymmetry: the BEF

[3]The divergence indicator was published every day in all major newspapers, and was calculated as the divergence between the actual value and central parity of the ECU in units of home currency, as a percentage of the allowed maximum divergence,

$$D := \frac{[\text{actual value} - \text{central parity}]/\text{central parity}}{\text{maximum divergence}}. \tag{2.2}$$

A positive divergence indicator means a strong ECU, that is, a weak home currency.

and DEM were in the same band regime, a symmetric characteristic, but the BEF was weaker than DEM, and unambiguously related to the smaller economy. LS (2009) shows asymmetry beta pattern of the BEF/DEM rates: the inverse U-shapes have maxima that occur at positive forward premiums rather than around zero. The reason for the asymmetry may be part technical. It is a fact that, in exchange rates with the DEM as base currency, negative forward premiums are few and small in absolute terms,[4] which would make it difficult to document a symmetric relation even if there was one. So the asymmetry may just be apparent because of a lack of observations at the negative forward premiums side. If so, when we look at the same data quoted for the ITL, the weakest currency within the system, we might see the negative-premium data and find back the half-curve that was missing from the SL tests.

Yet there may be more reasons behind the observed asymmetry. In the career-risk hypothesis, an individual traders' attitudes are asymmetric in signs as concerned: they especially fear to be caught by a devaluation because such a 'mistake' hurts them more than profiting from a revaluation would help them. But one currency's devaluation is another's revaluation, it could be argued; so an asymmetry in individuals' career risks is not enough to create an asymmetry in the risk premiums, unless one country's view somehow dominates the other country's view.

Upon reflection, however, there could be a few such size-related reasons for asymmetries. If Germany has more traders, and more money, than Belgium, then the German point of view is likely to dominate in the market as a whole. This asymmetry in weight holds for all ERM members except possibly France. Second, the parlance is asymmetric. In the language of ERM alignment, neither Germans nor Belgians would think of a devaluation of the BEF as a revaluation of the DEM, nor would a rise in the USD/HKD rate be called a revaluation of the USD. In a band setting, the potential losers are the small partners. In short, in this view the asymmetry arises because Germany is the biggest economy with the biggest money market and because the DEM is the reference point for the system.

The size of the economy could matter for other reasons than the number and wealth of its investors and analysts. The big economies come into the news more often, and their currencies are familiar to all players. Recent psychological research has shown how mere familiarity can have a surprisingly large impact on valuation. *The Economist* describes one experiment, by Alter and Oppenheimer (2008), as follows. Remarkably, the familiarity effect show up even for

[4]The interest rate of Germany was often lower than that of the other members in the system, accordingly, the forward premiums are usually positive.

different versions of one currency, the USD, with US players:

> For the first part of their study Dr Alter and Dr Oppenheimer picked 37 volunteers at random from the university's canteen. They asked them to estimate how many simple objects—gumballs, paperclips and pencils—they could purchase with either a standard dollar bill or a Susan B. Anthony dollar coin that was presented to them. Susan B. Anthony dollars are legal tender but, having been produced only from 1979-81 and then again in 1999, they are rarely seen in circulation.
>
> After the volunteers had made their estimates, they were asked to indicate on a scale of one to seven how familiar they were with either the banknote or the coin. Dr Alter and Dr Oppenheimer were not surprised to find that all participants were less familiar with the coin than with the banknote. Nor were they that surprised to find a difference in how the participants valued coin and note (the expectation that there would be a difference was, after all, the point of doing the experiment). They were, however, flabbergasted by the size of the difference. People offered the banknote believed, on average, that they could use it to buy 83 paperclips, 72 napkins or 46 sweets. Those offered the coin thought 39 paperclips, 51 napkins or 27 sweets. In other words, the note was believed to be almost twice as valuable as the coin.

By way of validity check, the authors then repeated the experiment, but comparing the reactions to two single dollar bills versus a single two-dollar bill—a low-circulation, rare note. The results were almost identical. The same pattern even emerged when the study was conducted a third time, this time involving a standard dollar and a subtly doctored version including, among other things, George Washington's head reversed. *The Economist* concludes that

> [p]eople, it seems, literally value familiarity.
>
> Whether this observation has wider significance is unclear, but it may. Familiarity takes time to build up. It may have been unfamiliarity with the currency itself, rather than with its face value, which caused price gouging (or, at least, allegations of price gouging) when the euro was introduced. With that in mind, it might be wise for America's Federal Reserve to watch retail prices carefully when it introduces a new series of banknotes in August. With money, it seems, it is not familiarity, but unfamiliarity that breeds contempt.

Another example of how familiarity affects economic behavior is provided in a study of international syndicate bank lending practices by Giannetti and Yafeh (2009). Banks turn out to accept a lower risk premium, and to participate for bigger amounts, if they are more familiar with the borrower's country, even though there turns out to be no discernible difference in performance between borrowers from familiar and unfamiliar countries.

We address the asymmetry issue by testing on the rates for the reference currencies chosen on currency strength and economic size. The selected samples are introduced in next section.

3 Empirical results

3.1 Sample Selection

We run the tests in seven samples. Three sets consist of the mainstream non-ERM currencies quoting different base currencies. The currencies were the Australian Dollar (AUD), Canadian Dollar (CAD), Swiss Franc (CHF), Pound Sterling (GBP), Hong Kong Dollar (HKD), Japanese Yen (JPY), New Zealand Dollar (NZD), Singapore Dollar (SGD) and U.S. Dollar (USD). The first floating-rate set are the rates for a half strong base currency, the USD, excluding the HKD, which is pegged to the USD. In the second and third sets, all the floating currencies are quoting a strong base, namely the JPY and CHF. The difference between the two samples obviously is that the Japanese economy is larger than Swiss, so the JPY has more weight than the CHF in output and in world trade. Japan also has more wealth to manage, and the Yen's share in worldwide currency trading consistently dwarfs the Franc's share. In terms of familiarity, things are less clear. Japan's world brands are omnipresent and known to be Japanese. Switzerland has fewer such world brands, and even its flagship, Nestlé, may look more international than Swiss; but in international banking Switzerland has been very much more present than Japan, at least since the 1990s, and its reputation for financial safety is (or was) unparallelled.

The other four samples represent the fixed-rate regime. First, the ERM rates in LS's work are reexpressed into quotes for the ITL. This sample has the twin characteristics of a weak base currency and a relatively small economy. In fact, the Lira was arguably the weakest currency within the European Monetary System and Italian traders do not dominate markets, whether in terms of numbers of amounts under management. Also, for the ITL, negative forward premiums were the rule rather than the exception. If the choice of the base currency matters because of the weight and strength of the currency, then in ITL terms there should be little or no career-risk patterns and little or no asymmetry even though this currency was part of a band regime. If the choice of the base currency matters only insofar that the range of observed forward premiums is different, in contrast, then the switch to the ITL should not have much of an impact.

The other two samples are the ERM rates quoted for the ESP and NLG. Similar to the ITL, both ESP and NLG are based on small economies. The ESP was almost as weak as the ITL, so this sample can provide a robustness test of the ITL sample. The NLG is the closest to being a clone of the DEM among the members, and represents a strong currency of a small economy. The comparison between the ITL-ESP and DEM-NLG sets can help to disentangle the effect of

Table 3: Descriptive statistics: currency strength, means, and standard deviations

Statistic Summary on $s_{t,\Delta}$ and $f_{t,\Delta}$

	Panel A: Floating Rates, quotes for USD							Peg Regime
	AUD	CAD	CHF	GBP	JPY	NZD	SGD	HKD
$\%_{f>0}$	83.9	68.6	20.7	87.7	13.9	89.6	10.8	40.0
$\frac{m(s_{t,\Delta})}{m(f_{t,\Delta})}$	0.00	-0.55	1.94	-0.11	1.32	-0.46	1.15	0.02
$\frac{\sigma(s_{t,\Delta})}{\sigma(f_{t,\Delta})}$	10.93	10.25	14.95	1.82	14.54	6.72	8.77	1.25
	Panel B: Semi-pegged Rates I, quotes for DEM							
	ATS	BEF	DKK	FRF	NLG	ITL	ESP	IEP
$\%_{f>0}$	68.5	81.2	98.3	89.9	57.2	99.8	93.2	99.6
$\frac{m(s_{t,\Delta})}{m(f_{t,\Delta})}$	-0.73	0.38	0.36	0.52	0.76	0.58	0.57	0.45
$\frac{\sigma(s_{t,\Delta})}{\sigma(f_{t,\Delta})}$	3.95	2.71	2.64	2.64	4.16	5.01	4.05	3.20
	Panel C: Semi-pegged Rates II, quotes for ITL							
	ATS	BEF	DKK	FRF	NLG	DEM	ESP	IEP
$\%_{f>0}$	0.4	3.7	11.8	4.0	0.3	0.2	52.4	18.0
$\frac{m(s_{t,\Delta})}{m(f_{t,\Delta})}$	0.66	0.72	0.88	0.66	0.58	0.58	0.41	0.79
$\frac{\sigma(s_{t,\Delta})}{\sigma(f_{t,\Delta})}$	5.30	6.85	5.92	7.76	5.18	5.01	5.22	4.31

Key: "$\%_{f>0}$" is the percentage of observations which have positive forward premiums for the base currency (USD or DEM or ITL); "$\frac{m(s_{t,\Delta})}{m(f_{t,\Delta})}$" denotes the ratio of averages of $s_{t,\Delta}$ and $f_{t,\Delta}$; and "$\frac{\sigma(s_{t,\Delta})}{\sigma(f_{t,\Delta})}$" is the ratio of the standard deviations of $s_{t,\Delta}$ and $f_{t,\Delta}$.

currency strength from that of economic size.

Lastly, we study the USD, quoted indirectly in HKD. The HKD is stronger than the USD in the sense that its interest rate was typically below the American one even though the strength is not as pronounced as for the DEM and the JPY. An additional characteristic is that Hong Kong has a much smaller-scale economy than the U.S. As a strong base currency of a small economy, the HKD-case under the fixed regime can be matched with the CHF-set under the floating regime. Statistically, the HKD sample probably is the weakest in terms of power: being a one-series set only, it has fewer observations and less variability on the right-hand side. We need to bear this in mind when interpreting the evidence.

All observations are weekly, and the forward quotes are for one-month contracts. We want comparable sample sizes (about 20 years), but the data from the ERM tautologically end in 1998, so they have to start earlier. Thus, the sample period is from Apr. 2nd, 1979 to Dec. 31st, 1998 (1030 weeks) for the ERM currencies, and from Jan. 2nd, 1985 to Dec. 31st, 2006 (1148 weeks) for the floaters and the HKD.

3.2 Descriptive statistics on forward premia

Panel A of Table 3 presents some summary statistics on the exchange-rate changes and the forward premium for three illustrative sets of sample, those for the USD, the DEM, and the ITL. The first line shows the percentage of observations with positive forward premiums for the base currency or quoted currency (USD or DEM or ITL). In the view of the Unbiased Expectation Hypothesis (UEH), a positive forward premium f corresponds to an expected appreciation of the base currency. So, a high percentage of positive fs within the observed period indicates that most of the time the base currency was strong or, equivalently, the quoting currency was expected to lose value relative to the base. Among the floating currencies, the AUD, CAD, GBP and NZD have more then 50% positive fs for the USD, meaning that these quoting currencies were usually weak relative to the USD. In contrast, the CHF, JPY and SGD have much fewer positive fs for the USD, indicating that these HC's were relatively strong relative the USD. In the admissible-band regime group, intra-ERM currencies are all weaker against the DEM (where positive fs for the DEM are in the majority); but relative to the ITL the currencies become the stronger group: only the ESP is close to the ITL in terms of strength, with a percentage of positive premiums for the ITL even (slightly) exceeding 50. The HKD, lastly, is pegged to the USD, whose status is neither as good as the DEM nor as bad as the ITL. On the basis of f we would classify the HKD as mildly strong because the USD trades at a premium only 40% of the weeks. Note also that this currency provides us with a welcome additional case: while in forward-premium terms it is not nearly as strong as the DEM was in its own backyard, the dollar nevertheless stands for a huge economy, economically and financially, especially relative to Hong Kong's.

In the rest of Table 3, some summary statistic on s and f are reported as ratios, providing a direct view on the relation between regressee and regressor. We first show $\frac{m(s_{t,\Delta})}{m(f_{t,\Delta})}$, the ratio of the means of s and f. This provides a first rough test of the unbiased-expectations view, which predicts that these ratios should be about unity. A glance at the table shows they are not. Interestingly, the usual carry-trade logic (with weak currencies falling less, and strong currencies similarly rising less, than their fs predict and *vice versa*) seems to have worked within the ERM but nor so clearly for the USD. Against the strong floating currencies (CHF, JPY and SGD), the dollar depreciated by more than its premium predicted, as shown my their ratios exceeding unity; still, for weak floating currencies the ratio was below unity or even negative, exactly as the carry-trade logic would predict. For the ERM, that logic would have worked too. All ratios are, in effect, below unity, meaning that the Mark appreciated by less than its f predicted. and the Lira depreciated by less. Lastly, the ratio of the standard deviations of s and f, is always above unity and turns out especially big under the floating regime. All this suggests that there is substantial complexity and heterogeneity in the setting. A linear relation as in traditional Fama regressions may not be enough to capture all.

3.3 Currency-by-currency Estimation

All the competing theories mentioned before can be generally tested by the cubic model (Equation [1.1]), where the higher-order coefficients (β_2 and β_3) help to tell the pattern of betas (See Table 2). Following LS, we test the models not only on the forward premia, but also, after a Hodrick-Prescott decomposition, on the two components of the forward premium. The motivation for the Hodrick-Prescott (HP) decomposition was as follows. The image of a currency as safe or unsafe is probably changing slowly, so if this is to be picked up by the forward premium then our chances might be best if we filter out the short-term fluctuations. In addition, the LS long-term component of the forward premium has a unit root or is at least close to it, while the short-term part is definitely mean-reverting. Since in a band regime expected rates of change of currency prices cannot be unit-root processes, the expectations component, if any, in the forward premium would be more present in the short-term fluctuations, and the risk-premium component in the long-run part.[5] In each case we estimated models series per series.

With the currency-by-currency estimation, we hardly find significant higher-order coefficients for the floating currencies. The cubic model does not add much explanatory power to the Fama regressions, and there usually is not even a dominant beta pattern across the rates for a given base rate.[6] The only interesting results, beside those for the DEM that are already described in LS (2009a), are those for the ITL; so we report the latter in Panel A of Table 4, compared with the DEM-set quoted from LS's work, displayed in Panel B. From left to right, we show the estimates of the cubic model related to various regressors, the forward premium f, its two components, ff and $\widehat{f}$, accompanied by the Wald tests on nonlinearity. In Panel A, there are consistent patterns with unanimous signs of β_2s and β_3s when the ERM rates are quoted for the ITL, but there are fewer significant coefficients and Wald tests than the DEM-set in Panel B. Furthermore, when we further explore the difference between two

[5]If risks are orthodox covariances with consumption growth or market returns, they would be unlikely to be unit-root too; but in this paper we allow for very different concepts of risk.

[6]The empirical results can be found in LS (2009b).

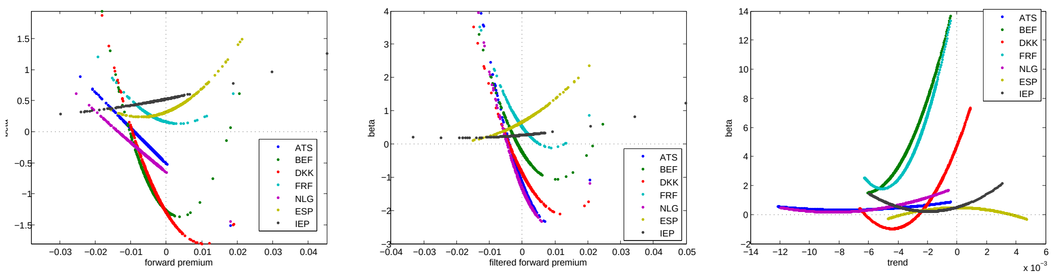
Table 4: **The cubic models with different regressors**

$$\tilde{s}_{t,\Delta} = \alpha + \beta_1 x + \beta_2 x^2 + \beta_3 x^3 + \tilde{\epsilon}_{t,\Delta}$$

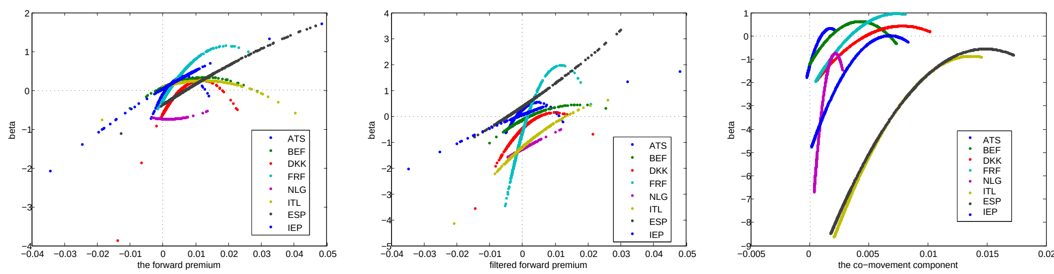
	regressor: $x = f_{t,\Delta}$				regressor: $x = ff_{t,\Delta}$				regressor: $x = \widehat{f}_{t,\Delta}$				best
	β_1	β_2	β_3	$Wald$	β_1	β_2	β_3	$Wald$	β_1	β_2	β_3	$Wald$	x
Panel A: ERM rates quoted by ITL, weak reference currency of a small economy													
ATS	-0.51	***-56.19	60.75	**6.46	-1.18	**-254.10	**1.26e+4	2.75	0.93	161.17	1.06e+4	0.32	ff
BEF	**-1.27	-52.74	6948.83	1.98	-0.25	-162.02	7.96e+3	1.72	15.51	4.53e+3	3.65e+5	2.20	ff
DKK	***-1.30	**-94.58	4421.88	*3.38	-0.88	-189.93	7.27e+3	1.70	4.23	**2.59e+3	***2.95e+5	*3.33	ff
FRF	0.16	-15.08	2074.05	0.15	0.51	-136.93	7.51e+3	0.39	15.56	5.44e+3	5.36e+5	1.98	ff
NLG	**-0.65	**-46.41	136.01	**4.52	-1.34	**-236.12	1.18e+4	2.25	1.90	414.01	2.46e+4	0.65	ff
ESP	0.31	22.08	1540.92	0.33	0.66	56.01	1.30e+3	0.36	0.47	-0.89	-3.54e+4	0.15	ff
IEP	0.52	***11.37	**109.91	1.35	0.26	8.66	212.68	1.74	0.50	292.56	7.53e+4	0.61	f
Panel B: ERM rates quoted by DEM, strong reference currency of a big economy													
ATS	-0.01	150.17	-2.73e+4	1.75	**0.25	***117.42	***-1.26e+4	***7.73	**-1.27	1.82e+3	-5.23e+5	2.58	ff
BEF	-0.04	***97.45	***-2.91e+3	2.08	-0.15	**68.16	-1.99e+3	2.42	-1.20	**854.09	***-1.00e+5	***12.06	ff
DKK	***-0.64	***158.30	***-6.98e+3	***41.16	***-0.49	***124.63	***-6.24e+3	***30.65	-2.25	**684.55	**-4.38e+4	3.01	ff
FRF	**-1.10	**252.78	***-6.91e+3	***6.69	**-0.64	**441.00	***-1.87e+4	***18.64	-2.39	909.82	-6.20e+4	3.09	ff
NLG	**-0.55	53.34	3.58e+3	0.43	***-1.27	-68.98	-349.88	1.17	-1.16	***4.26e+3	***-1.84e+6	***6.46	ff
ITL	**0.08	***26.30	-1.06e+3	0.75	**-1.20	110.14	-1.55e+3	2.93	***-11.56	***1.56e+3	***-5.71e+4	***11.76	$\widehat{f}$
ESP	***0.82	***-141.92	***6.76e+3	***10.93	0.36	**85.81	422.63	*4.21	***-10.75	***1.37e+3	***-4.61e+4	***11.97	ff
IEP	0.04	***50.40	**-329.33	***23.84	0.05	***49.37	-302.77	***23.82	**-4.98	**1.48e+3	**-1.10e+5	*4.90	f

Key: From left to right, the Columns are the coefficients and Wald tests of the cubic models in terms of three specifications of the regressor x: f, ff and $\widehat{f}$; in the last column, "x^{super}" is the regressor which has the best goodness-of-fit among the raw f and its two components. From up to down, Panel A is the estimates from the sample of the ERM rates, quoted for the ITL, the weak reference currency of a small economy. Panel B is from LS (2009), as a comparison, where the ERM quoted for the DEM, the strong core of a big economy within the zone.

Figure 2: **Betas as a function of f, ff and $\widehat{f}$, time-series analysis**



(a) Betas in terms of f (ITL) (b) Betas in terms of ff (ITL) (c) Betas in terms of $\widehat{f}$ (ITL)



(d) Betas in terms of f (DEM) (e) Betas in terms of ff (DEM) (f) Betas in terms of $\widehat{f}$ (DEM)

panels, we find that the tell-tale β_3 estimates are all positive in the ITL-set but there is only one significant t-test. In contrast, in the DEM-set six out of eight β_3s are negative and four of them significantly. Accordingly, Figure 2 shows U-shaped patterns for the ITL-set, supporting the limit-to-arbitrage theory; inverse U shapes for the DEM-set, consistent with the career-risk effect. So, the asymmetry in the patterns of two samples suggests that the choice of reference currency make difference in the validity of the theories. But the non-linearity in the ITL betas is often quite weak, even aside from the issue of significance. For all other sets of rates than the ITL ones, the currency-by-currency estimations yield even less satisfactory results.

3.4 Empirical Evidence: Pooled Regressions

As we saw, the ITL-set offers unanimity of sorts but no significance. In an attempt to gain power and obtain a clearer overall picture, we abandon currency-by-currency estimation and present aggregate estimates instead, which can be thought of as average estimates.[7] We present

[7] One question that arises in this connection is the heterogeneity among the estimates of the individual series: pooled regressions are consistent with equation-by-equation estimates only of the coefficients are identical across equations. Our purpose, however, is to get some average patter. According to Pesaran and Smith (1995), there are four procedures that can be used to estimate an average effect: the mean group estimator (estimating separate regressions for each group and averaging the coefficients over groups, as in LS), pooled regression, aggregate time-series regressions, and cross-section regressions on group means. In the static case, where the

data estimated from one pooled equation per sample, via a panel with fixed country effects and common slopes.

The pooled estimation did provide more significant patterns than the equation-by-equation method. In fact, we often ran into the opposite problem, in the sense that statistically some nonlinearities are often quite convincing while, judging by the graphs of plotted betas, they seem downright puny. Our procedure will be, first filtering by statistical significance, and then among the significant effects, retaining only the conclusions that do look important in practice on the basis of the graphical evidence.

As there are many samples and regressors we first provide a roadmap to our findings. The general picture will be that the DEM results in LS, with inverse-U betas for forward premia, are to some extent unusual: typically we need to drill down to the level of long- versus short-term decomposition before we see similar patterns. Specifically, for the long-term part of the forward premium we see inverse-U (*ie* fallen-angel) patterns for the USD, representing a moderately strong currency from the ultimately dominant economy, and for all strong currencies from at least midsize economies, whether floating or not. For weak fixed-rate currencies we see U-shapes for the long-run beta, suggesting the absence of benchmarking effects and, instead, a standard limits-to-arbitrage story. All this fits in with the LS results for the DEM and the (indicative) equation-by-equation results for the ITL.

The main difference with the LS findings has to do with the short-run components in the forward rates, which almost unanimously exhibit Bansal patterns. For the sum, *i.e.* the total forward premium, the picture is muddled, which is not surprising in view of the disagreement between the beta patterns we saw for the long- and short-term components.

3.4.1 The link between expected return and the long-run forward-premium level

Table 5 presents the estimates for the long-run component in the forward premium. Panel A, B, and C are based on the results of the floating-currency groups quoting the USD, JPY and CHF, respectively; Panel D to G contains the results for the band-regime ERM rates re-expressed

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regressors are strictly exogenous and the coefficients differ randomly and are distributed independently of the regressors across groups, all four procedures provide a consistent and unbiased estimate of the coefficient means (Zellner, 1969).

Table 5: Estimates from the pooled regressions in terms of the trend components

$$\tilde{s}_{t+\Delta,i} = \alpha_i + \beta_1 \widehat{f}_{t,i} + \beta_2 \widehat{f}^2_{t,i} + \beta_3 \widehat{f}^3_{t,i}, \quad \beta(\widehat{f}_{t,i}) = \beta_1 + \beta_2 \widehat{f}_{t,i} + \beta_3 \widehat{f}^2_{t,i}.$$

Panel A: floating regime: weak base-currency and big economy(base: USD)

x		Common slopes			Fixed-effect intercepts						
	E[$\beta(x)$]	β_1	β_2	β_3	AUD	CAD	CHF	GBP	JPY	NZD	SGD
$\widehat{f}$	-1.217	***-1.346	***72.850	***-971.841	0.004	0.002	-0.004	0.003	-0.006	0.003	-0.002

Panel B: floating regime: strong base-currency and big economy (base: JPY)

x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	AUD	CAD	CHF	GBP	HKD	NZD	SGD	USD
$\widehat{f}$	-2.079	***-2.771	***173.527	***-2431.238	0.005	0.002	-0.005	-0.003	0.000	0.003	-0.003	0.001

Panel C: floating regime: strong base-currency and small economy (base: CHF)

x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	AUD	CAD	GBP	HKD	JPY	NZD	SGD	USD
$\widehat{f}$	-0.112	-0.232	**42.550	**-713.567	0.002	0.002	-0.006	0.002	-0.002	-0.000	0.000	0.002

Panel D: ERM rates: strong reference currency from a big economy (base: DEM)

x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	NLG	ITL	ESP	IEP
$\widehat{f}$	0.012	-0.037	***136.353	*-6643.663	-0.000	0.000	-0.000	0.001	0.000	0.000	-0.000	-0.000

Panel E: ERM rates: strong reference currency from a small economy (base: NLG)

x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	DEM	ITL	ESP	IEP
$\widehat{f}$	0.563	***0.553	26.238	559.812	-0.000	0.000	-0.000	0.000	0.001	-0.000	-0.001	-0.000

Panel F: fixed regime: weak reference currency and small economy (base: ITL)

x		Common slopes			Fixed-effect intercepts						
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	NLG	ESP	IEP
$\widehat{f}$	-0.446	0.199	***399.168	***36098.95	-0.003	-0.001	0.000	0.001	-0.002	0.004	0.001

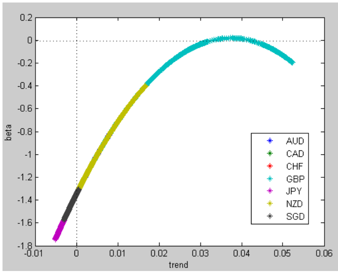
Panel G: ERM rates: weak reference currency from a small economy (base: ESP)

x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	DEM	ITL	NLG	IEP
$\widehat{f}$	0.777	***1.279	**126.006	***5610.171	-0.000	-0.001	-0.000	0.000	0.000	-0.000	0.000	-0.000

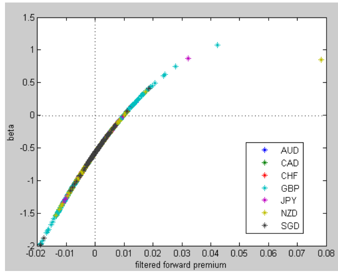
Panel H: fixed regime: strong reference currency from a small economy (base: HKD)

x		Common slopes		
	E[$\beta(x)$]	β_0	β_1	β_2
$\widehat{f}$	0.002	0.022	-63.956	-8590.054

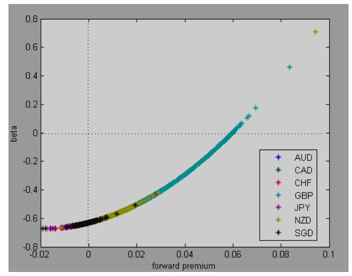
Figure 3: **Floating Regime: betas as a function of $\widehat{f}$, ff and f**



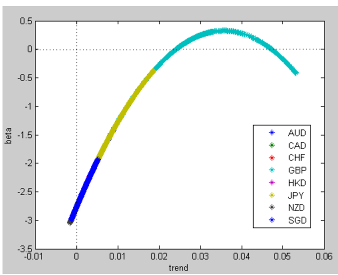
(a) regressor: $\widehat{f}$ (base: USD)



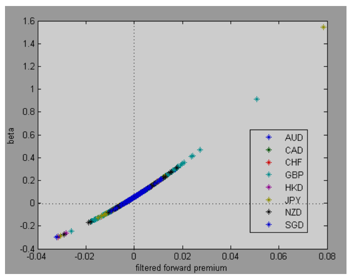
(b) regressor: ff (base: USD)



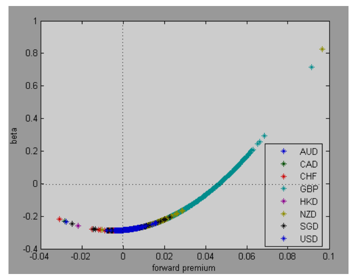
(c) regressor: f (base: USD)



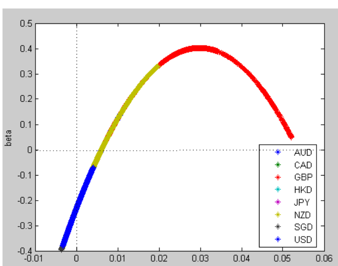
(d) regressor: $\widehat{f}$ (base: JPY)



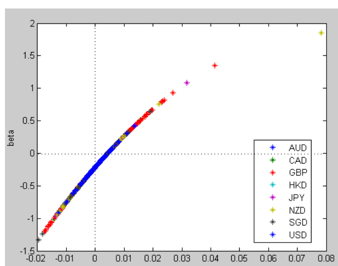
(e) regressor: ff (base: JPY)



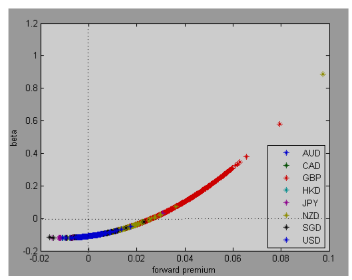
(f) regressor: f (base: JPY)



(g) regressor: $\widehat{f}$ (base: CHF)



(h) regressor: ff (base: CHF)



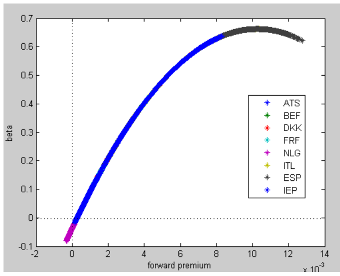
(i) regressor: f (base: CHF)

as quotes for the DEM, NLG, ITL and ESP, respectively; and Panel H also refers to a fixed-rate regime, notably where the USD is indirectly quoted with the HKD.

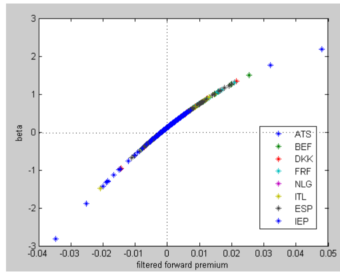
Figure 3 plots the betas of samples under the floating regime, in terms of various regressors. The plots offer a more convenient way to judge the strength of the non-linearity, apart from its statistical significance, and also given an impression about the level of the betas—for instance, whether $\beta(f)$ is typically positive. From top to bottom are the betas of the floating-rate quotes for the USD, JPY and CHF. From left to right, the regressors are the long-run component $\widehat{f}$, the short-term component ff, and the total forward premium forward premium f, respectively. The shaded graphs refer to samples where the nonlinearity is insignificant. In the same manner, Figure 4 displays the betas patterns under the fixed regime: the ERM quotes for the DEM, NLG, ITL, ESP and the USD indirectly quoted by HKD.

For all the floating currency sets (in Panel A, B and C), β_2 is positive and β_3 negative,

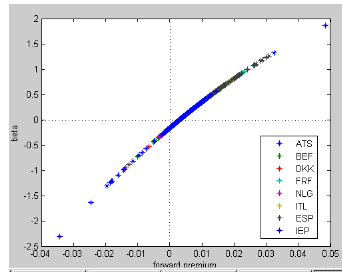
Figure 4: **Fixed Regimes: betas as a function of $\widehat{f}$, ff and f**



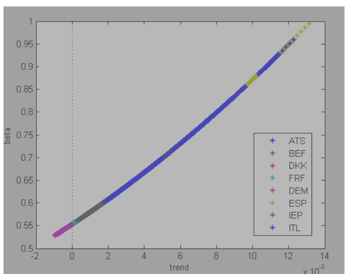
(a) regressor: $\widehat{f}$ (base: DEM)



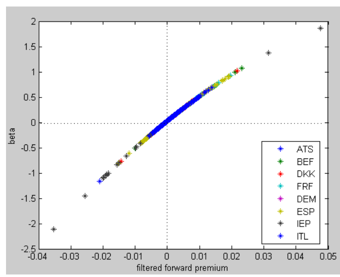
(b) regressor: ff (base: DEM)



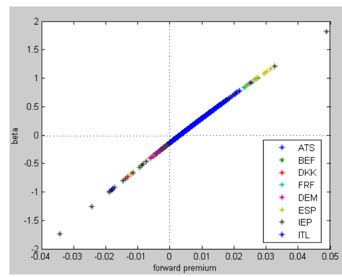
(c) regressor: f (base: DEM)



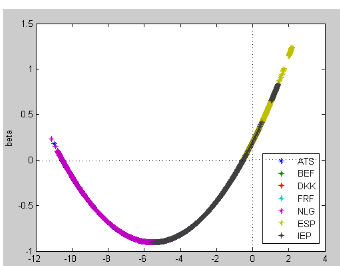
(d) regressor: $\widehat{f}$ (base: NLG)



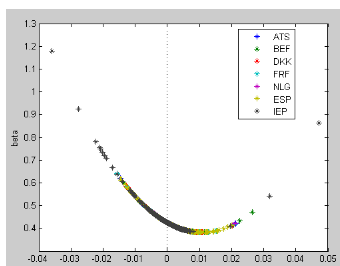
(e) regressor: ff (base: NLG)



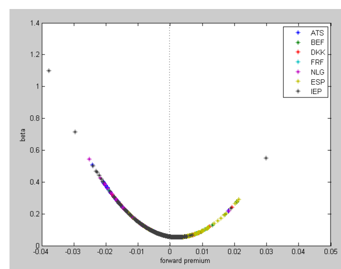
(f) regressor: f (base: NLG)



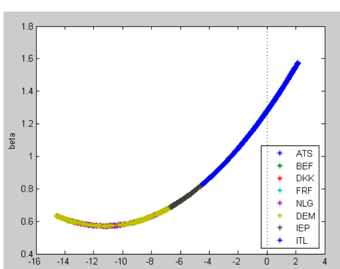
(g) regressor: $\widehat{f}$ (base: ITL)



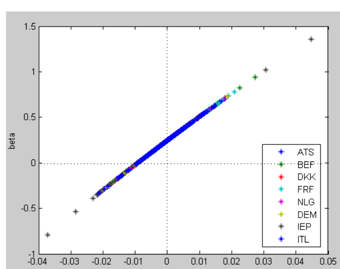
(h) regressor: ff (base: ITL)



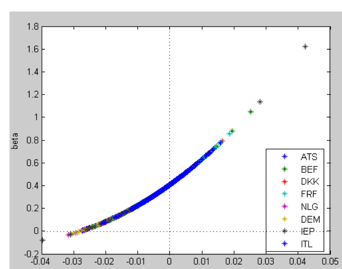
(i) regressor: f (base: ITL)



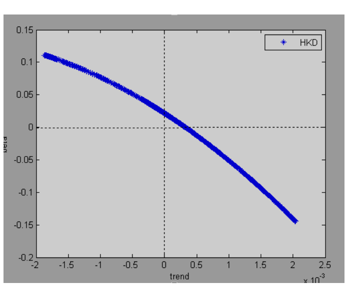
(j) regressor: $\widehat{f}$ (base: ESP)



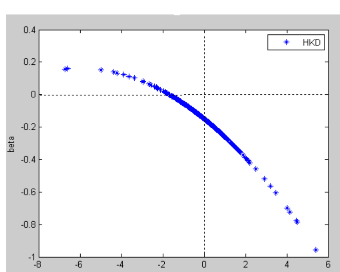
(k) regressor: ff (base: ESP)



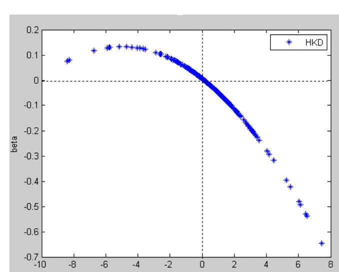
(l) regressor: f (base: ESP)



(m) regressor: $\widehat{f}$ (base: HKD)



(n) regressor: ff (base: HKD)



(o) regressor: f (base: HKD)

and all of them are significant, indicating an inverse U shape in the betas. This pattern is consistent with the work of LS, where the ERM rates for the DEM also show an inverse U, interpreted as the career-risk/fallen-angel effect. One conclusion definitely is that we do not need a band regime to see a career-risk pattern. A second one is that top performance in terms of strength does not seem to be needed either. Two of the three floating currencies are clearly very strong (JPY and CHF), and from midsize countries—if, at least, we base Switzerland's economic weight on the size and reputation of its financial institutions, which makes sense in the current context. The USD, in contrast, is of average strength only, but the size of its economy seems to make up for its average performance in terms of forward premia; it does seem to have benchmark status, all in all.

In the fixed-regime samples, base-currency strength and economic size seem to have an impact: the LS evidence of benchmarking, which is very much present in the DEM sample, disappears totally when the ITL is considered. Instead of exhibiting an inverse U pattern, the long-run trend of the ITL-set picks up a U-shaped pattern with $\beta_2 < 0$ and $\beta_3 > 0$. This is in line with the equation-by-equation evidence and fits in with the transaction cost or limit-to-arbitrage theory. The same pattern emerges for the ESP, even though the U is more lopsided. The remaining cases, lastly, are the HKD- and NLG-sets, where in terms of the long-run component $\hat{f}$ no significant slope coefficients are found. Both are strong or at least fairly strong currencies but have no world-class financial visibility.

Generally speaking, then, the long-run forward premia tell us that for a currency to acquire career-benchmark status it needs to be from a huge economy and have at least moderate strength (the USD), or have good monetary strength and come at least from a moderately big economy (DEM, JPY, CHF). For a strong currency from a less visible economy (NLG) we do not see the pattern, and similarly for a tiny economy with only a moderately strong currency (HKD). Also with a mid-sized economy and a weak currency, as we see in the ITL and ESP cases, agents do not seem to pick the currency as a benchmark against which they will be judged (traders' career risks) or which can serve to classify currencies as recent winners or losers (fallen-angel effects).

The second LS conclusion, that the short-term components is better at picking up expectations, is not validated anywhere. The mean betas $\mathrm{E}[\beta(ff)]$ are more often smaller than $\mathrm{E}[\beta(\widehat{f})]$.

Table 6: Estimates from the pooled regressions in terms of the filtered components

$$\tilde{s}_{t+\Delta,i} = \alpha_i + \beta_1 ff_{t,i} + \beta_2 ff^2_{t,i} + \beta_3 ff^3_{t,i}, \quad \beta(ff) = \beta_1 + \beta_2 ff + \beta_3 ff^2.$$

Panel A: floating regime: weak base-currency and big economy(base: USD)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_1	β_2	β_3	AUD	CAD	CHF	GBP	JPY	NZD	SGD	
ff	-0.574	***-0.570	***63.377	***-577.527	0.002	0.002	-0.001	-0.002	-0.001	0.000	0.001	
Panel B: floating regime: strong base-currency and big economy (base: JPY)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	AUD	CAD	CHF	GBP	HKD	NZD	SGD	USD
ff	0.054	0.053	13.289	72.165	0.001	0.001	-0.002	-0.001	0.001	-0.001	-0.000	0.001
Panel C: floating regime: strong base-currency and small economy (base: CHF)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	AUD	CAD	GBP	HKD	JPY	NZD	SGD	USD
ff	-0.215	-0.213	***50.859	-313.591	0.001	0.001	-0.002	0.001	-0.002	-0.001	-0.000	0.001
Panel D: ERM rates: strong reference currency from a big economy (base: DEM)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	NLG	ITL	ESP	IEP
ff	-0.032	-0.049	***65.353	***-469.625	-0.001	-0.001	-0.000	-0.000	-0.001	0.002	0.002	-0.000
Panel E: ERM rates: strong reference currency from a small economy (base: NLG)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	DEM	ITL	ESP	IEP
ff	0.030	0.031	***51.247	***-266.614	-0.001	-0.001	-0.000	0.000	-0.001	0.002	0.002	-0.000
Panel F: fixed regime: weak reference currency and small economy (base: ITL)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	NLG	ESP	IEP	
ff	0.428	***0.425	-7.921	*364.648	-0.001	-0.000	-0.000	0.000	-0.001	0.002	0.000	
Panel G: ERM rates: weak reference currency from a small economy (base: ESP)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2	ATS	BEF	DKK	FRF	DEM	ITL	NLG	IEP
ff	0.246	***0.246	***26.465	-37.273	-0.001	-0.000	0.000	0.000	-0.001	0.002	-0.001	0.000
Panel H: fixed regime: strong reference currency from a small economy (base: HKD)												
x		Common slopes			Fixed-effect intercepts							
	E[$\beta(x)$]	β_0	β_1	β_2								
ff	-0.154	-0.148	***-102.884	-8532.932								

3.4.2 Results for the short-term component.

Table 6 presents the estimates for the short-run component in the forward premium. Panel A, B, and C are again based on the results of the floating-currency groups quoting the USD, JPY and CHF, respectively; Panel D to G refers to the band-regime ERM rates, the quotes for the DEM, NLG, ITL and ESP, respectively; and Panel H refers to he USD quote for the HKD.

In terms of the filtered or short-term component there often is a discrepancy between the statistical and graphical evidence. In three cases (USD, DEM and NLG) the t-statistics show a significantly negative coefficient for the quadratic component in beta, indicating an inverse U. The graphical picture however tells us the effect is minimal. We prefer to err on the safe side and ignore the curvature of these betas. Only for the ITL we see a curvature in the beta that is both moderately significant and visually non-trivial; interestingly, it follows the same limits-to-arbitrage pattern as its long-run counterpart. Again, there is no empirical trace of the notion that traders may regard exchange-rate changes against the Lira as potentially career-threatening; rather, the agents seem to think of transaction costs.

The overall picture, then, is one where betas fall or rise linearly in the short-term component of the forward premium, in line with mainstream financial theory (Bansal). In terms of the career-risk argument the conclusion is that short-term fluctuations of the forward premium around the long-run trend do not seem to affect the benchmark status (or lack thereof) of a currency.

3.4.3 Test Results for the Total Forward Premium

Table 7 presents the estimates for the total forward premium. Panel A-C again refer to floating-currency groups; Panel D-G to the band-regime ERM rates, and Panel H to the USD quote for the HKD.

From the betas in the left columns of the table, we find that the currency regime seems to act as a watershed to determine the model's nonlinearity: none of three floater samples have significant β_2s or β_3s, but each fixed-regime set has at least one significantly higher-order slope, suggesting a presence of nonlinearity. Thus, the clear fallen-angel effect that was present in the long-run part of f for floating currencies seems to have been largely blotted out by the different pattern in the short run, resulting in a muddled overall picture.

This seems to have been less of a problem in the band-regime samples: in all samples the

Table 7: Estimates from the pooled regressions in terms of total forward premiums

$$\tilde{s}_{t+\Delta,i} = \alpha_i + \beta_1 f_{t,i} + \beta_2 f_{t,i}^2 + \beta_3 f_{t,i}^3, \quad \beta(f) = \beta_1 + \beta_2 f_t + \beta_3 f_t^2.$$

	Panel A: floating regime: weak reference currency from a big economy										
	Common slopes			Fixed-effect intercepts							
Base	β_1	β_2	β_3	AUD	CAD	CHF	GBP	JPY	NZD	SGD	
USD	***-0.631	4.244	105.600	0.002	0.001	-0.003	0.005	-0.004	0.001	-0.002	
	Panel B: floating regime: strong reference currency from a big economy										
	Common slopes			Fixed-effect intercepts							
Base	β_0	β_1	β_2	AUD	CAD	CHF	GBP	HKD	NZD	SGD	USD
JPY	-0.286	1.060	108.137	0.002	0.001	-0.003	0.000	0.001	-0.000	-0.001	0.001
	Panel C: floating regime: strong base-currency and small economy										
	Common slopes			Fixed-effect intercepts							
Base	β_0	β_1	β_2	AUD	CAD	GBP	HKD	JPY	NZD	SGD	USD
CHF	-0.109	1.895	85.373	0.002	0.001	-0.003	0.001	-0.002	-0.000	-0.000	0.001
	Panel D: ERM rates: strong reference currency from a big economy										
	Common slopes			Fixed-effect intercepts							
Base	β_0	β_1	β_2	ATS	BEF	DKK	FRF	NLG	ITL	ESP	IEP
DEM	***-0.163	***53.948	**-253.522	-0.001	-0.000	-0.000	0.000	-0.001	0.001	0.001	-0.000
	Panel E: ERM rates: strong reference currency from a small economy										
	Common slopes			Fixed-effect intercepts							
Base	β_0	β_1	β_2	ATS	BEF	DKK	FRF	DEM	ITL	ESP	IEP
NLG	***-0.137	***44.012	-82.952	-0.001	-0.000	-0.000	0.000	-0.001	0.001	0.001	-0.000
	Panel F: ERM rates: weak reference currency from a small economy										
	Common slopes			Fixed-effect intercepts							
Base	β_0	β_1	β_2	ATS	BEF	DKK	FRF	NLG	ESP	IEP	
ITL	0.056	-2.868	***651.991	-0.001	-0.001	-0.000	0.000	-0.001	0.002	0.000	
	Panel G: ERM rates: weak reference currency from a small economy										
	Common slopes			Fixed-effect intercepts							
Base	β_0	β_1	β_2	ATS	BEF	DKK	FRF	DEM	ITL	NLG	IEP
ESP	***0.408	***20.258	**201.246	-0.001	-0.000	-0.000	0.000	-0.001	0.001	-0.000	-0.000
	Panel H: fixed regime: strong reference currency and small economy										
	Common slopes										
Base	β_0	β_1	β_2								
HKD	0.000	***-50.405	**-5032.786								

Key: We run the pooled regression, and "Base" indicates the reference currency of the panel.

constant-beta model is clearly rejected even for the total forward premium. Statistically, there is supposed to be a clear curvature in the betas for the DEM and the ESP, but visually the effect is unimpressive. There is a decent U-shape for the ITL, perfectly in line with the results in both the short and the long run. Only for the HKD it is not clear whether the statistically clear inverse-U pattern means something in practice or not; this is also the only currency where there is more significance in the results for the total f than in those for the components.

A second observation is that the graphs for the total-f betas of the band-regime rates are very similar to those of the short-term components. Apart from the ITL, we see orthodox Bansal premiums. What exactly the economic link is between this phenomenon and the band regime is less clear.

4 Conclusion

The forward puzzle is traditionally explained as the reflection of a covariance-risk premium, market friction or limits to arbitrage. Recently, Liu and Sercu (2007), working on intra-ERM rates for the DEM, presented evidence consistent with career-risk considerations (portfolio managers shun assets with danger signals, including negative forward premia), or with investors otherwise assign fallen-angel status to such assets. In this paper, we test the external validity of this finding: we compare floating rates to band regimes, strong base currencies to weak ones, and large economies to small ones. We find that the exchange-rate regime seems to matter the least; but the bench-marking role can come from either a huge economy (the U.S.), a strong currency (Switzerland), or good ratings on both counts (Japan and Germany). Consistent with the idea that these are slow-moving reputational effects, the evidence is especially present in the long-run-trend component of the forward premium. In the short-run, filtered part, other factors seem to be at work, mostly Bansal risk premiums. In the case of floating rates, these Bansal effects seem to blot out the long-run effects, resulting in unclear overall effects; but for band-regime rates the net effect is dominated by the short-term component. The second LS conclusion, that the short-term components is better at picking up expectations, is not validated across the board.

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A Risk Premium and Forward Premium in Prospect Theory

Psychological research by Tversky and Kanheman (1979) suggests that people analyze risk and uncertainty in a different way than rational-expectations Von Neuman/Morgenstern agents. Allegedly, human beings are not judging wealth in an absolute way, but in a benchmarked way, usually referring to the status quo as the point of reference. Thus, a person's decision is likely to be different, depending on the initial situation, even if in both cases the final distribution of wealth is identical. In addition, real-world humans are not consistently risk-averse; rather, they are loss-averse and risk-averse in gains but risk-taking in losses. Loss aversion means that, at the zero point, the left derivative of $U(\tilde{W}_1 - W_0)$ is much steeper than the right derivative; that is, a small loss has discretely larger impact than an identical small gain. But for larger changes, the curve is concave to the right only, in the 'gains' direction; to the left, the curve is said to be convex.[8]

Another non-rational element is 'mental accounting': agents do not care about the total capital gain on the portfolio as a whole, but pay overly much attention to individual assets. In mean-variance terms, they would think too much about each asset's variance, and not really about the asset's contribution to the portfolio variance—its covariance risk.

The combination of mental accounting with risk-averse in gains/risk-taking in losses would mean that choices are based on a stretched-S type function of ΔS rather than on a concave function of W. Let's take a one-risky-asset case where W_0 is invested risk-free and where, in addition, n units of forex are bought forward (or sold, if n is negative). This formulation in terms of forwards is convenient for our purpose; there is, of course, an equivalent story about mixing home- and foreign-currency spot positions, where n refers to the number of forex T-bills held. For convenience we also take $W_0(1+r)$ as the reference point in the utility function, not W_0 itself. Then

$$\tilde{W}_1 - W_0(1+r) = n\,(\tilde{S}_1 - F_0), \tag{1.3}$$

where r and F are the risk-free rate and the forward rate, respectively, both one-period, and $\tilde{S}_1$ is the spot price of next period. A simple example of a prospect-theory preference function

[8] Less important for our story, there are also biases in the probability processing, and in the way information is processed ('framing').

might be a piecewise quadratic (with $A_+ > A_- > 0$):[9]

$$U(\tilde{S}_1) = \begin{cases} n\,(\tilde{S}_1 - F) - \frac{A_+}{2} n^2 [\tilde{S}_1 - F]^2 & \text{if } \tilde{S}_1 > F, \\ \\ n\,(\tilde{S}_1 - F) + \frac{A_-}{2} n^2 [\tilde{S}_1 - F]^2 & \text{if } \tilde{S}_1 < F. \end{cases} \tag{1.4}$$

The first-order condition immediately leads to a forward bias determined by a weighted difference of the upper and lower partial second moments, and the size of the position.

$$\mathrm{E}(\tilde{S}_1 - F) = n[A_+ E(\tilde{S}_1 - F)_+^2 - A_- E(\tilde{S}_1 - F)_-^2], \tag{1.5}$$

where $E(\tilde{S}_1 - F)_+^2$ is short for $[\mathrm{Max}(\tilde{S}_1 - F, 0)]^2$, and likewise for the lower second moment.[10] In Appendix, we analyze the relation between the risk premium and forward premium.

Let's therefore investigate whether the above model is likely to explain Fama betas below unity. We first get closer to the regression test following a simple manipulation of (1.5):

$$\frac{\mathrm{E}(\tilde{S}_1)}{S_0} - 1 = \left[\frac{F}{S_0} - 1\right] + \frac{nS_0}{W_0}\left[(A_+W_0)\mathrm{E}\left(\frac{\tilde{S}_1 - F}{S_0}\right)_+^2 - (A_-W_0)\mathrm{E}\left(\frac{\tilde{S}_1 - F}{S_0}\right)_-^2\right]. \tag{1.6}$$

Here, the variables are all stated as percentages; the position n has been scaled into a portfolio weight, nS_0/W_0; and the absolute risk-aversion or -preference parameters A have been turned into relative risk-aversion versions, AW_0. While we can see a natural link between expected income from the forward contract and the difference of expected squared gains and losses, there is no obvious prediction as to how this difference relates to the forward premium, which is just one component of the income. It could actually be that peso-risk type currencies have low (*ie* very negative) forward premiums; and as we just saw, higher peso risk should mean a lower risk premium. If so, this would predict Fama betas that are above unity rather than the universally observed below-unity ones. The prospect-theory view of the carry trade phenomenon would similarly be that the low total expected returns on strong currencies must reflect expected squared gains are small relative to expected squared losses. This seems to mean either a low chance of positive outcomes, or a serious left-skewness, with possibly very big losses. Both

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[9]Familiarly, this can at best be a local approximation valid in a limited range only, otherwise marginal utilities might become negative.

[10]The above is for a home investor. The foreign investor solves a similar problem in foreign-currency units, and the solution would differ from the above because of Jensen's Inequality effects that are hard to handle in discrete math. Subject to that proviso, world demand would be an equation similar to (1.5), or will at least contain a term similar to (1.5), beside the Jensen's Inequality terms. The advantage of studying world demand is that in this case n can be equated to the net outstanding amount of forex. Traditionally, in these models, lending and borrowing is among investors so that no net amount of bills is outstanding; but wealth also consists of money balances, which do have an implicit bill component.[11] Thus, in the aggregate, n equals the money's total supply which, crucially for us, is a positive amount.

scenarios seem to be at odds with the notion of a strong currency. We conclude that prospect theory is unlikely to be behind the below-unity betas and, therefore, would be less likely as an alternative explanation besides the career-risk/fallen-angel view.

According to the prospect theory, first, the risk premium changes sign depending on the variation $(\tilde{S}_1 - F)^2$ is in the gains zone *v.s.* the loss zone. This is contrast with the regular Von Neumann-Morgenstern quadratic, where in a one-risky-asset setting the risk premium is always positive. Risk premia that do change signs are more compatible with the empirical findings of Fama betas below unity, if at least the risk premium negatively co-varies with the forward premium. Second, the risk premium depends not so much on the difference of the odds of gains *v.s.* losses (the zero-th partial moments), but on the differences between the second partial moments, the expected squared gains and losses (See Equation [1.5]). For well-behaved distributions the two types of moments must be related, but there are interesting differences. Specifically, increased downward jump risk, defined as an increase in the size of the most negative outcomes of $(S_1 - F)$, counterintuitively lowers the risk premium and *vice versa*. Third, the risk premia are bounded by the total uncertainty. For a nearly sure winner, the risk premium $\mathrm{E}(\tilde{S}_1 - F)$ would be positive, reflecting the aversion to uncertainty about gains, but bounded from above by the total expected squared payoff $A_+\mathrm{E}(\tilde{S}_1 - F)^2$. Similarly, for the near-sure losers the risk premium $\mathrm{E}(\tilde{S}_1 - F)$ would be negative, reflecting the preference to uncertainty about losses, but again bounded from below by the total expected squared payoff $A_-\mathrm{E}(\tilde{S}_1 - F)^2$.

The sobering message from prospect theory, at least at this level of generality, would be that many patterns of risk premia could also be the result of prospect-theory behavior. We do not know whether the difference of the two partial second moments would typically be positive at high forward rates, or at low forward rates. All we can say is that the net risk premium is finite. If we have a Fama-type pattern, with positive risk premia being associated with negative interest rates and vice versa, the relation between $\mathrm{E}(\tilde{s})$ and F would be like a stretched cotangent shape, whose first derivative would follow an inverse-U pattern, as would the career-risk premium.

B Monte-Carlo Standard Deviations

The remaining issue is the reliability (SE) of the estimations. There are two complications. First, the forward premium is non-stationary or nearly so. Second, following Hansen and

Hodrick (1980) we do not want to waste information by considering only non-overlapping forward contracts, so we use the weekly observations on one-month forward contracts. For either reason, the conventional standard deviation is underestimated. The standard deviations can be calculated by the OLS, the Monte Carlo Simulation (MCS) and Hansen-Hodrick (HH) methods Obviously, the OLS is not precise for the overlapping data; while, the HH is also questioned when the forward premiums are non-stationary. So, the Monte Carlo Simulation (MCS) is employed to calculate the standard deviations of this paper.

The Monte Carlo method is a stochastic technique that uses random numbers and probability statistics rather than math to discover the distribution of parameter estimates. Here it works like this: firstly, the variables on both sides of the Fama regression are expressed in their Autoregressive models (AR),

$$\delta s_{j,t} = \alpha_1 + \beta_1 s_{j,t-1} + \beta_2 s_{j,t-2} + ... + \beta_6 s_{j,t-my} + \nu_{j,t}, \quad (2.7)$$

$$f_{j,t} = \alpha_2 + \theta_1 f_{j,t-1} + \theta_2 f_{j,t-2} + ... + \theta_6 f_{j,t-mx} + \xi_{j,t}. \quad (2.8)$$

where the my and mx are the optimal orders of the AR(p) for the exchange rate change $\delta s_{j,t}$ and the forward premium $f_{j,t}$. Secondly, we randomly generate the residuals ν and ξ and add them to the fitted values of the AR(my) or AR(mx) to make new $\delta s_{j,t}$ and $f_{j,t}$, Thirdly, the cubic models are run on the new data and after 1000 times iterations there are distributions for the t-statistics of the coefficients. Lastly, we can tell the significant levels of the coefficients by checking which intervals are the t-statistics of the actual data fall into according to the distributions.

However, the residuals ν and ξ turned out non-normally distributed. Edward and John (1979) provide a technique for a non-normal distribution number generator. This technique accommodates a broad class of distributions because it transforms a uniform random number into distribution with any desired set of values for the first four statistical moments (mean, variance, skewness and kurtosis). These four moments, denoted below as μ_1, μ_2, μ_3 and μ_4, are functions of four parameters $\lambda_1, \lambda_2, \lambda_3$ and λ_4, as described in the following equations:

$$\mu_1 = \lambda_1 + \frac{A}{\lambda_2}, \quad (2.9)$$

$$\mu_2 = \frac{B - A^2}{\lambda_2^2}, \quad (2.10)$$

$$\mu_3 = \frac{C - 3AB + 2A^3}{\lambda_2^3}, \quad (2.11)$$

$$\mu_4 = \frac{D - 4AC + 6A^2B - 3A^4}{\lambda_2^4}. \quad (2.12)$$

In these equations, the terms A, B, C and D are also functions of $\lambda_1, \lambda_2, \lambda_3$ and λ_4:

$$A = \frac{1}{1+\lambda_3} - \frac{1}{1+\lambda_4}, \tag{2.13}$$

$$B = \frac{1}{1+2\lambda_3} + \frac{1}{1+2\lambda_4} - 2\,\mathcal{B}(1+\lambda_3, 1+\lambda_4), \tag{2.14}$$

$$C = \frac{1}{1+3\lambda_3} - \frac{1}{1+3\lambda_4} - 3\,\mathcal{B}(1+2\lambda_3, 1+\lambda_4) + 3\,\mathcal{B}(1+\lambda_3, 1+2\lambda_4), \tag{2.15}$$

$$D = \frac{1}{1+4\lambda_3} + \frac{1}{1+4\lambda_4} - 4\,\mathcal{B}(1+3\lambda_3, 1+\lambda_4) + 6\,\mathcal{B}(1+2\lambda_3, 1+2\lambda_4) - 4\,\mathcal{B}(1+\lambda_3, 1+3\lambda_4), \tag{2.16}$$

where $\mathcal{B}(u, v)$ is the beta function. To generate the residuals we estimate their first four moments and numerically solve for the corresponding values of the λ's. The desired non-normal random number $\tilde{R}$ is the following transformation of a unit uniform random number $\tilde{p}$:

$$R(\tilde{p}; \lambda) = \lambda_1 + \frac{\tilde{p}^{\lambda_3} - (1-\tilde{p})^{\lambda_4}}{\lambda_2}. \tag{2.17}$$

C Table of the Exchange-rate Strength

Table 8: Currency Strength, Measured by Frequency of Positive Forward Premiums

Floating Regimes: $\%_{f>0}$								
Base	AUD	CAD	CHF	GBP	USD	NZD	SGD	HKD
JPY	98.3	97.6	80.7	95.5	85.7	98.9	74.2	81.2
	AUD	CAD	JPY	GBP	USD	NZD	SGD	HKD
CHF	91.2	89.7	19.3	93.9	78.7	92.8	58.8	73.2
	AUD	CAD	CHF	GBP	JPY	NZD	SGD	
USD	83.9	68.6	20.7	87.7	13.9	89.6	10.8	

Band Regimes: $\%_{f>0}$								
	ATS	BEF	DKK	FRF	NLG	ITL	ESP	IEP
DEM	68.5	81.2	98.3	89.9	57.2	99.8	93.2	99.6
	USD							
HKD	40.0							
	ATS	BEF	DKK	FRF	NLG	DEM	ESP	IEP
ITL	0.4	3.7	11.8	4.0	0.3	0.2	52.4	18.0
	ATS	BEF	DKK	FRF	DEM	ESP	IEP	ITL
NLG	53.7	88.1	97.8	95.8	38.3	99.7	96.0	99.7
	ATS	BEF	DKK	FRF	DEM	NLG	IEP	ITL
ESP	0.6	5.0	9.3	6.6	0.3	0.2	21.3	47.6

Key: "$\%_{f>0}$" is the percentage of observations which have positive forward premiums for the base currency (USD or DEM or ITL).