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About the author

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Marielle de Jong joined Amundi in 2011. Before that she was vice-president of the financial engineering team at Sinopia Asset Management (a Paris-based HSBC subsidiary). She started her working career in London in 1994 as a research analyst with BARRA and an equity fund manager with Quaestor (Yasuda subsidiary).

She holds a graduate degree in econometrics from the Erasmus University in Rotterdam, an MSc in operational research from the University of Cambridge (UK), and a PhD in economics and finance from the University of Aix-Marseille (in 2010). She has published a series of articles on equities, currencies and recently on fixed-income risk modelling issues.

1. Outline

The way investment risk is perceived by the actors on the capital markets strongly depends on the hypotheses and conventions that have been adopted as standards in the measurement of risk. The fact that certain standards have been used since long doesn't necessarily mean that they are the most adequate and accurate. This paper points at a number of those standards that are liable to lead to a misperception of risk. Conventions are being reviewed that are profoundly inscribed in the theory and practice of investment management.

It is not new to alert for the limits of financial modelling. Shortcomings in financial models and concepts are much discussed in the literature, and are regularly subject of debate. In most studies the limitations of a model are of secondary order though after the presentation of the model itself. Few research projects have been undertaken that assess the validity of the standard axioms in finance as the primary objective. Such study makes one realise to what extent the perception of investment risk is shaped by the conventions that have been established over time. It helps to explain why the investment industry seems weak to respond to novel circumstances and why it is prone to systemic failure. The goal of this paper is this, to help understand the weaknesses in the finance industry in terms of risk perception.

Analyses underlying this paper have been carried out in a traditional investment setting. Common risk concepts are analysed that apply to common investments instruments. No derivatives, credit risk vehicles or other structured investment products are considered, for which the profit-and- loss profile is not directly intuitive. Well-established finance models are used as the reference for defining the investment risk, notably the Capital Asset Pricing Model (*CAPM*) introduced by Sharpe (1964) and the Arbitrage Pricing Theory (*APT*) introduced by Ross (1976).

It is not evident to perceive risk; even less is it easy to perceive risk perception, as the act of perception is in the same time subjective, irresolute and unequivocal. Perception is a cognitive experience that starts by a form of measurement which necessarily simplifies the world such that it enables an analytical assessment which eventually leads to some form of judgment. A misperception can potentially enter in any of those stages. One can gather accurate information, then make an erroneous analysis or draw a wrong conclusion, or it can go wrong from the start in the measurement stage. The latter situation is the focus in this research

project. It is traced how erroneous or oversimplifying measurements may hinder a proper judgement on risk.

Three studies have been undertaken, one on equity one on bonds and one on currencies. They share the same schema of analysis. I start by identifying a conception error that I believe is committed in the measurement stage, notably in the way information is extracted from data. I then review the debate in the literature trying to establish to what extent the general risk perceptions may be affected by the measurement problem. The three studies differ in this respect. In the first this exercise can be carried through relatively well thanks to an extensive literature on the subject. In the second the risk of misperception is more hypothetical. It is inferred what can potentially go wrong if no attention is paid to the measurement problem. In the third study the risk of misperception is real and can in certain cases be made apparent, though it lacks debate as it stands to affirm whether the misperception is widespread or not.

In the final stage of the analysis I discuss how the conjectured misperception of risk may lead to sub-optimal investment decisions. A few such events that have taken place are described. I propose a way to avoid the potential conception error and the sub-optimal investment decisions that may result from that. A few situations are briefly described below.

In the first study, I examine a risk factor that is generally recognised to be the second most significant source of equity risk after the market risk factor; it is called the *value* factor. This *value* factor is ill-defined. Due to an inaccuracy in the definition of a *value* stock, the risk and return characteristics that are generally associated to those stocks and to the related factor are being confused. Empirical tests are carried out that are designed to make the confusion apparent.

In the second study, Fisher's (1930) Theory of Interest is confronted against recently-available bond market data. The issuing of inflation-linked (real) bonds in parallel to nominal bonds has made it possible to empirically test the hitherto theoretical Fisher equation. The discrepancy that is observed by many between the theory and bond market practice raises concerns on the validity of relying on interest rate theory in bond risk analysis. The tests carried out contribute to the analysis in that it tests in an *international* context, which is giving new clues as to where the discrepancy may stem from.

In the third study, the way in which exchange rate returns are being calculated is revisited. Attention is paid to the mathematical inconvenience that arises when applying the standard

return measure onto currencies, which is generally referred to as the Siegel (1972) paradox. The seeming paradox haunts the testing and the interpretation of the Uncovered Interest Rate Parity. Moreover, it has led to confusion in the debate on currency hedging. There is a discussion on the question whether it is sensible to leave an internationally-invested portfolio partially unhedged against currency risk. The additional risky positions it would introduce could somehow be beneficial for the total profile of the portfolio. The incentives to install a partial hedge onto an equity portfolio are unrightfully attributed to the Siegel paradox by Black (1992), and rightfully attributed to an equity-currency covariance structure by Solnik (1974).

2. Induction

The conception error that I believe is committed in each situation is remarkably elementary. In the first two studies the source of error is in my view that observations are made in a too narrow perspective. In the study on equities the point is made that stocks are classified as either *value* or *growth* on the basis of their current valuation ratios, without considering how long the stocks have been priced that way. By introducing the time dimension into the classification criterion such that a distinction can be made between structurally- versus transitorily low- or high-priced stocks, it is brought to light that fundamental risk characteristics are being confused in the standing definition.

The study on bonds points out that the cross-sectional dimension lacks in the research on the Fisher relation. The nominal interest rate in a country is decomposed into the real interest rate and the inflation expectation, the interest being that the two components are driven by distinct economic events. Many researchers attempt to prove a statistical independence between the two components within the country, ignoring the possibility of cross-border dependencies, at least in the tests. The near-zero correlation that can be measured in the bond prices within countries is deceiving. Panel data analysis that have been carried out shows that it is the net result of a positive price correlation worldwide cancelled out by idiosyncratic negative correlations within countries. The result casts doubt on the validity of the abundant time-regression evidence.

In the study on currencies the source of error is different; it is the failure to recognise that the standard return measure doesn't possess the Euclidian properties when applied on currencies.

The problem is that under such conditions the laws of algebra don't apply. The existence of an inconsistency issue has often been raised but that has not dissolved the confusion in the debate on currency-related topics. There is no easy solution. On the one hand, an alternative return measure may be adopted that respects the Euclidian conditions, yet on the other hand, such measure wouldn't fit into the Markowitz (1953) mean-variance framework within which investment utility is usually defined. I address the confusion borne from the unbridgeable gap. The main instances of confusion are mentioned below.

On the forward exchange market there continues to be a belief in an arbitrage opportunity stemming from the algebraic artefact that the expected future spot rate between two currencies, as specified by the Uncovered Interest Rate Parity, cannot be identical to the forward rate in both perspectives simultaneously. The wedge between the two is due to Jensen's inequality. Engel (1984) suggests comparing currencies in real- rather than in nominal terms effectively taking out the wedge, however, it starts a new undue belief that the arbitrage opportunity is somehow 'nominal'.

On the spot market the same belief in an authentic performance opportunity persists for the same technical reason. The summed return of a spot rate move between any two currencies calculated from the two perspectives is strictly positive. Black (1992) argues that because of that investors have a mutual benefit in holding foreign cash. Black (1989) quantifies the potential benefit and establishes the corresponding optimal proportion of exchange rate risk that is to be maintained in an internationally-invested equity portfolio. His publication is surprisingly few contested.

3. Analysis

Are those conception errors serious? What is their impact on asset management in terms of loss of optimality or in terms of misperception of risk? This question is addressed for each issue that is raised in each study separately. Below the general framework is laid out in which the analysis is carried out. Before discussing the rationale of the analysis, it is amusing to tell a few less rational anecdotes that have taken place which illustrate to what situations a misunderstanding may lead.

On the forward exchange markets there have been, and perhaps still are, so-called Siegel traders who try to exploit the seeming arbitrage opportunity. They take position on a currency

in one account, take the exact opposite position in another account, and expect that on the whole it will make money. Edlin (2002) is strongly opinionated against those traders and claims they are responsible for the forward discount bias that is reported to exist. Kemp and Sinn (1999 and 2000) give 'prove' that Siegel traders lower welfare and call for the closure of the forward markets in order to stop such what-they-call socially irresponsible speculation. It is difficult to decide whom to give more credit. Judging by the number of quotes of their papers, probably neither has been taken very seriously.

This is not the case for Fisher Black. His publications in which he derives the 'optimal' currency hedging ratio have been and continue to be much quoted. His erroneous optimal hedge calculation has actually been integrated in leading portfolio optimisation software, indicating the extent to which his recommendations have been followed up by fund managers. The question of how much currency risk to effectively hedge in an internationally invested portfolio remains meanwhile an open debate.

Concerning the value factor that is present in equity prices, the repetitive claim that value stocks tend to outperform growth stocks, a claim which is proven to be inaccurate in the first study, has pushed asset management firms specialised in growth investment products to rename their branch. They invented the term *GARP* around the turn of the century, standing for Growth at A Reasonable Price, as do Broussard et al. (2005).

3.1. Theoretical foundation

In order to methodically analyse the impact of the misconceptions in terms of risk, it is necessary to go back to basics and revisit the definition of the term itself. The risk of an asset is in the standard finance text books defined as the price volatility of the asset, usually denoted by sigma σ. The asset price is assumed to follow a Gaussian distribution specified by two parameters, the return- and the risk parameter, denoted as $n(\mu,\sigma)$. Higher moments, in particular the skew and the kurtosis of the probability distribution, and issues like counterparty risk are not included in this definition. In the analysis I adopt this narrow definition of investment risk.

In reality assets are seldomly assessed in isolation but in groups, typically an asset class or a portfolio. The singular definition of risk is generalised to the multivariate case. An asset group is assumed to follow a multivariate normal distribution, denoted as $n(M,\Sigma)$, where M

contains the mean asset returns and Σ is the covariance matrix between the asset prices. A covariance matrix is not as meaningful as a volatility level is. It is not trivial to appreciate or express the risk of an individual asset within its group. One may refer to the volatility level of the asset price accompanied by an average level of correlation with other assets, but that doesn't make an operational definition.

Risk can only be appreciated or formulated in a meaningful way by means of a risk model that builds a structure into the covariance matrix Σ. The role of the model is to define the risk factors that are relevant for the asset group and specify to what extent the individual assets are exposed to each of them. Only when a risk model is specified and estimated for a certain asset group, the risk of an individual asset can be expressed. It can be expressed in terms of the volatility levels of the factors multiplied by the exposures of the asset to the factors.

Sharpe (1964) has laid the foundations of financial risk modelling in his Capital Asset Pricing Model. The CAPM states that if all investors agree on the price behaviour of an asset class, meaning that they all assume the same probability distribution $n(M,\Sigma)$ to hold, they would all buy the same portfolio of assets that is exactly in proportion to the market capitalisations. This portfolio -called the Market Portfolio- serves as a benchmark to decompose risk into *systematic* or *market* risk, and asset-specific risk. The risk of an asset can in this framework be expressed by its specific volatility plus its market beta, i.e. its sensitivity to general market movements.

The virtue of Sharpe's model is that it provides a universal and transparent risk reference. The drawback is that, for its simplicity, the risk may be underestimated. Ross (1976) has relaxed the assumption of a universal view in his theory called the Arbitrage Pricing Theory. The APT states merely that capital market risk can be effectively decomposed over a set of independent factors, leaving it unspecified which factors play for which asset classes.

In practice both theories are in use today; investors use the CAPM as well as applications of the APT to estimate the risk of their portfolios. There is a wide variety of APT applications in use. Firstly, there is the macroeconomic application that relates asset price moves directly to macroeconomic events. Secondly, there is the fundamental application that relates price performance to certain characteristics of the underlying security, and thirdly, there is the statistical application that extracts synthetic or inexplicit factors from the price return series.

3.2. Methodology of analysis

It is important to realise that, even in the narrowest definition, investment risk is not unequivocally defined, but depends on the choice of risk model. Connor (1995) compares the three APT applications and concludes that they naturally lead to very different risk perceptions, which all merit their existence. It is not evident and there is no intention to prove one risk perception to be superior over another. I underline that in the analysis on the potential impact of a conception error, it is not sufficient to demonstrate that the error modifies the risk perception; it must be proven that the perception is somehow deficient or misleading, which is not a trivial task.

There are basically two approaches in doing so. There is the practical approach by which covariance structures estimated on market data are compared within the habitual framework of financial risk modelling as described above. And there is the more analytical approach by which the accuracy of a concept is challenged through argumentation. In this paper both approaches are taken, whereby the first two studies rely more on a practical demonstration, and the third study rather on an analytical demonstration.

In each study a risk model is specified and estimated such that it is set to be free of the conception error that is identified. The models are purposely parsimonious, concentrating on the most essential risk sources only. This is chosen to favour transparency and avoid over-fitting, which can potentially introduce new modelling errors. The models play a key role in the analysis in the sense that they provide a practical setting for testing and that they anchor thought. In the following the choices of model specification that are made in each study are described and explained.

3.3. Examination

In study on equities a risk model is specified that spans the risk structure of equity shares within a given country. A combination of the CAPM and the APT approach is taken. The price behaviour of the shares is explained by the general market movement as well as by a fundamental stock variable, in particular the book value of the company with respect to its share value, named the book-to-price ratio. Among others Fama and French (1992, 1998) have initiated this model specification, motivated in part by its statistical significance. The market betas appear to be robust and significant for stocks conform to the CAPM theory, yet

they fail to comprise a *value* effect, which according to Fama and French can be captured effectively by book-to-price ratios.

The Fama and French two-factor model, thus containing a market- and a value factor, has been widely adopted in the finance literature and in investment practice. To be precise, their more general three-factor model, containing a size factor as well, is the standard reference, though within a restricted universe of large and liquid stocks this factor doesn't manifest, as point out many among whom Fama and French themselves. The model has been estimated on such restricted stock universe for which the two-factor model is thus the standard reference.

The focus of research is on the specification of the value factor. Since the time dimension of valuation ratios such as the book-to-price ratio is ignored in the classification criterion of stocks, it is *de facto* ignored in the specification of the value factor as well. The standard procedure to build the factor is to rank stocks on the basis of current values of valuation ratios, and build a fictive portfolio at regular intervals that is long the highest- and short the lowest ones in the ranking. Individual stock returns are then regressed against the return series of this portfolio in order to obtain an estimate for their sensitivity to the value effect.

In a series of publications, Bourguignon and de Jong (2001, 2003 and 2006), we integrate the time-behaviour of the book-to-price ratios into the specification of the value factor. Based on a trailing history a distinction is made between a structurally- versus a transitorily high or low book-to-price. The value factor is effectively decomposed into two components, a structural- and a transitory value component. It is shown that both components identify a distinct source of equity risk, and that the sum of the two is much less effective, as it is mixing different risk characteristics.

The practical demonstration that the standing value concept is deficient relies on a hypothesis test, where Fama and French' model is challenged in terms of statistical significance by a model with a decomposed value factor. The same test is repeated on thirteen countries, the same thirteen as Fama and French had initially selected for their tests. The same data sources have been used and care has been taken that issues like non-normally distributed price returns or discontinuities in the data series do not invalidate the tests.

In the study on bonds a specification is chosen for modelling the risk structure between nominal- and real bonds worldwide. Unlike for equities there is no standard reference in doing so, and the choices are not straightforward. In the finance literature bond risk modelling is

naturally inscribed in an international context where interest rate variations are recognised to be cross-border dependent. In the macroeconomic literature this is not the instant reflex; traditionally interest rate dependencies are studied in a closed economy set-up, whereby the two (Fisher decomposed) interest rate components, the real rate and the inflation expectation, are assumed to be independent of each other a priori.

In a series of publications, Cette and de Jong (2008, 2012), we specify a model that is most compatible with both views. It identifies two global risk factors reflecting the pricing of the two Fisher components on a global scale. The factors which recognise international dependency by construction, are estimated independently each on the data corresponding to the component. The covariance structure between the two factors is left unspecified and is uncovered by statistical inference as part of the testing experiment. The two sub-models are estimated by a maximum-likelihood procedure.

The practical demonstration of an erroneous conception lies in the statistical inference. If the Fisher hypothesis holds in all countries, i.e. if the two components were independently priced country per country, the two global factors should be independent of each other as well. We demonstrate this not to be the case. There appears to be a positive correlation in the pricing of the two components worldwide that is offset within countries by an idiosyncratic negative correlation. The demonstration makes evident that even if the Fisher hypothesis were proven to hold country per country, it is not sufficient proof that the hypothesis holds generally.

In the same study I give an alternative model specification that doesn't respect the Fisher hypothesis yet that adapts better to the price behaviour of bonds. Again two global risk factors are identified, this time one is reflecting the global pricing of the nominal interest rates and the other the pricing of the real interest rates. Note that this model specification is closer to the idea of the CAPM, since the factors represent directly-observed market movements. Moreover, the idiosyncratic negative correlation between the two interest rate components can be made apparent in this model specification, as is shown in the chapter.

In the study on currencies, I specify and estimate a model that has the quality to provide a universal perception of currency risk to all investors with different numéraire perspectives. In order to align the perceptions it is necessary to replace the conventional *Laspeyres* return measure by logarithmic returns. The covariance matrices that can be measured on those

returns from different perspectives are exact algebraic rotations of each other. This is prerequisite for building a universal model.

I carry out standard statistical analysis on the covariance matrices that are measured over long periods of time from the different currency perspectives. When applying a principal components analysis on the matrices one by one, one of the factors retained in each case appears to be common to all perspectives. This factor marks an opposite price reaction of European currencies on one side against the dollar-denominated currencies on the other. This apparent clustering phenomenon observed by all determines for a large part the covariance structure between the exchange rates.

Thanks to this market phenomenon a concise universal risk model can be built that is meaningful to all investors and is valid since an extended period of time. The specification that has been chosen is relatively simple. There are two global factors, one reflecting the common movements of all currencies with respect to the US dollar and one reflecting the clustering movement between Europe and the dollar countries. The model parameters are estimated by means of principal components from a US dollar perspective.

The importance of the model is that it supports the basic finance principle that all investors face the same investment opportunity set. This principle is shown to hold for currency investing by Solnik (1974), but has not been generally acknowledged and is even contested in the literature. The analytical demonstration is given. The direct link to the equal-opportunity principle reinforces the argument that the conventional return measure is an odd choice for currencies. The practical demonstration of misconception is, I suppose, accomplished by showing that building an operational universal risk model for currencies is actually feasible.

4. Deduction

Up to this point it is outlined how misconceptions are detected and deciphered. In the following I describe what their influence may be on certain investment management activities and decision taking. The three studies are taken in order once again.

4.1. Equity risk

The two components of the value factor established in the first study actually correspond to two schools of thought that are being defended in the literature. The component identified as *structural value* corresponds with the view that value stocks have a distinct price behaviour compared to other stocks due to certain fundamental characteristics of the underlying firms. Loosely speaking value companies operate in industrial branches that generate moderate and stable income, according to adherents of the fundamentals view, and such characteristics condition share prices in a way that can be effectively captured by the level of book-to-price ratio.

The component identified as *transitory value* corresponds with the view that value stocks are priced differently for pure market-related reasons. Actors on the market are receptive to sentiment according to the market-sentiment view. In particular they tend to price glamorous stocks higher compared to presumably less glamorous value stocks. Also they tend to systematically overreact to certain news announcements. It is remarkable that, despite their confrontational standpoint vis-à-vis the fundamentals view, adherents of the market-sentiment view rank stocks by the level of book-to-price ratio in an exactly identical manner in order to screen out the value stocks.

A lively debate has been ongoing for decades on the value question. Deducing from the various arguments that are being deployed by the two camps, it seems that the difference in opinion lies essentially in the principle of an equilibrium price. In the fundamentals view it is implicitly assumed that stocks are priced in equilibrium with respect to the firm fundamentals at all times. Only if this principle holds strictly, ranking stocks at an arbitrary instant in time naturally isolates the stocks with a low equilibrium price level. In the market-sentiment view stock prices may be pushed away from the equilibrium by actors on the market. Rankings are made with the intention to isolate the stocks that are temporarily lower priced than their equilibrium level.

The empirical test that has been carried out makes the incompatibility of the opposing standpoints apparent in a transparent way. The test not only proves the error in concept statistically, it also helps to clarify the blocking element in the value definition. In particular, it can easily be demonstrated that the transitory value effect is shorter-lived than the structural value effect, a result which is coherent with the notion that a market influence tends to last shorter than a structural situation in a firm. Such relatively simple observations cannot be made in the standing definition of value.

In brief, the test makes clear that both views on value may be valid yet that neither has an accorded definition. This situation is in my opinion a great source of confusion in the finance literature and in value investment practice. A number of papers quoting our publications back up this opinion. The debate on the value question is not likely to progress as long as empirical evidence continues to be produced on the faulty definition. In the investment industry, value strategies that are on offer may be misaligned with their philosophy and are not liable to be managed optimally in terms of risk.

The lack of a time dimension in the value concept also puts into question whether the much-discussed *value premium puzzle* is actually formulated correctly. This puzzle refers to the observation made by many that value stocks tend to outperform growth stocks on average over time and over countries, which indeed seems anomalous. By means of a simple experiment that traces how the constituents of the value and growth groups evolve over time, it can be made apparent that the stocks migrating between the two groups are responsible for the outperformance, not the stocks that stay.

This observation, made by Bourguignon and de Jong (2003) and repeated by Fama and French (2007), changes the nature of the puzzle. It is more precise to say that the valuation ratios are persistently mean-reverting. While a lowly-valued (value) stock reverts, the price rises and contributes mechanically to the value premium, whereas while a highly-valued (growth) stock reverts the negative return is subtracted from the premium thus contributes equally well. The mean-reversion effect is interesting in itself, yet it presents less as an anomaly. Part of the value puzzle lies to my mind in the illusion that a fixed set of stocks is systematically outperforming another fixed set.

The fantasy of a value premium has had a considerable influence on the investment industry. Especially in the nineties a wide range of value investment products has been on offer with

the tacit suggestion that they are winning strategies. And perhaps they were. According to my empirical tests those strategies have been betting, in a roundabout way, on the mean-reversion effect in the valuation of stocks. The tests show that a portfolio exploiting this effect successfully must be rebalanced frequently though so that the transactions costs involved are necessarily high. High transactions costs don't match with the idea of a holding a fixed set of winning stocks, and may have come as a bad surprise to those who engaged in value investing.

4.2. Bond risk

Let us move to the second study, on bonds. The theory on interest rates seems to be ill-adapted to explain certain price phenomena on the bond market. Consider the following situation. A holder of an American Treasury Inflation-Protected Security (TIPS) is by definition protected against inflation uncertainty since the payouts are all inflation-corrected. Coherent with the theory, the price evolution of this bond is measured to be uncorrelated with the inflation anticipations in the US. What the theory fails to explain is why the TIPS is significantly correlated with the inflation anticipations priced in Canada, or in other countries. The lack of cross-sectional vision makes this impossible to understand.

A direct consequence of the unrecognised cross-country correlations in bond prices is that bonds are much less risk-diversifying than one would expect. Hunter and Simon (2005) make this observation based on experiments with risk-optimised bond portfolios. In order to explain the lack of risk-diversification capacity, a global bond risk model must be called in that captures the cross-correlation structure and inherently recognises an anti-correlation between the price variation of an inflation-linked bond and the priced inflation anticipation. This anti-correlation is not intuitive with respect to macroeconomic theory but is explained by market-related events.

As long as those market events are playing up, no link can be laid between interest rate theory and bond market practice. This reality is a deception for the Central Banks who had initially lobbied to issue inflation-linked bonds in part with the intention to use the new bond data as a test bed for obtaining feedback on their monetary policy. If the inflation anticipation priced through the breakeven inflation rate is in line with the inflation target set by the Central Bank, it is an indication that the monetary policy is perceived as credible. As it stands the priced

breakeven inflation is oscillating too violently around the inflation target, as remark two Central Bank governors, Bernanke (2004) and Noyer (2004).

4.3. Currency risk

Let us move to the last study, on currencies. What are the consequences of the odd measure of return expectation? A first answer already given above is confusion, which, once installed, may drift off to more confusion. An example of such drift is the undue belief that the Uncovered Interest Rate Parity is meant to hold in real- rather than in nominal terms, i.e. corrected for purchasing power. When Engel (1984) made this derivation, he did make mention that a technical issue was being treated rather than a conceptual one. Studies have been pursued even though, assessing the validity of the UIP if the Purchasing Power Parity doesn't hold, or if for instance the consumption baskets are not comparable between countries. Those studies may be of interest but Engel's finding gives no justification of the direction that is chosen.

A more serious consequence of the measurement problem is that the incentives for leaving an international portfolio partially unhedged are mistaken. I replicate the portfolio example that Black and Litterman had used in their article, on which they had applied a partial hedge. I show that a partial hedge is sensible not because it somehow improves the performance perspectives of the portfolio, as they argue, but because it diversifies risk. The covariance matrix in the example is such that including some currency exposure in the given portfolio reduces its total risk, in line with Solnik's argument.

There is today no clear consensus on the rationale of currency hedging. The general belief is that so many different factors are at stake in the decision on the currency hedge that each investor very much ends up with his/her personalised optimum in practice. There is not enough exchange of ideas to be able to judge the viability of this statement. It may very well be that the impact of the covariance relations is not well understood, the more since the perception on the relations differs per currency perspective. What is clear is that the covariance structure matters between exchange rates and assets and that there is no consensus view on this either.

Relatively recently researchers have started to take interest in studying the structural price relations of currencies with other assets. Hau and Rey (2004) establish that the equity price level of a country compared to that of the United States is inversely related to the exchange

rate of the local currency with respect to the US dollar. They show this relationship to hold over a long list of countries over an extended period of time. Cappiello and De Santis (2005) make the same observation and postulate that the so-called Uncovered Equity Return Parity is responsible. If the price of equity in one country diverts from the US reference level, price correction takes place via the foreign exchanges. Hau and Rey give an explanation of this market phenomenon with reference to portfolio balancing theory. The price inequality in equities provokes a general portfolio rebalancing, the trades of which influence the currency prices involved.

I take their theory one step further and show that the list of observations country per country resumes into one global observation. If the global equity price level is on the rise usually led by the US stock market, European stock markets tend to outperform the general trend while the dollar-nominated countries underperform. In the same time the opposite tendency takes place on the foreign exchanges, that is European currencies depreciate while dollar currencies appreciate. Note that this one observation encloses all observations per country. The significance tests for this global effect largely outdo the individual tests per country as well. In addition, with relative success, the balancing theory of Hau and Rey is shown to hold on a global scale.

This global market phenomenon, which has been left uncommented in the literature as far as I am aware, shapes the structural covariance structure between equities and currencies over the most recent period of around fifteen years (1995-2009). The concerted anti-correlation relationship is such that a partial currency hedge in an international equity portfolio proves beneficial. All investors from all currency perspectives can improve the risk profile of their equity portfolio by intentionally taking on some currency risk. Of course the optimal hedge doesn’t take the same form in all currency perspectives. This is made clear in a practical example. In the example it is shown that an Australian investor records a much lower volatility of the unhedged world equity basket than a Japanese investor, the explanation being that the Australian dollar is involved in the global anti-correlation relationship whereas the yen isn’t.

Postulating and studying the global equity-currency correlation relationship is useful from a practical point of view because it explains to a large extent the variance in the exchange rates since fifteen years. The markets have not always been in this status quo though. It is shown

empirically that the anti-correlation is significant only if the price reaction of the European versus the dollar-nominated equities is in accordance. It is a conditional situation, depending on the price reactivity which itself very much depends on the industries the countries are engaged in. Considering that the industry composition of a country is stable over time, it may be expected that for the time being the global market phenomenon is likely to stay.

The market phenomenon is interesting from a theoretical point of view as well since it is fully inscribed in Solnik's International CAPM. The generalisation of the original CAPM to an international scale has the immediate implication that the exchange rates become part of the equity equilibrium pricing process. This is exactly what is observed to happen. A question that remains unresolved however is how exactly this equilibrium pricing works. It is not clear why the price inequalities on the equity markets get compensated on the foreign exchange markets. The theorem of the Uncovered Equity Return Parity is appealing but fails, as far as I am concerned, to give a satisfying explanation.

5. Conclusion

In conclusion, the three studies expose in different manners that what starts off as an elementary neglect or an over-simplification may end up in a misgiving situation of confusion. The studies serve to better understand how an inexactness or in the worst case a misperception of risk may accrue in the financial system. It is worth noting that the settings in which this is shown to take place are commonplace. The basic financial risks related to equities, bonds and currencies are considered to be well established. Moreover, regulatory bodies are permanently active to increase market transparency, initiating schemes such as the Basel II Accord in 2004 that reinforces risk control, and the Markets in Financial Instruments Directive, the MiFID, in 2007, a risk awareness and best execution directive for the protection of the clients.

Despite the long-acquired experience and the permanent efforts to improve the conditions, dramatic mishaps continue to take place on the capital markets. No less than two events have shaken the markets in the twenty-first century so far. There has been the technology bubble during which the risks related to the dotcom start-ups were immensely underestimated, and there has been the subprime crisis eight years later reminding us that the housing market bears

elementary risks as well. At each such occasion we ask ourselves how it has been possible for things to escalate.

My thesis doesn't give the healing answer; however, it does contribute to a better understanding of how potentially dangerous risk misperceptions may arise. One of the causes seen to stand at the origin of the two latest escalations is complexity. The commercial potential of the technology that was newly-available at the turn of the century was esteemed to be too complex to grasp thus pushing evaluations way off-track. And likewise, the derivative instruments that combined individual housing loans into bulk sales, the Collateral Debt Obligations, have been condemned to be too complex and non-transparent.

My thesis goes against this line of thought. In the concrete examples that are studied complexity has not been identified to be the blocking point. It is on the contrary a sequence of seemingly minor omissions or short-cuts that lead to misperception. I make note that those omissions can typically not be caught in the mazes of regulatory bodies or being alerted for in risk awareness schemes. The investment industry is and remains in this respect vulnerable to internal error. It is important to realise that correctly assessing the basic financial risks should therefore remain an ongoing concern at all levels in the industry.

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