Amonlirdviman, Kevin; Carvalho, Carlos

Working Paper

Loss aversion, asymmetric market comovements, and the home bias

Staff Report, No. 430

Provided in Cooperation with:
Federal Reserve Bank of New York

Federal Reserve Bank of New York
Staff Reports

Loss Aversion, Asymmetric Market Comovements, and the Home Bias

Kevin Amonlirdviman
Carlos Carvalho

Staff Report no. 430
February 2010

Loss Aversion, Asymmetric Market Comovements, and the Home Bias

Kevin Amonlirdviman and Carlos Carvalho

Federal Reserve Bank of New York Staff Reports, no. 430
February 2010
JEL classification: G11, G15

Abstract

Loss aversion has been used to explain why a high equity premium might be consistent with plausible levels of risk aversion. The intuition is that the different utility impact of wealth gains and losses leads loss-averse investors to behave similarly to investors with high risk aversion. But if so, should these agents not perceive larger gains from international diversification than standard expected-utility preference agents with plausible levels of risk aversion? They might not, because comovements in international stock markets are asymmetric: Correlations are higher in market downturns than in upturns. This asymmetry dampens the gains from diversification relatively more for loss-averse investors. We analyze the portfolio problem of such an investor who has to choose between home and foreign equities in the presence of asymmetric comovement in returns. Perhaps surprisingly, in the context of the home bias puzzle we find that the loss-averse investors behave similarly to those with standard expected-utility preferences and plausible levels of risk aversion. We argue that preference specifications that appear to perform well with respect to the equity premium puzzle should be subjected to this "test."

Key words: loss aversion, home bias, asymmetric market comovements, equity premium puzzle

---

Amonlirdviman: The Boston Consulting Group. Carvalho: Federal Reserve Bank of New York. Corresponding author e-mail: carlos.carvalho@ny.frb.org. The authors thank Michael Melvin, an anonymous referee, and participants at the Latin American Meeting of the Econometric Society and the Econometric Society European Meeting for comments and suggestions.

1 Introduction

Behavioral explanations, in particular loss aversion, have been used to explain why a high equity premium might be consistent with plausible levels of risk aversion. Loss-averse decision makers have preferences over gains and losses relative to a reference point rather than overall wealth. Typically, such preferences display a kink at the reference point, with the slope of the utility function over losses being steeper than the slope of the utility function over gains. For a given absolute loss or gain, this implies a first-order difference between the decrease in utility due to a wealth loss and the increase in utility due to a wealth gain of equal magnitude. Thus, this nondifferentiability of the utility function at the reference point is loosely analogous to locally high risk aversion. This type of loss-averse utility provides a possible explanation why investors may prefer safer bonds with low returns to riskier equities with high returns.[1]

Choosing between equities and bonds is just one dimension of investors' portfolio allocation problems. Another dimension that has been extensively analyzed is the extent of international diversification of equity portfolios. French and Poterba (1991) and others present evidence that households in the United States, the United Kingdom, Japan, Germany, and France typically hold between 80% and 95% of their equity portfolio in domestic equities. In contrast, optimal equity portfolios derived from various models are well diversified internationally, and imply sizeable utility losses from holding undiversified portfolios observed in the data (e.g. Lewis, 1999). This discrepancy between model predictions and the observed portfolios is called the home bias in equities.[2]

A desirable property of any potential explanation of either the equity premium puzzle or home bias in equities is that the resolution of one puzzle should not make the other puzzle more difficult to explain. In this paper we ask whether loss aversion satisfies this property. At first pass, this does not seem to be the case: the fact that loss aversion leads investors to behave similarly to highly risk-averse investors should imply that the gains from international diversification are even larger than those assessed with standard expected-utility preferences.[3] In turn, this would make the home bias in equities "even more of a puzzle". In fact, one might reasonably conjecture that this potential

[1] Benartzi and Thaler (1995) show that this behavior can account for the equity premium in a partial equilibrium static model with myopic loss-averse investors, while Barberis, Huang, and Santos (2001) incorporate loss aversion into a dynamic general equilibrium pricing model.

[2] There is, however, evidence that the home bias has diminished over time (see, for example, Amadi, 2004).

[3] In the related literature on international risk sharing in consumption, van Wincoop (1999) reports that studies using standard preferences and a coefficient of relative risk aversion that matches the equity premium show high unexploited gains from international risk sharing.

problem is common to all preferences that display first-order risk aversion.

When choosing equity portfolios, however, investors must consider the fact that comovements in international stock market returns are asymmetric: correlations are higher in market downturns than in upturns. For any level of unconditional comovement in international stock returns, a higher asymmetry should dampen the gains from diversification for investors with standard expected-utility preferences (Ang and Bekaert, 2002). This dampening effect is even stronger for loss-averse investors due to the first-order difference between the utility impact of losses and gains.

We address the question of the perceived gains from international diversification by analyzing the portfolio problem of a loss-averse U.S. investor who must decide between domestic and foreign equities that are subject to asymmetric comovements in returns. In particular, we adopt the model of myopic loss-averse (MLA) investors used by Benartzi and Thaler (1995) to study the equity premium puzzle. To account for return asymmetries, we solve the portfolio problem under the empirical distribution of stock returns. We benchmark the results against those obtained for an expected-utility investor with constant relative risk aversion (CRRA) preferences facing the same portfolio problem. As a simple way to assess the effect of the asymmetry in return comovements, we compare the results with those obtained under a parameterized joint Gaussian distribution of stock returns that features the same unconditional level of return comovement as in the data, but no asymmetry. The gains from diversification are quantified for each utility specification by determining the additional expected return that must be added to the expected return of home equities in order to shift the portfolio allocation away from the optimal to the point where it displays a degree of concentration in home equities equal to that documented in the literature.

We find that the gains from international portfolio diversification as perceived by myopic loss-averse investors are reduced significantly by the presence of asymmetric market comovements. The reduction in diversification gains is large for short evaluation horizons (between 1.6% and 2.3% per year for the 2-3 month horizons) while the reduction is not as pronounced for longer evaluation horizons (roughly 0.40%-0.60% per year for the 12-18 month horizons). These results are due to an interaction between the kink in the myopic loss-averse utility function and the distribution of market returns. For short horizons, the kink is more salient in determining the behavior of the MLA investor. As a result, gains from international diversification are large, and very sensitive to asymmetric market comovements. For long horizons, total returns tend to be positive and away from the kink, and the MLA investor behaves more similarly to a CRRA investor with plausible levels of risk aversion. As a consequence, gains from diversification are smaller, and less affected by asymmetric comovement in returns. In contrast, asymmetric market comovement only affects the perceived gains from diversification to a small extent for CRRA investors (approximately 0.10% to 0.50% per year in additional required return). Moreover, this effect does not vary much with the evaluation horizon nor with the level of risk aversion.

Finally, we do an additional exercise to assess whether our findings are driven mainly by the asymmetry in return comovements, or by other dimensions in which the empirical distribution may differ from our parameterized Gaussian distribution. We fit to the data a parametric model of the joint distribution of international stock returns that allows for asymmetric comovement in returns. We assume Gaussian marginal distributions for domestic and foreign stock returns, and use a Symmetrized Joe-Clayton copula (Patton, 2006) to introduce comovement asymmetry in the joint distribution.[4] The two-parameter copula allows us to control the degree of comovement between returns conditional on being high or low, and nests a symmetric copula. We calibrate the two parameters to reproduce with artificial data the results of the regressions that we use to document the comovement asymmetry in the actual data. We find that the perceived gains from international diversification under our calibrated copula distribution are not much larger than the ones obtained under the empirical distribution. This supports our conclusion that, in the context of the portfolio problems that we consider, the asymmetry in return comovements is a key determinant of the gains from international diversification.

Numerous studies have examined the home bias in equities and proposed different explanations to account for the apparent puzzle. Since this is not the focus of this paper, for brevity we do not survey this literature here, and instead refer the interested reader to Karolyi and Stulz (2003). Previous work has also analyzed the international portfolio selection problem in the context of asymmetrically correlated returns. Ang and Bekaert (2002) show that correlations between domestic and foreign equities tend to be higher when the markets are falling and lower when the markets are rising. In this context, they study the international portfolio selection problem of standard expected-utility-preference agents. Das and Uppal (2004) study the optimal portfolio selection problem in a model where asymmetries in correlations arise from simultaneous jumps in international stock re-

[4] We thank an anonymous referee for suggesting this type of parameterization as a counterfactual return distribution.

turns. Asymmetries in return comovements have also been studied independently of the international portfolio selection problem (e.g. Hong, Tu, and Zhou, 2007).

Section 2 presents the myopic loss aversion framework and our method for analyzing the portfolio allocation problems. Section 3 presents some empirical evidence on the comovement of international stock returns. Section 4 presents the results for the portfolio allocation problems and for our measure of the gains from international diversification. Section 5 analyzes the results and Section 6 concludes.

2 Theoretical framework and methodology

We base our analysis on the framework of myopic loss aversion proposed by Benartzi and Thaler (1995) (henceforth, BT). Utility is defined over gains and losses in the agent's portfolio (returns) relative to some reference point, rather than over terminal wealth. Loss aversion implies that the utility function representing agent preferences is steeper over losses than over gains, and displays a kink at zero (the reference point which corresponds to current wealth). The prospective utility of a given risky outcome is computed as a weighted average of the utility value of each possible realization. The weights, called decision weights, are nonlinear functions of the whole probability distribution of payoffs which capture some features of procedures that decision makers might employ when making decisions involving risk. As set forth by BT, myopic behavior means that agents have an evaluation period or horizon at the end of which they review their portfolios and perceive utility.[5] This period affects decisions through the distribution of returns.

More specifically, we use a functional form for utility originally proposed by Kahneman and Tversky (1979, 1991), and common in the prospect theory literature:

$$v(x) = \begin{cases} x^{\eta} & \text{if } x \geq 0 \\ -\lambda(-x)^{\beta} & \text{if } x < 0, \end{cases}$$

where x is the net return, the degree of loss aversion is given by $\lambda \geq 1$, and η and β are parameters which provide some additional flexibility to capture agents' behavior towards risk. For example, η , $\beta < 1$ imply that agents are risk averse in the domain of gains and risk seeking in the domain of losses. Figure 1 provides an illustration of this utility function.

[5] This differs from the agent's investment horizon, which in general tends to be much longer. BT argue that due to principal-agent and career concerns issues, this distinction tends to apply even to long-term institutional investors.

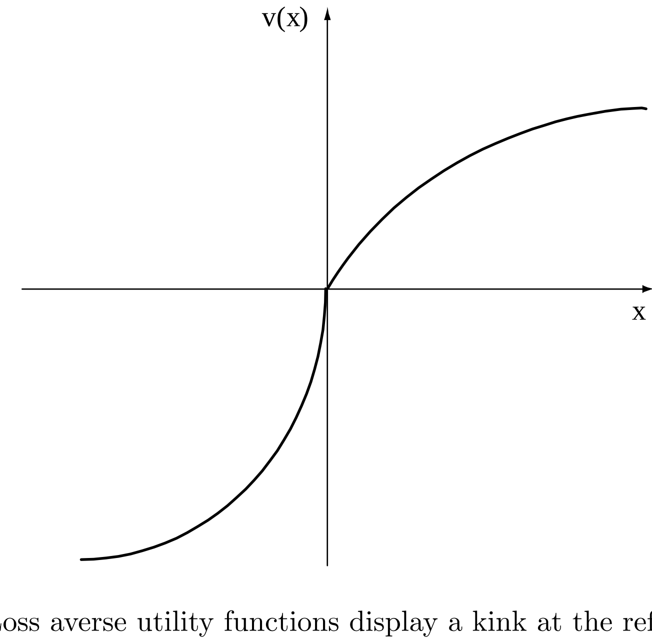

Figure 1: Loss averse utility functions display a kink at the reference point.

For an MLA investor with evaluation period τ, the prospective utility from investing in a given portfolio is:

$$V_{\tau} = \sum_{s \in S} \pi_{\tau,s} v\left(x_{\tau,s}\right),$$

where $\pi_{\tau,s}$'s are the decision weights, $x_{\tau,s}$ is the net return of the portfolio in state s at the end of the evaluation period τ, and S denotes the set of possible states.[6] For simplicity, these are ordered so that s_1 denotes the lowest possible return realization. The $\pi_{\tau,s}$'s are obtained through a nonlinear transformation of the cumulative distribution of returns as follows: let $p_{\tau,s}$ denote the probability that state s occurs at the end of the evaluation period τ. Define $P_{\tau,s} = \sum_{r \geq s} p_{\tau,r}$ and $P^*_{\tau,s} = \sum_{r > s} p_{\tau,r}$, i.e., the probabilities of obtaining a return at least as high as and strictly higher than $x_{\tau,s}$, respectively. Then, $\pi_{\tau,s} = \omega\left(P_{\tau,s}\right) - \omega\left(P^*_{\tau,s}\right)$, where ω is a nonlinear transformation which is (in general) different for gains and losses. We adopt the parameterization proposed by Kahneman and Tversky and used in BT:[7]

[6] We formulate the problem in the context of a discrete state space as in BT, but it is straightforward to extend it to the case of a continuum of states.

[7] The qualitative results are the same if, instead, we set $\rho = \beta = 1$ (i.e., a piecewise linear utility function) and $\zeta(q) \equiv 1$ (i.e., the actual probabilities rather than the nonlinear decision weights are used). This is also the case in BT and Barberis, Huang, and Santos (2001).

$$\omega(q) = \frac{q^{\zeta(q)}}{\left(q^{\zeta(q)} + (1-q)^{\zeta(q)}\right)^{1/\zeta(q)}}$$

The parameter values we use in the results reported subsequently are $\lambda = 2.25$, $\eta = \beta = 0.88$, $\zeta(q) = \begin{cases} 0.61 & \text{if } q \geq 0 \\ 0.69 & \text{if } q < 0 \end{cases}$. They have been estimated in the context of experiments designed to study behavior towards risk and were not chosen to influence the results we obtain in any particular way (see Kahneman and Tversky (1979) and Tversky and Kahneman (1992)).

The investor has to choose between home and foreign equities. For simplicity assume that each of these are available through a market index. Denoting by α the fraction of the portfolio invested in the *home* market, by $r^H_{\tau,s}$ the net return of the home market in state s at the end of the evaluation period τ, and by $r^F_{\tau,s}$ the analogous return for the foreign market, the portfolio problem can be written as:

$$\max_{\alpha} \sum_{s \in S} \pi_{\tau,s} v\left(\alpha r^H_{\tau,s} + (1-\alpha) r^F_{\tau,s}\right). \tag{1}$$

We solve the portfolio problem by maximizing prospective utility over feasible portfolio weights.[8] First we look at two different environments: one in which the investor faces the empirical distribution of returns, obtained by sampling repeatedly (with replacement) from the data that we describe in the next section; the other in which returns are generated by drawing (logarithmic) returns from a joint Gaussian distribution so that first and second moments of returns match the data.[9] In the results section we refer to these two cases as calculating prospect theory utility by (1) sampling from the empirical distribution of returns and (2) using a parameterized distribution. We also solve the portfolio problem of an expected-utility investor with CRRA preferences facing the same environments.

By comparing the results for the MLA investor with those of the CRRA investor in those two environments, we can assess the roles of asymmetric return comovements and myopic loss aversion, and study the interaction between the two. However, this assessment relies on a comparison between the empirical distribution of returns and a parameterized Gaussian distribution. It might be the case that other features of the empirical distribution are also important for the results. Thus, to isolate

[8] We do not allow for short selling and maximize by searching over a portfolio weight grid of increment size 0.01.

[9] In all simulations, we draw samples of size $N = 750,000$ and construct the empirical distribution of returns with histograms (100 bins).

the role of the asymmetry in return comovements we fit a parametric model of the joint distribution of international stock returns that allows for asymmetric comovement in returns, and compare the gains from international diversification to those obtained under the empirical return distribution.

3 Some evidence on asymmetric market comovements

In this section we examine the evidence on the comovement structure of home and foreign equity returns using simple econometric methods, and present descriptive statistics of the data we use. We provide a straightforward measure of the asymmetry in return comovements of U.S. and non-U.S. equities, and discuss how the results presented here fit with previous work in the literature.

Data on the stock market returns of the United States and other developed countries are from the Morgan Stanley Capital International (MSCI) U.S. and Europe, Australasia, and Far East (EAFE) indices.[10] We use before-tax returns at a monthly frequency from January 1970 to April 2009. For the United States the average annual logarithmic return is 8.6% with an annualized volatility of 16%.[11] For the EAFE index, the return is 9.1% and the volatility is 17.5%. Both empirical distributions are negatively skewed (-0.56 for EAFE and -0.69 for the U.S.), and display excess kurtosis (1.49 for EAFE and 2.83 for the U.S.). The unconditional cross-correlation is 0.62.

Taking the perspective of a U.S-based investor, we run an ordinary least squares (OLS) regression of U.S. returns on EAFE returns using the following specification, which allows for differences in slopes conditional on whether EAFE returns are positive or negative:

$$r_t^{US} = a + a^+ r_t^{EAFE} \mathbb{1}_{\{r_t^{EAFE} > 0\}} + a^- r_t^{EAFE} \mathbb{1}_{\{r_t^{EAFE} \leq 0\}} + \varepsilon_t, \qquad (2)$$

where the notation is self-explanatory.

The results of the regression are reported in Table 1. The point estimates show that, conditional on a positive EAFE return, the slope of the regression is smaller than over the domain of negative EAFE returns. A standard F test rejects the null hypothesis that the slopes are equal at a 1% significance level. A similar picture emerges when we regress EAFE returns on U.S. returns.

To check for robustness to outliers, we estimate (2) by median regression and test for equality

[10] Data are available at http://www.msci.com.

[11] The annualized volatility equals $\sqrt{12}$ times the standard deviation of monthly (logarithmic) returns.

Table 1: OLS estimates of the return comovements of the MSCI U.S. and EAFE indices. Standard errors are reported in parentheses. The reported F-statistic is for the test that the positive (+) coefficient is equal to the negative (-) coefficient.

$\widehat{a}$	$\widehat{a}^+$	$\widehat{a}^-$	R^2	Num. Obs.	$H_0 : \widehat{a}^+ = \widehat{a}^-$	
0.010	0.376	0.753	0.40	472	F statistic	13.59
(0.003)	(0.062)	(0.059)			p-value	0.0003

of a^+ and a^- using bootstrapped standard errors, with unchanged conclusions. We also estimate the comovement of returns for horizons greater than one month. Returns are divided into non-overlapping n-month windows, for $n = 3$, 6,..., 18 months. For all specifications, the coefficients for negative EAFE returns are larger than the coefficients for positive EAFE returns. Moreover, for all-but-one specifications a standard F test rejects the null hypothesis that the slopes are equal at a 10% (or lower) significance level. For brevity these results are presented in the Appendix.

Previous work on comovement of international stock market returns includes a number of additional technical considerations. Generally, all results are consistent with the asymmetric comovements of returns. Longin and Solnik (1995) find that the asset returns of seven developed economies do not exhibit constant correlation over the period 1960-1990. They provide evidence that correlation increases in periods of high volatility. Using a different setup, King, Sentana, and Wadhwani (1994) develop a model to explain time-varying correlations with unobservable factors. Erb, Harvey, and Viskanta (1994) argue that correlations vary with the business cycle. Ang and Bekaert (2002) employ a dynamic international asset allocation model with regime switching. They find that the returns of U.S., U.K., and German equities are more highly correlated during bear markets. Das and Uppal (2004) model international equity returns as jump-diffusion processes. They impose simultaneous jumps, which in their calibrated model generate asymmetric return comovements.

4 Results

4.1 Inferring diversification gains from optimal portfolios

First note the importance of the evaluation horizon, τ, for MLA investors, in contrast with expected-utility CRRA investors (for the latter we use γ to denote the coefficient of relative risk aversion). This can be seen by comparing the portfolio choices presented in Figure 2 (MLA investors) and Figure

3 (CRRA investors). The plots show utility under the empirical distribution of stock returns as a function of the fraction of the portfolio invested in foreign equities $(1 - \alpha)$. The curves correspond to different evaluation horizons: starting from the lower curve, the latter are 3, 6, 9, 12, 15 and 18 months. Utility is computed as the average across 750,000 draws from the empirical distribution of U.S. and EAFE returns. On each curve, the (red) dot indicates the point at which utility is maximized.

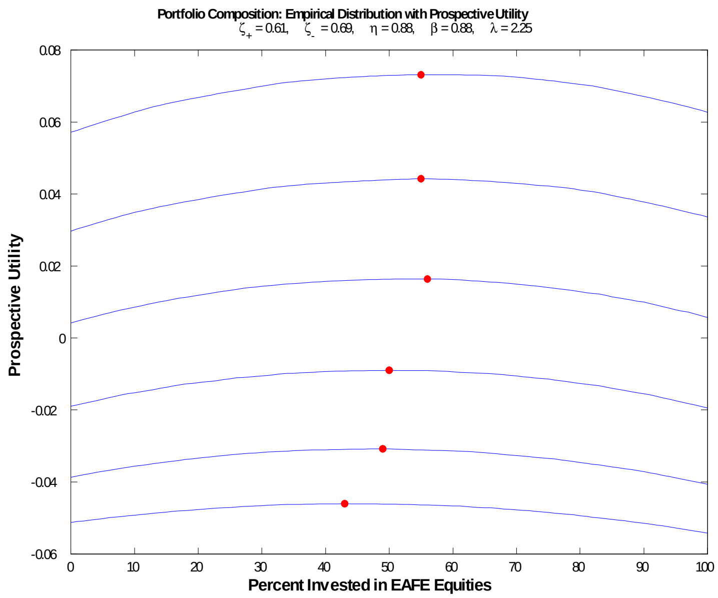

Figure 2: Prospective utility calculated on portfolios of U.S. and EAFE equities at various compositions (from 0% U.S. equities to 100% U.S. equities) using repeated sampling from the empirical distribution of stock market returns. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

In Figure 2, the fraction of the optimal portfolio invested in foreign equities tends to be slightly larger for longer evaluation horizons. It is slightly above 40% for a 3-month evaluation period, and increases to slightly more than 50% for an 18-month horizon. For the CRRA investor - with a coefficient of relative risk aversion $\gamma = 5$ - the optimal fraction invested in foreign equities is slightly below 50%, and is essentially independent of the evaluation horizon (Figure 3). The independence of the optimal portfolio allocation from the evaluation horizon is a well-known result shown by Merton (1969) and Samuelson (1969).

To get an initial assessment of how much each investor values the opportunity to diversify internationally, Figure 4 (MLA investor) and Figure 5 (CRRA investor) show what would happen to

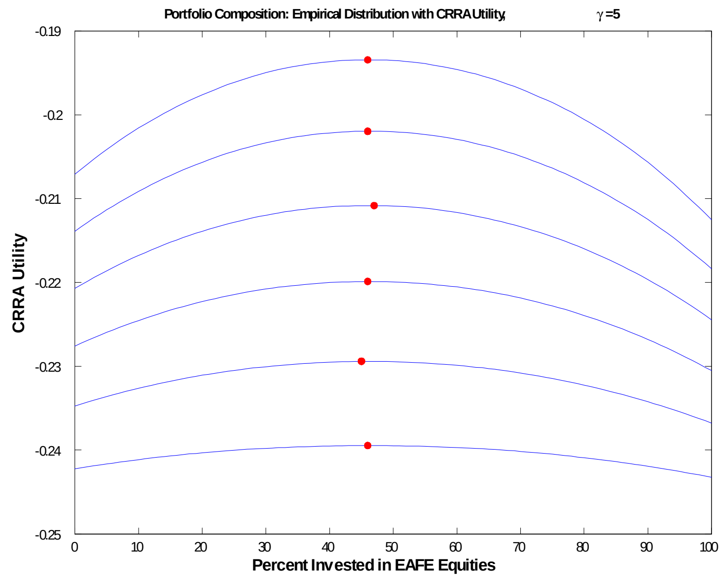

Figure 3: CRRA utility with $\gamma = 5$ calculated on portfolios of U.S. and EAFE equities at various compositions (from 0% U.S. equities to 100% U.S. equities) using repeated sampling from the empirical distribution of stock market returns. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

portfolio choices if average returns on domestic equities were 2% per year higher than they actually were.[12] As expected, both investors would shift their portfolios towards domestic equities. However, the shift is much more abrupt for MLA investors for all but the shortest evaluation horizon. Moreover, longer evaluation periods are associated with larger shifts towards home equities. This suggests that the value of diversification opportunities for MLA investors is smaller for longer evaluation horizons: for a given additional annual return, MLA investors with a short evaluation horizon choose to shift their portfolio relatively less than those with longer evaluation horizons.

Note that in Figures 2-5 we compute optimal portfolios under the empirical distribution of international stock returns. Thus, it is not possible to isolate the role played by features of the return distribution from the role of differences in behavior towards risk between MLA and CRRA investors. To get a sense of the role of the distribution, in particular of asymmetric return comovements, Figures 6-9 plot results analogous to Figures 2-5, but using a parameterized distribution for stock returns with no comovement asymmetry.

[12] To generate this counterfactual distribution we add a constant to all monthly logarithmic U.S. returns, so that the average annual logarithmic U.S. return increases by 2 percentage points.

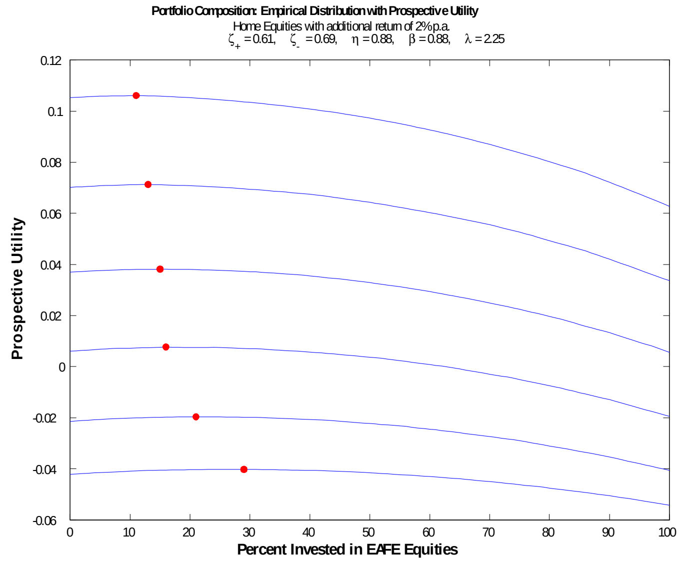

Figure 4: Prospect theory utility calculated on portfolios of U.S. and EAFE equities at various compositions (from 0% U.S. equities to 100% U.S. equities) using repeated sampling from the empirical distribution of stock market returns, with 2% p.a. added to U.S. monthly (logarithmic) returns. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

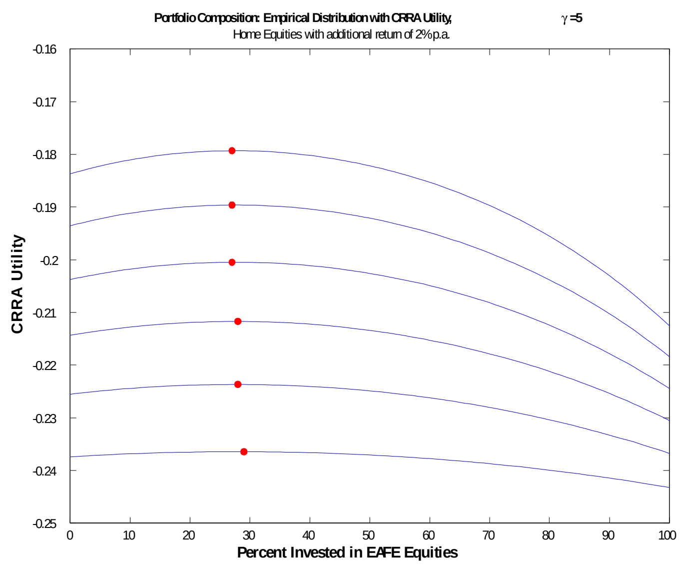

Figure 5: CRRA utility with $\gamma = 5$ calculated on portfolios of U.S. and EAFE equities at various compositions (from 0% U.S. equities to 100% U.S. equities) using repeated sampling from the empirical distribution of stock market returns, with 2% p.a. added to U.S. monthly (logarithmic) returns. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

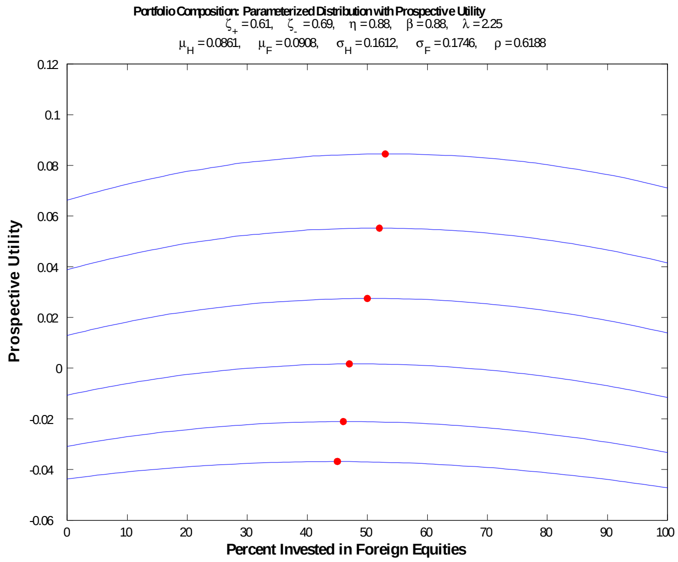

Figure 6: Prospect theory utility calculated on portfolios of home and foreign equities at various compositions (from 0% home equities to 100% home equities) using a parameterized distribution of stock market returns with estimated moments. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

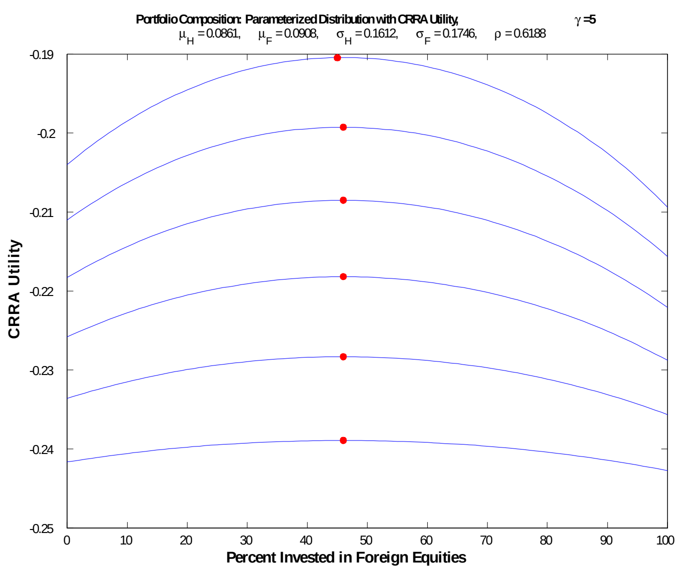

Figure 7: CRRA utility with $\gamma = 5$ calculated on portfolios of home and foreign equities at various compositions (from 0% home equities to 100% home equities) using a parameterized distribution of stock market returns with estimated moments. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

We use joint Gaussian distributions for logarithmic returns, calibrated so that home equities have an average annual logarithmic return of μ_H with a volatility of σ_H, and foreign equities have an average annual logarithmic return of μ_F with a volatility of σ_F; we set the (unconditional) correlation coefficient $\rho = 0.62$ to match the data. Figure 6 (MLA investor) and Figure 7 (CRRA investor) show the results with $(\mu_H, \sigma_H, \mu_F, \sigma_F)$ set equal to the moments of the empirical distribution, while Figure 8 (MLA investor) and Figure 9 (CRRA investor) show results when μ_H is higher by 2% per year. The same qualitative features arise, but now the portfolios are relatively more diversified, and the portfolio shifts when domestic returns are higher are less pronounced. This suggests that the gains from diversification are higher under the parameterized distribution.

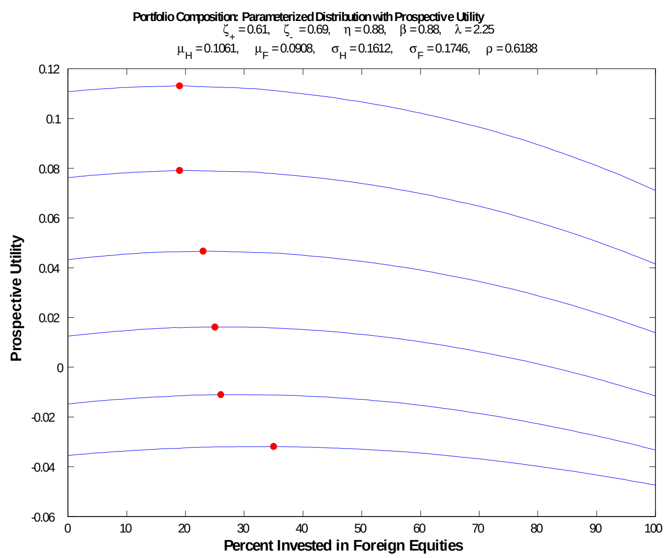

Figure 8: Prospect theory utility calculated on portfolios of home and foreign equities at various compositions (from 0% home equities to 100% home equities) using a parameterized distribution of stock market returns with estimated moments, with 2% p.a. added to home monthly (logarithmic) returns. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

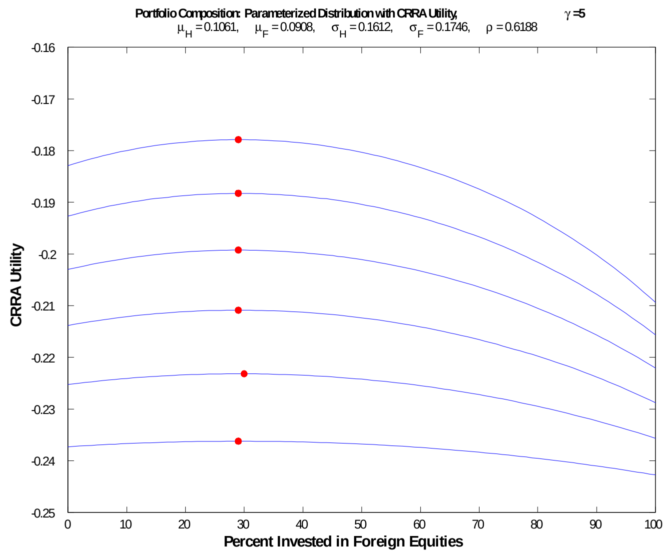

Figure 9: CRRA utility with $\gamma = 5$ calculated on portfolios of home and foreign equities at various compositions (from 0% home equities to 100% home equities) using a parameterized distribution of stock market returns with estimated moments, with 2% p.a. added to home monthly (logarithmic) returns. The curves correspond to different evaluation horizons. Starting from the lower curve, these are 3, 6, 9, 12, 15 and 18 months. The (red) dot indicates the optimal U.S./EAFE portfolio composition for a particular evaluation horizon.

4.2 Calculation of diversification gains from a direct measure

The results of the previous subsection indicate that the gains from international diversification are lower under the empirical distribution of international stock returns, and that in the case of MLA investors they also depend on the evaluation horizon. In this subsection, we address these issues with a direct measure of the gains from international diversification.

For any given sub-optimal portfolio, we measure the gains from diversification by determining the additional expected return that must be added to the expected return of home equities in order to justify holding that suboptimal portfolio rather than the optimal one. We refer to this measure of the gains from diversification as the “additional required return.”

Formally, let α_τ^* solve the portfolio problem (1), i.e.:

$$\alpha_\tau^* = \arg\max_\alpha \sum_{s \in S} \pi_{\tau,s} v \left(\alpha r_{\tau,s}^H + (1 - \alpha) r_{\tau,s}^F \right).$$

Then, for an MLA investor with evaluation period τ, the additional required return starting from a suboptimal portfolio α, denoted $ARR_\alpha(\tau)$, solves:

$$\sum_{s\in S}\pi_{\tau,s}v\left(\alpha_\tau^* r_{\tau,s}^H + (1-\alpha_\tau^*)\, r_{\tau,s}^F\right) = \sum_{s\in S}\pi_{\tau,s}v\left(\begin{array}{c}\alpha\left[\left(1+r_{\tau,s}^H\right)\left(1+ARR_\alpha(\tau)\right)^{\tau/12}-1\right]\\ +(1-\alpha)\, r_{\tau,s}^F\end{array}\right).$$

In particular, we measure the gains from international diversification by finding the additional required return that would induce the investor to hold a portfolio displaying the same degree of "home bias" as we see in the data, rather than the optimal portfolio implied by the model. To that end, we set $\alpha = 90\%$ (so that the fraction of equity portfolios assigned to foreign equities is 10%), and compute $ARR_{0.90}(\tau)$ for several evaluation horizons. To get a sense of the effects of asymmetries in return comovements, we again compare the results obtained by sampling from the empirical distribution of returns to those obtained by using a parameterized Gaussian distribution as described previously. We also perform the same calculations for CRRA investors with different degrees of risk aversion.

The results are summarized in Figure 10. They confirm that the gains from diversification for MLA investors fall with the evaluation horizon, and that these gains are lower under the empirical distribution. For MLA investors, this dampening effect is quite large, especially at short evaluation horizons. For example, with a 2-month horizon the gains from diversification measured by $ARR_{0.90}(2)$ drop from around 7.3% per year under the parameterized Gaussian distribution to 5% per year under the empirical distribution. With a one year horizon, the difference falls to around 0.60%-0.70% per year. The effects are smaller for CRRA investors: of the order of 0.10%-0.50% per year, depending on the level of risk aversion.[13] Moreover, they essentially do not vary with the horizon.

4.3 Isolating the role of asymmetry

The results of the two previous subsections show that the perceived gains from international diversification are lower under the empirical return distribution than under the parameterized Gaussian joint distribution. Moreover, they show that the difference is larger for MLA investors than for CRRA investors.

[13] This finding is qualitatively similar to the ones in Ang and Bekaert (2002) and Das and Uppal (2004), although there is no direct way to make a quantitative comparison with their results.

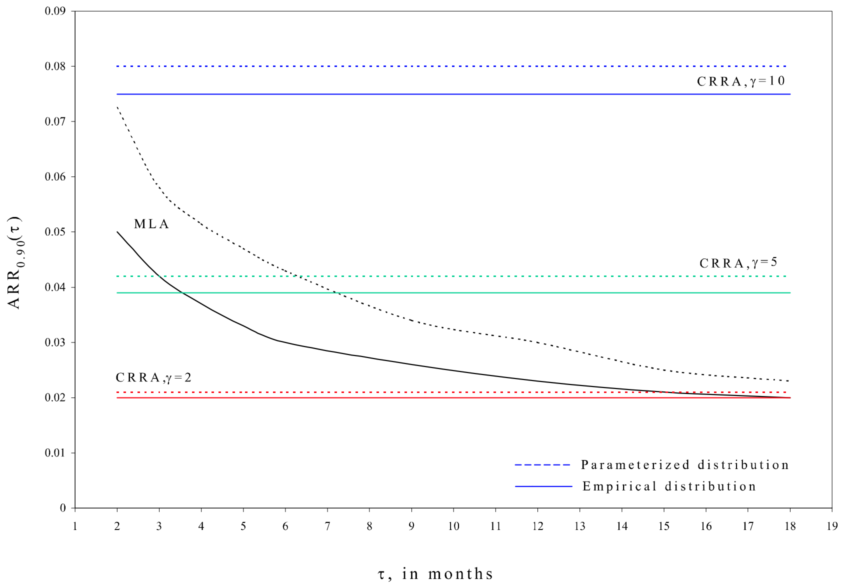

Figure 10: Gains from international diversification - $ARR_{0.90}\left(\tau\right)$.

However, as alluded to previously those results are only suggestive that the differences are due to asymmetric return comovements. The reason is that the previous assessment relies on a comparison between the empirical distribution of returns and a parameterized Gaussian distribution. It might be the case that other features of the empirical distribution are driving the results.

To isolate the role of the asymmetry in return comovements, in this subsection we fit a parametric model of the joint distribution of monthly international stock returns that allows for asymmetric comovement in returns. We continue to assume Gaussian marginal distributions for domestic and foreign stock returns, and use a Symmetrized Joe-Clayton copula (Patton, 2006) to introduce comovement asymmetry in the joint distribution. This two-parameter copula allows us to control the degree of comovement between returns conditional on them being high or low, and nests a symmetric copula. The p.d.f. of our joint distribution for returns can be written as:

$$f\left(r^H, r^F\right) = \phi\left(r^H|\mu_H, \sigma_H\right) \cdot \phi\left(r^F|\mu_F, \sigma_F\right) \cdot c\left(\Phi\left(r^H|\mu_H, \sigma_H\right), \Phi\left(r^F|\mu_F, \sigma_F\right)|\tau_U, \tau_L\right),$$

where $\phi\left(\cdot|\mu, \sigma\right)$ and $\Phi\left(\cdot|\mu, \sigma\right)$ denote, respectively, the p.d.f. and c.d.f. of a Gaussian distribution with mean μ and standard deviation σ, and $c\left(\cdot, \cdot|\tau_U, \tau_L\right)$ denotes the Symmetrized Joe-Clayton copula density, the expression of which can be obtained from Patton (2006). The parameters τ_U and τ_L control the so-called "tail dependence", which is essentially the degree of dependence between the two random variables when both are high relative to the mean (controlled by τ_U) or low relative to the mean (controlled by τ_L). In what follows we refer to the resulting distribution as the "copula distribution".

To calibrate our copula distribution we proceed as follows. We match the first two moments of each of the Gaussian marginal distributions to the data. Then, we calibrate the two copula parameters τ_U and τ_L to roughly reproduce with artificial data the extent of asymmetry that we document in the actual data. For any value for the pair (τ_U, τ_L) we draw a large sample from the copula distribution (fifty thousand observations),[14] and run an OLS regression identical to (2) on the artificial data. We calibrate the copula parameters to match the point estimates of a^+ and a^- reported on Table 1. This yields $\tau_U = 0.2$ and $\tau_L = 0.53$. To illustrate how well the calibrated copula distribution reproduces the kind of asymmetry in return comovement that we document in the data, Table 2 reports the OLS estimates from a typical regression on artificial data.[15]

Table 2: OLS estimates of the return comovements of artificial data from the copula distribution. Standard errors are reported in parentheses. The reported F-statistic is for the test that the positive (+) coefficient is equal to the negative (-) coefficient.

$\widehat{a}$	$\widehat{a}^+$	$\widehat{a}^-$	R^2	Num. Obs.	$H_0 : \widehat{a}^+ = \widehat{a}^-$	
0.011	0.371	0.760	0.36	50,000	F statistic	1,255
(0.0003)	(0.0059)	(0.0069)			p-value	0.000

We redo the calculation of the gains from international diversification for MLA investors under the calibrated copula distribution using the measure $ARR_{0.90}(\tau)$. Figure 11 summarizes the results. For comparison, we reproduce the results under the empirical and parameterized Gaussian distributions. While the gains from international diversification under the calibrated copula distribution are larger than under the empirical distribution, the difference is somewhat small relative to the gap between the results under the latter distribution and the parameterized Gaussian distribution. In fact, taking an average across all horizons from 2 to 18 months, the reduction in the gains from international diversification when moving from the Gaussian distribution to the calibrated copula distribution corresponds to roughly 3/4 of the distance to the diversification gains produced by the empirical distribution. Other features of the return distribution still have a non-negligible effect on optimal

[14] To draw from the Symmetrized Joe-Clayton copula we use Andrew Patton's copula toolbox for Matlab, available for download at http://econ.duke.edu/~ap172/code.html.

[15] With such a large number of observations the variation in point estimates across different samples is small.

portfolio decisions, and as such do warrant further research. However, in the context of the portfolio allocation problems that we consider, this result supports our conclusion that the asymmetry in return comovements is a key determinant of the gains from international diversification.

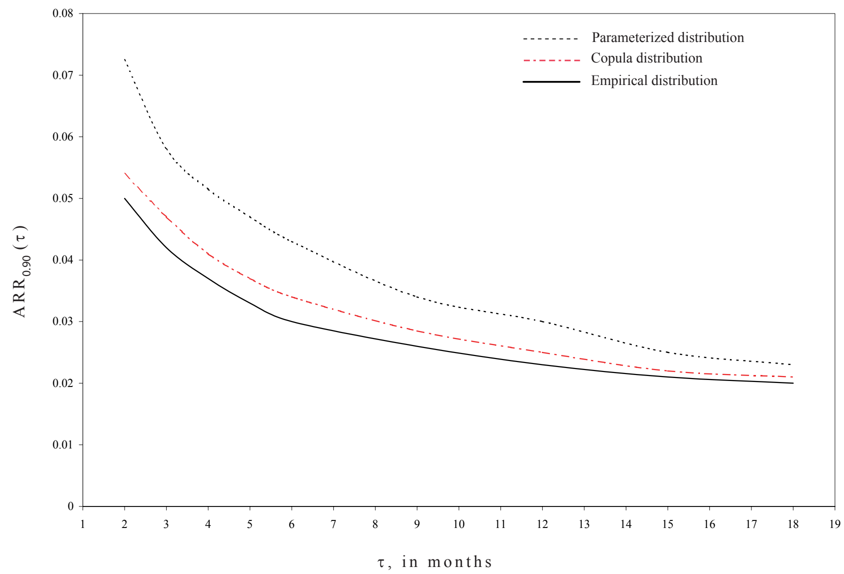

Figure 11: Gains from international diversification for MLA investors under various return distributions.

5 Discussion

The key to understand the results reported in the previous section is the interaction between the kink in the MLA utility function and the distribution of returns for any given evaluation horizon. For shorter horizons, returns are more concentrated around the reference point. This contrasts with longer horizons, for which the distribution shifts more into the domain of gains while simultaneously becoming more dispersed. For shorter horizons, the kink is more important in determining the behavior of the MLA investor towards risk, relative to the shape of the utility function away from the reference point. For such short horizons, the MLA investor behaves as an extremely risk-averse investor. In contrast, in the domain of gains and away from the reference point, notice that the MLA investor tends to behave more like a CRRA investor. In particular, for returns that are positive with probability one the MLA investor behaves like a CRRA investor with $\gamma = 1 - \rho$. With the parameterization that we borrow from Kahneman and Tversky ($\rho = 0.88$), this implies far less risk aversion than what most microeconomic estimates suggest.

With this intuition in mind we can account more easily for the behavior described in the previous section. For short evaluation horizons, the effect of the kink is pronounced, and the investor behaves like a highly risk-averse investor. This is clear in Figure 10: for the results under the parameterized Gaussian distribution, at the 2-month horizon the MLA investor perceives gains from international diversification that are roughly similar to those perceived by an expected-utility CRRA investor with $\gamma = 10$. With an evaluation horizon of 18 months, however, the effect of the kink is attenuated and the MLA investor perceives gains from diversification that are similar to those of a CRRA investor with $\gamma = 2$.

The importance of the kink in determining the behavior of the MLA agent towards risk at different evaluation horizons also affects the extent to which the gains from diversification are dampened by the presence of asymmetries in return comovements. At short horizons the effect of the kink is quite strong, and the asymmetries in comovement have a large dampening effect on the benefits from international diversification. This is because at short horizons there is a relatively large probability of incurring negative returns, and so the first-order difference in the marginal utility impact of gains and losses is relatively more important. In this context, asymmetries in return comovements significantly reduce the value of diversification opportunities, because these are less effective when they are most needed - i.e. when they could help the investor avoid ending the evaluation period with losses. For longer evaluation horizons, the relevant return distribution is shifted into the domain of gains, and the effect of the kink in shaping the MLA investor's behavior towards risk is attenuated by the shape of the utility function in that domain. This implies that MLA investors with longer evaluation horizons behave as if they had smoother preferences. In that case, the dampening effect that asymmetric return comovements have on the gains from diversification is reduced, because the first-order difference in the marginal utility impact of gains and losses becomes less important. This intuition can be confirmed by looking at the impact of asymmetric return comovement on the gains from diversification for investors with smooth utility functions, which is very small (see the comparison between the results with the empirical and the parameterized Gaussian distribution for all CRRA investors in Figure 10).

6 Conclusion

The key question of this study is whether the introduction of myopic loss aversion into an international portfolio diversification problem makes the home equity bias more difficult to account for. At first pass this should be expected: the fact that myopic loss aversion leads investors to behave similarly to highly risk-averse investors should imply that the gains from international diversification are even larger than those assessed with standard preferences. However, this effect might be mitigated by the observed asymmetry in the comovement of international stock returns, which dampens the gains from international diversification.

We find that a myopic loss-averse investor does indeed perceive substantial gains from international diversification at short investment horizons - more so than an expected-utility investor with CRRA preferences and reasonable levels of risk aversion. However, at longer horizons the smaller probability of facing a net loss in the investment makes the effect of loss aversion less salient, and reduces the perceived gains from diversification. Further, we find that the presence of asymmetric market comovements dampens these gains from diversification for MLA investors, but not materially for investors with standard expected-utility preferences. This effect is also more pronounced at shorter investment horizons.

We conclude that, depending on the evaluation horizon, myopic loss aversion can perform as well as standard expected-utility preferences with reasonable degrees of risk aversion when assessed against the background of the home equity bias puzzle.

While we focus on myopic loss-averse preferences, we conjecture more generally that in the absence of asymmetries in return comovements, other preferences that display first-order risk aversion would tend to make the home bias in equities more difficult to account for. At the same time, such asymmetries might also mitigate the problem in those cases. We think it is important to challenge preference specifications that appear to perform well in face of the equity premium puzzle by subjecting them to the “test” that we propose in this paper.

A Appendix

A.1 Empirical results - robustness

Figure 12 plots the monthly returns of the U.S. index against the monthly EAFE returns, and the OLS regression line from Table 1. Visual inspection suggests that the results are not driven by outliers. For robustness, we estimate (2) by median regression and test for equality of a^+ and a^- using bootstrapped standard errors. The results, reported in Table 3, show that our conclusions remain unchanged.

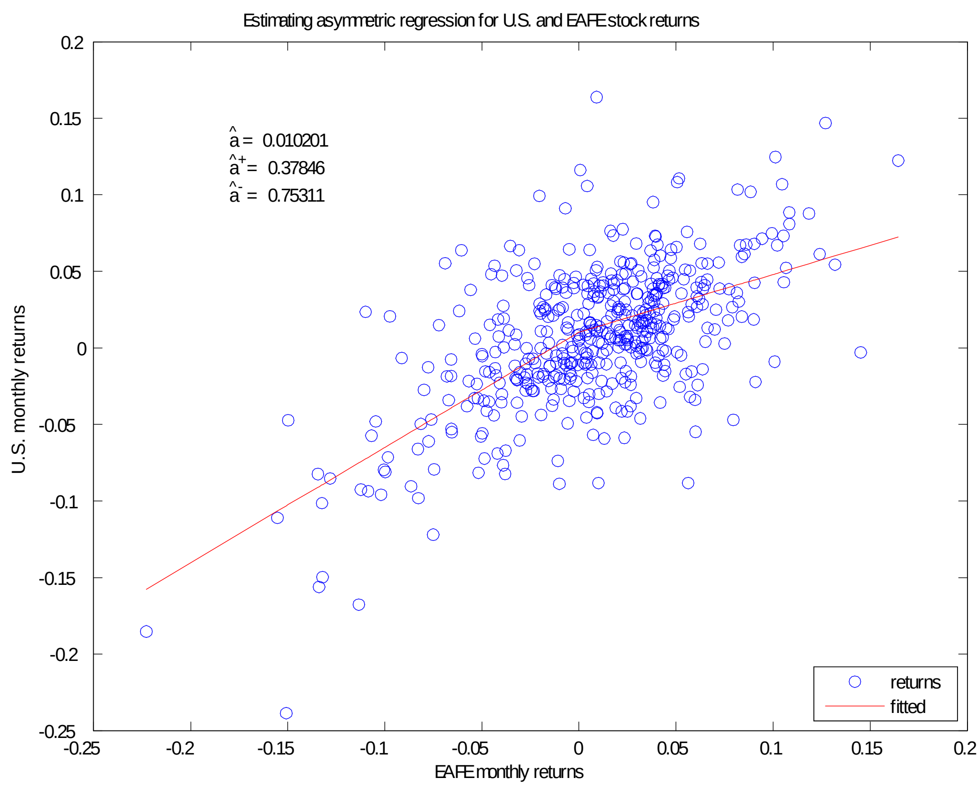

Figure 12: OLS regression of MSCI U.S. returns on EAFE returns.

Table 3: Median regression estimates of the return comovements of the MSCI U.S. and EAFE indices. Boostrapped standard errors are reported in parentheses. The reported F-statistic is for the test that the positive (+) coefficient is equal to the negative (-) coefficient.

$\widehat{a}$	$\widehat{a}^+$	$\widehat{a}^-$	$Pseudo\text{-}R^2$	Num. Obs.	$H_0 : \widehat{a}^+ = \widehat{a}^-$	
0.007	0.441	0.758	0.22	472	F statistic	7.65
(0.0015)	(0.076)	(0.065)			p-value	0.006

Finally, Table 4 shows that the results also hold across different horizons.

Table 4: OLS estimates of the return comovements of the MSCI US and EAFE indices at 3-, 6-, 9-, 12-, 15-, and 18-month horizons. Standard errors are reported in parentheses. The reported F-statistics are for the test that the positive (+) coefficient is equal to the negative (-) coefficient.

Horizon	3	6	9	12	15	18
$\widehat{a}$	0.021	0.035	0.068	0.125	0.100	0.175
	(0.007)	(0.017)	(0.028)	(0.033)	(0.044)	(0.046)
$\widehat{a}^+$	0.450	0.441	0.331	0.161	0.420	0.159
	(0.088)	(0.135)	(0.137)	(0.150)	(0.156)	(0.159)
$\widehat{a}^-$	0.841	0.812	1.028	1.164	1.053	1.361
	(0.093)	(0.157)	(0.182)	(0.181)	(0.253)	(0.221)
R^2	0.52	0.46	0.55	0.64	0.62	0.71
Num. Obs.	157	78	52	39	31	26
$H_0 : \widehat{a}^+ = \widehat{a}^-$						
F-statistic	6.66	2.27	6.66	12.29	3.16	13.74
p-value	0.011	0.136	0.013	0.001	0.086	0.001

References

Amadi, A. (2004): "Equity Home Bias: A Disappearing Phenomenon," *Unpublished Working Paper. SSRN: http://ssrn.com/abstract=540662*.

Ang, A., and G. Bekaert (2002): "International Asset Allocation with Regime Shifts," *Review of Financial Studies*, 15(4), 1137–87.

Barberis, N., M. Huang, and T. Santos (2001): "Prospect Theory and Asset Prices," *Quarterly Journal of Economics*, 116(1), 1–53.

Benartzi, S., and R. Thaler (1995): "Myopic Loss Aversion and the Equity Premium Puzzle," *Quarterly Journal of Economics*, 110(1), 73–92.

Das, S. R., and R. Uppal (2004): "Systemic Risk and International Portfolio Choice," *Journal of Finance*, 59(6), 2809–2834.

Erb, C. B., C. R. Harvey, and T. E. Viskanta (1994): "Forecasting International Equity Correlations," *Financial Analysts Journal*, 50, 32–45.

French, K. R., and J. M. Poterba (1991): "Investor Diversification and International Equity Markets," *American Economic Review*, 81(2), 222–26.

Hong, Y., J. Tu, and G. Zhou (2007): "Assymetries in Stock Returns: Statistical Tests and Economic Evaluation," *Review of Financial Studies*, 20(5), 1547–81.

Kahneman, D., and A. Tversky (1979): "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, 47(2), 263–91.

——— (1991): "Loss Aversion in Riskless Choice: A Reference-Dependent Model," *Quarterly Journal of Economics*, 106(4), 1039–61.

Karolyi, G. A., and R. M. Stulz (2003): "Are Financial Assets Priced Locally or Globally?," *NBER Working Paper no. 8994. NBER.*

King, M., E. Sentana, and S. Wadhwani (1994): "Volatility and Links between National Stock Markets," *Econometrica*, 62(4), 901–33.

Lewis, K. K. (1999): "Trying to Explain Home Bias in Equities and Consumption," *Journal of Economic Literature*, 37(2), 571–608.

Longin, F., and B. Solnik (1995): "Is the Correlation in International Equity Returns Constant: 1960-1990?," *Journal of International Money and Finance*, 14(1), 3–26.

Merton, R. C. (1969): "Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case," *Review of Economics and Statistics*, 51(3), 247–57.

Patton, A. (2006): "Modelling Asymmetric Exchange Rate Dependence," *International Economic Review*, 47(2), 527–56.

Samuelson, P. A. (1969): "Lifetime Portfolio Selection by Dynamic Stochastic Programming," *Review of Economics and Statistics*, 51(3), 239–46.

Tversky, A., and D. Kahneman (1992): "Advances in Prospect Theory: Cumulative Representation of Uncertainty," *Journal of Risk and Uncertainty*, 5(4), 297–323.

van Wincoop, E. (1999): "How Big Are Potential Welfare Gains from International Risksharing?," *Journal of International Economics*, 47(1), 109–35.