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ABSTRACT

The dramatic increase in gross stock of foreign assets and liability has revived interest in the portfolio balance theory of international investment. Evidence on the validity of this theory has always been scarce and inconclusive. The current paper derives testable empirical implications from microeconomic foundations, which we confront with a new comprehensive data set on the stock allocations of approximately 6,500 international equity funds domiciled in four different currency areas. The disaggregated data structure allows us to examine whether foreign exchange and equity risk measures trigger the predicted rebalancing behavior at the fund and stock level. The data provide strong support for portfolio rebalancing behavior aimed at reducing both exchange rate and equity risk exposure.

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1 Introduction

The gross stocks of cross-border assets and liabilities have increased dramatically from roughly 50 percent of world GDP in the early 1990's to more than 120 percent a decade later. Capital gains and losses on those assets have significant effects on the current account. Valuation effects induced by asset price changes become quantitatively large relative to traditional product account determinants of the current account.[1] What are the consequences of those valuation effects for international asset price dynamics? How do valuation effects influence international equity flows? Do they give rise to greater external imbalances or lead to an adjustment process which stabilizes the current account? These questions have revived interest in the portfolio balance models of the 1970s, which was devoted to the issue of international asset allocation and its relationship to exchange rate behavior.[2] This literature has often been dismissed for lack of microfoundations and inconclusive empirical performance in aggregate data. In the absence of suitable microeconomic data, it proved difficult to link differences in home and foreign investment returns to any observable capital flows. However, the increased leverage of the current international asset positions makes it important to revisit this linkage. At the heart of portfolio balance models lies the assumption that domestic and foreign assets are imperfect substitutes. While international investment provides diversification benefits beyond the domestic market, such investment carries additional exchange rate risk. Exchange rate risk may be imperfectly traded and contribute to the observed home bias of the international investment pattern.

But more interesting still are the dynamic implications of limited international asset substitutability. First, consider its role for the international asset price dynamics. Assume that the foreign stock market outperforms the investor's home equity market. This alters the investors' actual portfolio shares relative to his desired allocation. The home country investor - unlike the foreign investor - faces increased exchange rate risk and therefore wants to sell foreign assets for home assets, i.e. rebalance his portfolio. The corresponding capital flow appreciates the home currency and mitigates the original valuation shock in the equity market. Hau and Rey (2006) show that portfolio rebalancing implies an 'equity parity condition' in which exchange rates adjust and partly off-set the valuation effects of differential equity market performance. They provide evidence that dollar exchange rate changes of OECD countries are indeed negatively related to the relative performance of the respective equity markets. Higher stock returns in the European equity markets over the U.S. markets for example correlate with a depreciating Euro at all relevant frequencies from a day to a quarter. Interestingly, this negative correlation between exchange rates and relative equity market returns becomes more pronounced in the 1990s along with the quantitative rise of international asset positions.

Second, imperfect asset substitutability also has important consequences for the international financial adjustment to macroeconomic imbalances. Large trade deficits like those observed for the U.S. in the last decades imply increasing net positions in U.S. assets by foreign investors and are predicated on foreigners'

[1] For data on the increase of gross assets and liabilities see Lane and Milesi-Ferretti (2007). The valuation effects of price changes are discussed in Gourinchas and Rey (2007) and Tille (2004).

[2] See Kouri (1982). For a survey of this literature see Branson and Henderson (1985). Due to recent methodological advances, linearized dynamic stochastic general equilibrium with portfolio choice can now be solved. See for example Coeurdacier (2005), Devereux and Sutherland (2006) or Tille and Wincoop (2007).

willingness to hold such assets. External adjustment may take the form of either future trade surpluses or asset valuation effects. Imperfect international asset substitutability is necessary for the asset valuation channel to operate and plays a relatively important role for the short and medium term external adjustment as shown in Gourinchas and Rey (2007). Evidence on the portfolio balance model is therefore informative about the relative importance of the trade and valuation channels in the international financial adjustment mechanism.

The current paper makes two new contributions. First, we derive testable predictions for the investment behavior of international equity funds in a setting with incomplete trading of exchange rate risk. These predictions concern the portfolio risk dynamics of individual funds and are specific to the conjectured international market segmentation. We adopt imperfect international exchange rate risk trading as our working hypothesis and highlight that the predicted rebalancing behavior should not occur if exchange rate risk were fully traded. Second, we test the model predictions with new micro data. A unique data set allows us to track the investment strategies of international equity fund managers at the stock level. We can therefore observe portfolio rebalancing behavior "under a microscope" in a sample of pronounced heterogeneity both in investor location and investment destination. This approach provides a more direct and powerful test of portfolio rebalancing behavior compared to empirical work based on aggregate data. We highlight the following findings concerning foreign share rebalancing, fund level risk rebalancing and stock level risk rebalancing:

- Funds adjust their foreign portfolio share to mitigate the valuation effects of asset price changes. A higher equity return on the foreign portfolio share compared to the domestic share comes with capital repatriation, while foreign asset underperformance coincides with capital expatriation. The relative repatriation effect is quantitatively stronger than the expatriation effect.

- At the fund level we find that a total portfolio risk increase (decrease) due to valuation effects coincides with active rebalancing which decreases (increases) the overall portfolio risk. Fund level rebalancing behavior is documented both for changes in total equity risk (in investor currency) as well as for changes in the foreign exchange (FX) risk component. The risk rebalancing behavior is pronounced both for large and small funds.

- At the stock level, we calculate the valuation induced change in the marginal risk contribution of each stock to the total portfolio risk. Active reversal of marginal risk changes is found to be strong at the stock level if the marginal risk change and the overall portfolio risk change have the same direction (both increase or decrease), but absent if marginal risk and portfolio risk changes have opposite directions. The rebalancing evidence at the stock level is very strong for both overall equity risk and as well as for the FX component of the portfolio risk.

The previous literature tests portfolio balance models on the base of macroeconomic data. The corresponding results are generally inconclusive (Frankel (1982b), Frankel (1982a), Rogoff (1984), Park (1984), Loopesko (1984)). The literature on portfolio analysis at the fund level is more recent and scarce, but provides interesting new insights in addition to a considerable gain in statistical power. For example, Laurent Calvet and Sodini (2007) analyze portfolio rebalancing using microeconomic data on Swedish households. They examine the rebalancing between equity and riskless assets and find evidence of portfolio rebalancing especially for the most educated households. Our own analysis differs in its focus on the international investment of institutional investors with explicit consideration and computation of the exchange rate and portfolio risk.

The following section 2 presents a simple two-country model with three periods. Its parsimonious microeconomic structure allows us to derive 4 testable propositions. Of particular interest are propositions 3 and 4 which concern the rebalancing dynamics at the fund level. Section 3 presents the new microdata. It allows us to examine the model predictions about the foreign equity share dynamics in section 4.1 and portfolio risk dynamics in section 4.2. Section 4.3 extends this analysis further to the stock level rebalancing reaction conditional on the direction of the marginal risk change and the portfolio risk change. Section 5 concludes.

2 Model

Evidence from mutual fund surveys (see Levich, Hayt and Ripston (1999)) suggests that international equity funds do not widely use exchange rate derivatives to trade their exchange rate exposure. Such incomplete risk trading in derivatives can modify the investment behavior of international funds. Unhedged exchange rate risk reduces the substitutability of domestic and foreign assets and thus generates a home bias in the investment allocations. But it has also interesting dynamic implications. We show that an international equity fund manager should rebalance out of foreign equities into domestic equities whenever the foreign component of their portfolio outperforms the domestic component. Intuitively, the exposure of international equity managers to exchange rate risk increases as the weight of foreign securities increases. Rebalancing towards domestic equity decreases the exchange rate exposure.

Next, we present a simple model to illustrate this intuition and develop a series of testable implications for the investment dynamics on the fund level. The model simplifies the continuous time framework in Hau and Rey (2006) to a discrete time version with three periods. The model features a mean-variance framework and abstracts from any consumption related model structure. The important market friction is that investors cannot internationally trade their FX exposure through state contingent derivative contracts. The latter assumption captures an observable investment constraint of many fund managers discussed in Levich et al. (1999).

Assumption 1: Investment Opportunities

Home and Foreign CARA investors with risk aversion ρ make optimal portfolio allocation decisions in periods 1 and 2 to maximize their terminal wealth in period 3. Each investor can invest in risky home and foreign stocks with independent normally distributed (period 3) liquidation values, V^f and V^h, respectively, or in a domestic riskless asset with return r. In addition, the home and foreign stock each pay a stochastic (mean zero) dividend in period 3, d^h and d^f, respectively. The terminal exchange rate E_3 is also assumed to be normally distributed and uncorrelated with the stock payoffs. Formally the asset payoffs are given by

$$
\begin{aligned}
P_3^h &= V^h + d^h \sim N(1, \sigma_d^2 + \sigma_V^2) \\
P_3^f &= V^f + d^f \sim N(1, \sigma_d^2 + \sigma_V^2) \\
E_3 &\sim N(1, \sigma_e^2).
\end{aligned}
$$

The normality assumption for the payoffs is a convenient specification to obtain linear asset demand functions under the CARA utility functions. We assume that the risk aversion of the investors is sufficiently low ($\rho < \overline{\rho}$) to ensure that the international risk sharing equilibrium exists under exogenous exchange rate risk. For simplicity we normalize all unconditional terminal asset payoffs to one. We also abstract from more complicated correlation structures between the terminal asset prices in order to simplify the exposition and model solution. Any correlation in the payoff structure will diminish the benefits from international asset diversification without altering any of the qualitative findings in the subsequent analysis. Finally, the model is formulated only for one home and one foreign asset. However, the general insights carry over to the case where the home and foreign assets are themselves portfolios of many individual stocks.

Assumption 2: Information Structure

At the beginning of period 2, both investors learn of the dividend payments (d^h, d^f), while the liquidation values (V^f, V^h) remain unknown. The conditional terminal asset price distributions are then given by

$$
\begin{aligned}
P_3^h | d^h, d^f &\sim N(1 + d^h, \sigma_V^2) \\
P_3^f | d^h, d^f &\sim N(1 + d^f, \sigma_V^2) \\
E_3 | d^h, d^f &\sim N(1, \sigma_e^2).
\end{aligned}
$$

With a very small probability $\epsilon > 0$ the market is closed in period 2 so that investors cannot rebalance their portfolio.

The analytical focus of the model is on the rebalancing effect of the dividend payoff information. It is assumed throughout the paper that the exchange rate risk cannot be hedged and that the optimal risk management of the investors is reflected in the asset holdings. We also highlight that the full revelation of the dividend values in period 2 and continued investor uncertainty about the liquidation values is just a stylized representation of partial revelation of different stock market fundamentals in the two countries. Other Bayesian formulations of the same problem are possible, but are likely to be more complicated. The small probability ϵ of market closure in period 2 ensures that investors have an incentive to acquire optimal portfolios in period 1. Otherwise the period 1 holdings would be indeterminate since an investor could always wait until period 2 to implement his optimal portfolio choice. A small likelihood of market closure in period 2 eliminates this indeterminacy.

Next we turn to the asset supply assumptions and the market clearing conditions.

Assumption 3: Asset Supplies

The net supply of equity is constant and normalized to 1. The riskless rate is in perfectly elastic supply and is constant at r. Excess demand for foreign currency D_t^{Fx} is balanced by an elastic supply with elasticity η. Let $X_t = (x_t^h, x_t^f)$ and $X_t^* = (x_t^{h*}, x_t^{f*})$ denote the equity demands of the home and foreign investor, respectively. Hence, we have (for $t = 1, 2$)

$$\begin{aligned} (x_t^h, x_t^f) + (x_t^{h*}, x_t^{f*}) &= (1,1) \\ D_t^{Fx} &= \eta(E_t - 1). \end{aligned}$$

A fully elastic supply of the riskless asset and a fully inelastic supply of the risk asset are common in the finance literature. This describes a world in which investments with low and safe returns are always abundant, while investments with high payoff are both risky and in limited or fixed supply. The assumption about the constant elastic currency supply in periods 1 and 2 is quite natural. Assuming foreign exchange dealer with a CARA utility, we can show that their currency supply corresponds to a linear function $\eta(E_t - 1)$ given a normally distributed terminal value for foreign exchange balances. The linear currency supply can therefore be interpreted as a reduced form to a more elaborate FX market model with risk averse dealers (see Hau and Rey (2006)).

2.1 Solving the Model

Solving for the model is straightforward and mostly relegated to the appendix. We simply outline the major steps which allow us to characterize the solution. In period 1, the excess return of home and foreign investment over the risk-less rate is given by the vector $R = (R^h, R^f)^T$ for the home country investor and by $R^* = (R^{h*}, R^{f*})^T$ for the foreign country investor.[3] Excess returns are denominated in the currency of the investor and an increase in the exchange rate E denotes a depreciation of the domestic currency.

$$\begin{aligned} R^h &= P_3^h - (1+r)P_1^h \\ R^f &= P_3^f E_3 - (1+r)P_1^f E_1 \\ R^{h*} &= P_3^h / E_3 - (1+r)P_1^h / E_1 \\ R^{f*} &= P_3^f - P_1^f (1+r). \end{aligned}$$

[3] The domestic and foreign riskless rate could possibly differ. But this only introduces a model asymmetry between the home and foreign country which is of no qualitative relevance for the main model implications. Note also that date 1 and 2 are arbitrarily close so that the total interest accrued between dates 1 and 3 is $(1+r)$.

Furthermore, for international equity allocations $X_1 = (x_1^h, x_1^f)$ and $X_1^* = (x_1^{h*}, x_1^{f*})$, the period 3 wealth follows as

$$\begin{aligned} W_3 &= X_1 R + (1+r) W_1 \\ W_3^* &= X_1^* R^* + (1+r) W_1^*, \end{aligned}$$

for the home and foreign investor, respectively. The utility of the home and foreign investor is given by a CARA utility, which amounts to mean-variance framework. Hence, investors optimize

$$U = max_{(x_1^h, x_1^f)} \left[\mathcal{E}_1(W_3) - \frac{\rho}{2} Var_1(W_3) \right], \qquad U^* = max_{(x_1^{h*}, x_1^{f*})} \left[\mathcal{E}_1(W_3^*) - \frac{\rho}{2} Var_1(W_3^*) \right],$$

where ρ denotes the coefficient of absolute risk aversion. For the expectations in period 1 symbolized by $\mathcal{E}_1$, we can express the variance-covariance matrix of the returns in home currency by $\Omega_1 = \mathcal{E}_1(RR^T)$ and in foreign currency by $\Omega_1^* = \mathcal{E}_1(R^* R^{*T})$. Optimal equity holdings for home and foreign investors follow as

$$\begin{aligned} X_1 &= \frac{1}{\rho} \mathcal{E}_1(R) \Omega_1^{-1} \\ X_1^* &= \frac{1}{\rho} \mathcal{E}_1(R^*) \Omega_1^{*-1}, \end{aligned}$$

respectively. For independently distributed dividends and liquidation values, we find furthermore

$$\Omega_1 = \Omega_1^* = \begin{pmatrix} \sigma_d^2 + \sigma_V^2 & 0 \\ 0 & \sigma_d^2 + \sigma_V^2 + \sigma_e^2 \end{pmatrix}$$

Market clearing in both equity markets implies two additional constraints for period 1.

In period 2, information about the dividends (d^h, d^f) is revealed, but values (V^h, V^f) are still unknown. Equity prices (P_2^h, P_2^f) and equity returns $(\Delta R, \Delta R^*)$ need to fulfill the new first order conditions

$$\begin{aligned} X_2 &= \frac{1}{\rho} \mathcal{E}_2(R) \Omega_2^{-1} \\ X_2^* &= \frac{1}{\rho} \mathcal{E}_2(R^*) \Omega_2^{*-1}. \end{aligned}$$

The conditional covariance Ω_2 and Ω_2^* depends on the dividend realization (d^h, d^f) and we find

$$\Omega_2 = \begin{pmatrix} \sigma_V^2 & 0 \\ 0 & \sigma_V^2 + (1+d^f)^2 \sigma_e^2 \end{pmatrix}, \qquad \Omega_2^* = \begin{pmatrix} \sigma_V^2 & 0 \\ 0 & \sigma_V^2 + (1+d^h)^2 \sigma_e^2 \end{pmatrix}.$$

The period 3 equity prices (P_3^h, P_3^f) will now reflect any asymmetric realization of dividend payouts (d^h, d^f). This in turn implies that, under high foreign dividends, the foreign asset is more valuable and therefore the foreign investment constitutes a large exchange rate exposure. Optimal asset demands in period 2 have to account for the higher conditional variance. We show that it leads to rebalancing into domestic equity.[4]

[4]The model considers partial revelation of the stocks payoffs in period 2, which diminishes the payoff risk. In contrast,

This rebalancing simultaneously changes the currency demand. The net currency demand corresponds to the foreign rebalancing of the home investor, $(x_2^f - x_1^f)P_2^f E_2$, minus the reverse demand on the part of the foreign investor, $(x_2^{h*} - x_1^{h*})P_2^h$. Market clearing in the exchange rate market then implies

$$D^{Fx} = (x_2^f - x_1^f)P_2^f E_2 - (x_2^{h*} - x_1^{h*})P_2^h = \eta(E_2 - 1).$$

In order to solve the model for the two periods, we have to first conjecture a linear solution for all asset prices as a function of the dividend realizations. In a second step, we substitute these asset price solutions into the demand functions and use the market clearing and supply constraints to determine all coefficients. The appendix provides the solutions.

2.2 Model Implications

We summarize the implications of the model in 4 separate testable propositions. Propositions 1 and 2 concern stylized facts documented in the literature. Propositions 3 and 4 concern directly the rebalancing behavior at the investor level. The latter implications have not yet been subjected to empirical testing.

Proposition 1: Equilibrium Prices and Home Bias

International investors exposed to exchange rate risk (as described in assumptions 1 and 2) choose optimal period 1 asset allocations given by

$$\begin{aligned} x_1^h &= x_1^{f*} = \frac{\sigma_d^2 + \sigma_V^2 + \boldsymbol{\sigma}_e^2}{2\sigma_d^2 + 2\sigma_V^2 + \sigma_e^2} \\ x_1^f &= x_1^{h*} = \frac{\sigma_d^2 + \sigma_V^2}{2\sigma_d^2 + 2\sigma_V^2 + \sigma_e^2}. \end{aligned}$$

The corresponding unique equilibrium prices in period 1 follows as

$$P_1^h = P_1^f = \frac{1}{(1+r)} - \frac{\rho\left(\sigma_d^2 + \sigma_V^2 + \sigma_e^2\right)\left(\sigma_d^2 + \sigma_V^2\right)}{(1+r)\left[2\sigma_d^2 + 2\sigma_V^2 + \sigma_e^2\right]}, \qquad E_1 = 1.$$

Proof: For the derivation see Appendix.

The asset prices of the home and foreign equity are identical in period 1 because of identically distributed unconditional payoffs. The term $1/(1+r)$ for period 1 equity prices denotes the present value of the expected liquidation value and the second term captures a price discount linear in the risk aversion ρ of the investors. Home and foreign investors hold symmetric positions biased towards home assets. The home bias can be

exchange rate risk is fixed. Hence exchange rate risk plays conditionally a bigger role in period 2 compared to period 1. This gives rise to an "automatic rebalancing" effect towards home currency holdings in period 2. But this is of no consequence for our theoretical and our empirical results. Our results are about the covariance between rebalancing and returns and the covariance between active and passive risk rebalancing. The "automatic rebalancing" described above is like a time effect and does not alter any of these covariances. The model could be purged of the "automatic rebalancing" effect by assuming that conditional exchange rate risk decreases in the same proportion as stock payoffs. Such a modification is however immaterial for our results. Hence we favor the simpler model set-up.

quantified as

$$x_1^h - x_1^{h*} = x_1^{f*} - x_1^f = \frac{\sigma_e^2}{2\sigma_d^2 + 2\sigma_V^2 + \sigma_e^2},$$

and equals the proportion of foreign exchange rate risk $\frac{1}{2}\sigma_e^2$ relative to total payoff risk $\sigma_d^2 + \sigma_V^2 + \frac{1}{2}\sigma_e^2$ of an allocation of identical home and foreign portfolio shares. Higher exchange rate volatility should therefore reinforce the home bias. The home bias has been extensively documented in the international finance literature.[5] But a variety of alternative explanations can also account for the home bias and are complementary to ours; for example higher transaction costs for foreign stocks, international information asymmetries, or differences in investor familiarity. But while these alternative hypotheses explain the level effect of the home bias, they may not have the same dynamic implications for asset prices and portfolio choice particular to our model of risk based market segmentation. The particular asset price dynamics of risk based market segmentation is captured by Proposition 2.

Proposition 2: Dividend Information and the Covariance Structure of Prices

International investors exposed to exchange rate risk rebalance if the home and foreign stock markets perform differently and their rebalancing simultaneously influence the exchange rate. Formally, new dividend information in period 2, changes prices to

$$\begin{aligned} P_2^h &= \overline{P}_2 + \gamma(d^h - d^f) + \beta(d^h + d^f) \\ P_2^f &= \overline{P}_2 - \gamma(d^h - d^f) + \beta(d^h + d^f) \\ E_2 &= \overline{E}_2 + \theta(d^h - d^f), \end{aligned}$$

with positive constants $\overline{P}_2, \overline{E}_2$, positive coefficients γ, β, θ with $\gamma - \beta > 0$, and

$$\theta = \frac{(\gamma - \beta)\left(2\sigma_V^2 + \sigma_e^2\right)}{\overline{P}_2\sigma_V^2} > 0.$$

Information about different stock market fundamentals ($d^h - d^f \neq 0$) creates a negative covariance between relative home and foreign stock price performance $P_2^h - P_2^f$ and the exchange rate, that is

$$Cov\left[P_2^h - P_2^f, E_2\right] = -4\gamma\theta\sigma_d^2 < 0.$$

Proof: For the derivation see Appendix.

Asset prices in period 2 therefore feature a particular correlation structure in spite of the assumed independence of the final asset payoffs. When faced by increased foreign exchange risk due to an appreciation of the foreign assets of their portfolios relative to the domestic ones, investors rebalance out of foreign assets. This risk rebalancing investment strategy implies net sales of the foreign currency and hence an

[5] For a study of the home bias at the fund level see Hau and Rey (2008). For recent country level evidence, see chan, Covrig and Ng (2005).

appreciation of the domestic exchange rate. This correlation structure of stock prices and exchange rates, called "uncovered equity parity condition" by Hau and Rey (2006), has also been examined by Brooks, Edison, Kumar and Slok (2001), Krylova, Cappiello and Santis (2005) and Chaban (2008). For most OECD countries the exchange rate returns and differential stock market returns feature the predicted negative correlation at all frequencies from daily to quarterly data. Such covariance structures could potentially be induced by macroeconomic channels which do not rely on portfolio rebalancing. It is therefore interesting to explore direct microeconomic evidence on the relevance of the portfolio channel. Proposition 3 states the microeconomic hypothesis of fund rebalancing:

Proposition 3: Portfolio Rebalancing Measures Based on Portfolio Shares

International investors exposed to exchange rate risk react to (relatively) higher returns on their foreign portfolio component by rebalancing into domestic assets. We define a measure of 'active rebalancing' from foreign to domestic equity for the home country investor as

$$RB^f = w_2^f - \widehat{w}_2^f,$$

where $w_2^f = x_2^f P_2^f / (x_2^h P_2^h + x_2^f E_2 P_2^f)$ denotes the foreign portfolio weight for an optimal rebalanced allocation at the beginning of period 2 and $\widehat{w}_2^f$ the portfolio weight induced by passive holding of the weight from the previous period 1. The latter follows as

$$\widehat{w}_2^f = w_1^f \left(\frac{1 + r_1^f}{1 + r_1^P} \right),$$

where r_2^P represents the home investor's total portfolio return (in period 1), while r_1^h and r_1^f denote the return on his home and foreign investment component, respectively. The model implies a negative covariance between RB^f and the return differential $r_1^f - r_1^h$, that is

$$Cov\left[RB^f,\ r_1^f - r_1^h\right] < 0.$$

Proof: For the derivation see Appendix.

The active rebalancing measure RB^f is intuitive. If the return on the foreign share of the portfolio r_1^f is higher than the return on the total portfolio r_1^P then the share of foreign assets in the portfolio increases automatically and such 'passive weight changes' are *not* captured in the measure RB^f. If for example investors pursue a passive holding strategy, then the new foreign portfolio share in period 2 follows as

$$w_2^f = \widehat{w}_2^f = w_1^f \left(\frac{1 + r_1^f}{1 + r_1^P} \right).$$

In this case the active rebalancing measure RB^f is zero. Active rebalancing into home equity implies $RB^f < 0$ and should occur for foreign market excess returns, hence whenever $r_2^f - r_2^h > 0$. This corresponds to the negative covariance between RB^f and $r_2^f - r_2^h$. A positive covariance by contrast would imply a change in weights that further increases exchange rate exposure after such exposure has increased due to valuation effects.

A more direct approach to the analysis of rebalancing behavior is to measure its effect on the exchange rate risk of the portfolio. We can decompose the return vector denominated in home currency ΔR into a pure equity return vector denominated in local currency ΔR_{Eq} and the complementary exchange rate vector $\Delta R_{Fx} = \Delta R - \Delta R_{Eq}$. Accordingly, the covariance matrix can be decomposed into the pure equity covariance and into a complementary exchange rate covariance matrix, that is

$$\mathcal{E}_t(RR^T) = \Omega_t = \Omega_t^{Eq} + \Omega_t^{Fx},$$

where we define

$$\begin{aligned}\Omega_t^{Eq} &= \mathcal{E}_t(R^{Eq}(R^{Eq})^T) \\ \Omega_t^{Fx} &= \mathcal{E}_t(R^{Eq}(R^{Fx})^T) + \mathcal{E}_t(R^{Fx}(R^{Eq})^T) + \mathcal{E}_t(R^{Fx}(R^{Fx})^T)\end{aligned} .$$

The total portfolio risk of an international investor and the exchange rate component can be defined as

$$\begin{aligned}Risk(w_t) &= w_t \Omega_t w_t^T \\ Risk^{Fx}(w_t) &= w_t \Omega_t^{Fx} w_t^T,\end{aligned}$$

respectively. We can now characterize rebalancing behavior based on portfolio risk in proposition 4:

Proposition 4: Portfolio Rebalancing Measures Based on Portfolio Risk

International investors reduce their exposure to exchange rate risk after an increase in such exposure following differences in equity performance at home and abroad. We denote by $w_1 = (w_1^h, w_1^f)$ the initial portfolio weights in period 1, $\widehat{w}_2 = (\widehat{w}_2^h, \widehat{w}_2^f)$ the portfolio weights of the home investor resulting from a passive investment strategy in period 2 and by $w_2 = (w_2^h, w_2^f)$ the actual portfolio weights in period 2. The passive risk changes (without rebalancing) between period 1 and 2 are given by

$$\begin{aligned}\Delta Risk(\widehat{w}_2, w_1) &= \widehat{w}_2 \Omega_2 \widehat{w}_2^T - w_1 \Omega_1 w_1^T \\ \Delta Risk^{Fx}(\widehat{w}_2, w_1) &= \widehat{w}_2 \Omega_2^{Fx} \widehat{w}_2^T - w_1 \Omega_1^{Fx} w_1^T,\end{aligned} \tag{1}$$

where the first line corresponds to the total portfolio risk while the second line accounts for changes in foreign exchange risk only. Active risk changes due to optimal portfolio management are given by

$$\begin{aligned}\Delta Risk(w_2, \widehat{w}_2) &= w_2 \Omega_2 w_2^T - \widehat{w}_2 \Omega_2 \widehat{w}_2^T \\ \Delta Risk^{Fx}(w_2, \widehat{w}_2) &= w_2 \Omega_2^{Fx} w_2^T - \widehat{w}_2 \Omega_2^{Fx} \widehat{w}_2^T,\end{aligned} \tag{2}$$

where the first line corresponds to the total portfolio risk while the second line accounts for changes in foreign exchange risk only. Risk rebalancing implies a negative covariance between passive and active weight changes

$$\begin{aligned} Cov\left[\Delta Risk(w_2, \widehat{w}_2), \Delta Risk(\widehat{w}_2, w_1)\right] &< 0 \\ Cov\left[\Delta Risk^{Fx}(w_2, \widehat{w}_2), \Delta Risk^{Fx}(\widehat{w}_2, w_1),\right] &< 0, \end{aligned}$$

for total risk and exchange rate risk rebalancing, respectively.

Proof: For the derivation see Appendix.

An increase in the portfolio risk between periods 1 and 2 due to the dividend information is measured by the term $\Delta Risk(\widehat{w}_2, w_1)$ for the total portfolio risk and by $\Delta Risk^{Fx}(\widehat{w}_2, w_1)$ for the exchange rate risk. The optimal portfolio adjustment and the corresponding change in risk is measured by the term $\Delta Risk(w_2, \widehat{w}_2)$ for the total risk and $\Delta Risk^{Fx}(w_2, \widehat{w}_2)$ for its exchange rate component. The model predicts that any risk increase of a passive strategy should be counterbalanced by weight changes inducing a portfolio risk reduction. Hence we expect a negative covariance.

3 Data

A data set of global equity holdings from Thomson Financial Securities (TFS) is used to explore the theoretical predictions. The data documents individual mutual fund and other institutional holdings at the stock level. TFS itself was created by the merger of The Investext Group, Security Data Company and CDA/Spectrum. Holding data from the same source has been previously used and documented by chan et al. (2005) for the years 1999 and 2000. Our own data set consists of an extended version of their data set and covers the five year period 1997 to 2002.[6]

The TFS holding data comprise fund number, fund name, management company name, country code of the fund incorporation, stock identifier, country code of the stock, stock position (number of stocks held), reporting dates for which holding data is available, security price on the reporting date and the security price on the closest previous days in case the reporting date had no price information on the security, total return index (including dividend reinvestments) in local currency, and daily dollar exchange rates for all investment destinations. Most funds report only with a frequency of 6 months. This suggests that the analysis is best carried out at a semi-annual frequency. Reporting dates differ somewhat, but more than 90 percent of the reporting occurs in the last 30 days of each half-year. Roughly a third of the funds also report on a quarterly frequency and a still smaller percentage at the monthly frequency. Moving to quarterly or monthly reporting frequency implies a substantial sample reduction.

A limitation of the data is that they do not include any information on cash holdings, financial leverage, investments in fixed income instruments or investments in derivative contracts. All the portfolio characteristics we calculate therefore concern only the equity proportion of a fund's investment. We believe that missing

[6] Another paper using disaggregated data on international institutional investors holdings is Covrig, Fontaine, Jimenez-Garcs and Seasholes (2007) who focus on the effect of information asymmetries on international stock holdings. Thomas, Warnock and Wongswan (2004) use TIC data to study the international investment strategy of US investors.

cash holdings in home currency or financial leverage are not a major concern for our analysis, since leverage simply implies a scaling of the absolute risk by a leverage factor. All our analysis is based on portfolio shares and therefore not affected by leverage decisions which scale the absolute risk but do not alter the unit risk based on portfolio shares.[7] A more serious concern is that funds may carry out additional hedging operations which escape our inference. In spite of this data shortcoming, we believe that the analysis is still informative. As documented in previous surveys (Levich et al. (1999)), most mutual funds do not engage in any derivative trading and their equity position may therefore represent an accurate representation of their risk taking. We also note that any additional hedging is likely to attenuate rebalancing and therefore bias the predicted negative correlation towards zero.

To keep the data processing manageable, we focus our analysis on funds domiciled in four geographic regions, namely the United States (US), Canada (CA), United Kingdom (UK) and the Euro area (EU).[8]. These locations represent 88 percent of all semi-annual fund reports in our data and constitute 91 percent of all reported positions. Euro area funds are pooled together because of their common currency after 1999 and very little relative exchange rate movement in 1997 to 1999. In order to reduce data outliers and limit the role of reporting errors, a number of data filters are employed:

- We retain holding data only from the last reporting date of a fund in half-year. Fund holdings are only taken into account for reporting dates within the last 100 days of the half-year. A fund has to feature in two consecutive half-year periods in order to be retained. Consecutive reporting dates are a pre-requisite for the dynamic inference in this paper. The first reporting half-year to be retained is 1998.[9]

- Funds are retained if their total asset holding exceeds 10 million U.S. Dollars. Smaller funds might represent incubator funds and other non-representative entities.

- We retain only international funds which hold at least 5 stocks in the domestic currency and at least 5 stocks in another currency area. This excludes all funds with less than 10 stock positions and also purely domestic or purely international funds. International rebalancing for the latter might be incompatible with the fund investment objective.[10]

- Non-diversified funds with extreme investment biases in very few stocks are also ignored. We consider a fund diversified if fund weights produce a Herfindahl-Hirschman index below 20 percent.

- We discard funds if their return on combined equity holdings exceed 200 percent or if they lose more than 50 percent of their equity holdings over a half-year. Individual stock observations are ignored if they feature extreme half-annual returns which exceed 500 percent or below −80 percent.

[7] This argument is only valid for home currency cash and cannot be maintained if cash is held in foreign currency. In the latter case the exchange rate risk alters the risk features of the portfolio.

[8] Ireland, Finland, France, Greece, Germany, Austria, Netherlands, Italy, Belgium, Luxembourg, Portugal, Spain.

[9] Very few holdings were reported in the first semester of 1997. The first sizeable combination of consecutive reporting dates is therefore 1997/2 and 1998/1 which is reported under 1998/1.

[10] We are also unable to capture any 'household rebalancing' which might consist in rebalancing out of foreign country funds into purely domestic equity funds.

To start we examine the representativeness of our disaggregated data set. For this purpose we compute the correlations statistics of aggregate destination country holdings in our sample with the aggregate cross-country holdings data of the Coordinated Portfolio Investment Survey of the IMF. The CPIS data have been systematically collected since 2001 and constitute the best measures we have of aggregate cross-country asset holdings. The correlations of our holdings with the CPIS geographical distribution[11] are very high as shown in Table 1. They range from 0.73 for Euro area funds to 0.99 for Canadian funds. The high correlations for both years suggests that our sample is representative of foreign equity positions in the world economy.

Next, we document the summary statistics for the fund holding data according to fund domicile. In Table 2, Panel A, we report by half-year the number of funds in each fund domicile, the number of equity positions and their aggregate market value. The sample period extends over 10 half-years from 1998/1 to 2002/2. The number of funds in the sample generally increased over time. For example, for the U.S. in 2002, first half-year, we have 1422 funds with a total of 390,849 stock positions valued at around $1,658 billion. For the same half-year, the European fund sample comprises 1,782 funds, and their aggregate holding amounts to only $205 billion. While the U.S. and European fund sample contain roughly the same number of fund periods, both the number of equity positions and the aggregate fund value over all half-years is considerably higher for the U.S. funds. In Panel B, we report the total investment over the period 1998-2002 by investment destination, broken up into U.S., Euro area, U.K., Canada, other OECD economies, off-shore markets[12] and emerging markets. As expected, our data show a clear home bias and sizable cross-country investments among the more developed economies.

4 Empirical analysis

The empirical contribution of this paper is to document rebalancing behavior based on microeconomic data across a broad sample of funds and countries. Using disaggregated data allows for a more precise identification of portfolio rebalancing. Section 4.1 examines rebalancing evidence based on the time series of the foreign portfolio share. Rebalancing out of foreign equity is considered an implicit risk reduction due to a decrease in exchange rate risk exposure. In Section 4.2, we analyze portfolio risk explicitly by calculating it from the fund specific covariance matrix of all fund positions and their corresponding portfolio weights. Rebalancing is defined here as the reversal of portfolio risk changes. Section 4.3 carries out additional analysis at the stock level as a robustness check to the previous results.

4.1 Foreign Portfolio Share Rebalancing

According to proposition 3, domestic and foreign equity are imperfect substitutes because of differences in exchange rate risk exposure for the home and foreign investors. We show that, if exchange rate risk is

[11] These correlations have been computed on foreign holdings only and do not include zeros. Adding investments into the domestic markets would push these correlations even higher.

[12] The off-shore markets in our sample are Bermuda, Cayman Islands, Netherlands Antilles, Bahamas, Belize, British and US Virgin Islands, Jersey, Guernesey, Liechtenstein, Puerto Rico and the Dominican Republic.

imperfectly traded, equity holdings themselves dynamically reflects this lack of substitutability. In particular, a relative increase in the value of the foreign portfolio share triggers a rebalancing in favor of domestic equity and vice versa. The rebalancing behavior reflects the desire of investors to partly off-set exogenous changes in exchange rate risk exposure. The domestic investor is not exposed to exchange rate risk and therefore accommodates the rebalancing desire of the foreign investor. But do fund managers indeed sell foreign equities whenever foreign holdings outperform the domestic part of their portfolio in order to decrease their exposure to exchange rate risk? In order to answer this question, we measure portfolio rebalancing by computing the active rebalancing statistic RB^f of proposition 3. It compares the actual foreign equity weights to those implied by a simple holding strategy which induces weight changes stemming only from valuation effects. A negative rebalancing statistic implies an active decrease of the foreign equity weight in the portfolio, while a positive rebalancing statistic indicates an active increase in foreign exchange rate exposure. Let the portfolio weight of foreign securities at date t in the portfolio of fund j be denoted by $w^f_{j,t}$. Formally, the active rebalancing statistic for fund j is defined as

$$RB^f_{j,t} = w^f_{j,t} - \widehat{w}^f_{j,t} \qquad \text{with} \qquad \widehat{w}^f_{j,t} = w^f_{j,t-1}\left(\frac{1+r^f_{j,t}}{1+r^P_{j,t}}\right),$$

where $r^P_{j,t}$ represents the total portfolio return and $r^f_{j,t}$ the return on the foreign component of the portfolio of fund j. Furthermore,

$$w^f_{j,t} = \sum_{s=1}^{N_j} 1_{s=f} \times w_{s,j,t-1},$$

where $1_{s=f}$ is a dummy variable which is 1 if stock s is a foreign stock and 0 otherwise. We note that if we define symmetrically a rebalancing measure for the domestic part of the portfolio, we get

$$RB^f_{j,t} + RB^h_{j,t} = 0.$$

Figure 1 illustrate the distribution of the rebalancing measure for each of the 4 fund domiciles. We graph the realized foreign portfolio share $w^f_{j,t}$ of each fund against the implied share $\widehat{w}^f_{j,t}$ under a passive holding strategy. The vertical distance of any fund observation from the 45 degree line measures active portfolio management $RB^f_{j,t}$ for the respective fund. Fund rebalancing over a half-year has a standard deviation of 8 percent for the full sample of 26,436 fund periods as stated in Table 3. It is highest for Euro area funds at 10 percent and lowest for the U.K. and U.S. funds at 5.5 and 6.1 percent, respectively. The lower variation for both the U.K. and the U.S. follow from a strong foreign investment bias for U.K. funds and a strong home bias for U.S. funds. By contrast, the E.U. fund sample is more evenly distributed in terms of its foreign investment share, which leaves more scope for valuation effects and consecutive rebalancing.

The total portfolio return $r^P_{j,t}$ on fund j is defined as

$$r^P_{j,t} = \sum_{i=1}^{N_j} w_{i,j,t-1} r_{i,t},$$

where $r_{i,t}$ is the return on security i and N_j is the total number of stocks in the portfolio of fund j. The foreign and domestic return components of the portfolio are defined as

$$r^f_{j,t} = \sum_{s=1}^{N_j} \frac{w_{s,j,t-1}}{w^f_{j,t-1}} r_{s,t} \times 1_{s=f} \qquad r^h_{j,t} = \sum_{s=1}^{N_j} \frac{w_{s,j,t-1}}{w^h_{j,t-1}} r_{s,t} \times 1_{s=h}.$$

As a test of the rebalancing hypothesis, we regress the portfolio rebalancing measure on the excess return of the foreign part of the portfolio over the home part of the portfolio, that is

$$RB^f_{j,t} = c + \alpha \left[r^f_{j,t-k} - r^h{}_{j,t-k} \right] + D_t + \varepsilon_{j,t},$$

where $k = 0$ represents instantaneous rebalancing and $k = 1, 2, 3...$ captures delayed portfolio reallocations. Time dummies D_t capture all common reallocations in each period which are not related to relative return differences and c represents a constant term. For the half-annual data in our data set, we restrict the analysis to $k = 0$ and $k = 1$. The rebalancing hypothesis outlined in the model implies a negative regression coefficient ($\alpha < 0$). Note that a passive buy and hold strategy of an index produces $RB^f_{j,t} = 0$ and should imply a zero coefficient.

Table 4 reports the regressions results for funds from the United States (US), Canada (CA), the United Kingdom (UK) and Euro area (EU), respectively, as well as the pooled regression results. The baseline regression with contemporaneous returns ($k = 0$) yields a statistically significant negative coefficient for all the geographic areas. The strongest rebalancing is found for Canadian and Euro area funds with coefficients of -9.54 and -6.04, respectively. We note that such rebalancing generates important aggregate capital flows if the home and foreign market show pronounced performance differences. An excess performance of the foreign portfolio share by 10 percent implies a 0.494 ($= .10 \times 4.94$) percent aggregate shift towards domestic holdings in the pooled sample. Applied to an aggregate foreign equity position of 4 trillion U.S. dollars, the corresponding equity flow amounts to 19.8 billion U.S. dollars.[13]

It is also interesting to explore the possible asymmetries in the rebalancing behavior of international investors. For this purpose, we split the sample into negative and positive excess returns and estimate separate regression coefficients α^+ and α^- for positive and negative return differentials. Formally, we have

$$RB^f_{j,t} = c + \alpha^+ \left[r^f_{j,t} - r^h{}_{j,t} \right] \times 1_{\Delta r \geq 0} + \alpha^- \left[r^f_{j,t} - r^h_{j,t} \right] \times 1_{\Delta r < 0} + D_t + \varepsilon_{j,t},$$

where $1_{\Delta r \geq 0}$ represents a dummy which is equal to 1 whenever the foreign excess return $\Delta r = r^f_{j,t-k} - r^h{}_{j,t-k} \geq 0$ and 0 otherwise. The complementary dummy marking negative foreign excess returns is given by $1_{\Delta r < 0}$. Both coefficients are generally negative for all geographical areas, but rebalancing appears to be stronger for an overexposure to exchange rate risk than for an underexposure except for the U.K. funds. In the pooled sample, the rebalancing coefficient for positive foreign excess performance is at -6.79, almost twice as negative as the -3.37 in case of negative foreign underperformance. The equity capital repatriation

[13]The Bureau of Economic Analysis of the U.S. Department of Commerce reports in International Economic Accounts private corporate stock holdings of U.S. residents in foreign companies of 4.2 trillion U.S. dollars for year end 2006.

effect is quantitatively stronger than the capital expatriation effect.

Looking only at contemporaneous rebalancing ($k = 0$) may underestimate the permanent effect of return differentials on capital reallocation. Some rebalancing might occur with a time lag and hence not be fully captured by the contemporaneous return differential. Columns (3), (7), (15), and (19) show that the lagged return differentials ($k = 1$) are also statistically significant for all four fund locations, though of smaller magnitude. Using lagged returns also has the advantage of controlling for potential measurement errors. The implied foreign share $\widehat{w}_{j,t}^{f}$ on the left-hand-side uses (by construction) the returns on the foreign portfolio share $r_{j,t}^{f}$ and the return on the total portfolio $r_{j,t}^{P}$ (linear combination of $r_{j,t}^{f}$ and $r^{h}{}_{j,t}$), which are also part of the a right-hand-side regressor (with opposite sign). Mis-measurement of $r_{j,t}^{f}$ or $r^{h}{}_{j,t}$ may therefore generate a spurious negative coefficient estimate α for the contemporaneous regression ($k = 0$), but not for the lagged return differential ($k = 1$). An additional robustness check consists in an IV regression, where we use lagged foreign portfolio share $w_{j,t-1}^{f}$ interacted with fixed time and domicile dummies as instruments[14]. The IV regression confirms statistically negative coefficients for both the U.S. and Canadian samples. However, standard errors are inconclusively large for the U.K. and European fund samples. The IV regression for the pooled sample yields a coefficient estimate $\alpha_{IV} = -11.1$ which is even more negative than the OLS point estimate. The regressions are also immune to any simultaneity problem since we looked at the effect of realized returns between date $t-2$ and $t-1$ on changes in portfolio weights at date t. The capital flows induced by portfolio rebalancing cannot drive these lagged return changes.

The rebalancing model developed in section 2 does not allow for time changing expected returns since all the effects come from realized values, which are exogenous from the point of view of the investor. The hypothesis we maintain in the empirical exercise is that time changing expected returns enter the error term and are uncorrelated with the realized excess return. Note that if changes in expected returns were positively correlated with current realized excess returns, then this would bias the results *against* finding a negative correlation. Only in the case where changes in expectations are negatively correlated with current realized excess returns could we get a potentially spurious negative coefficient. However, the regressions based on lagged returns or the IV specification should still produce the correct coefficient as long as changes in expected returns are uncorrelated with the lagged returns or the instruments.

4.2 Risk Rebalancing at the Fund Level

While the previous section proxied exchange rate risk with the foreign portfolio share, we now measure risk directly based on the estimated covariance matrix corresponding to the fund specific stock holdings. Proposition 4 states that active rebalancing should produce a portfolio risk change which counteracts any passive risk change due to valuation effects. We highlight that alternative theories of international market segmentation based on information asymmetry or transaction costs do not imply an equivalent hypothesis.

But testing proposition 4 poses a formidable computational task. The portfolio risk needs to be calculated for approximately 20,000 fund periods with each fund period requiring the data input from a set

[14] Using only time and domicile dummies as instruments (no fund specific variable) gives qualitatively similar results.

of approximately 30,000 different international stocks. We use an algorithm to construct a data base with daily equity return and exchange rate data for each fund period. The covariance estimation for the half-year t is based on daily returns over the three preceding half-year periods $S = \{t-1, t-2, t-3\}$. A typical covariance element is therefore estimated using approximately $n = 380$ daily return observations. We calculate the historical sample covariance matrix $\widehat{\Omega}_{j,t-1}$ for fund j using the vector of (log) daily equity returns $R_s = R_s^{Eq} + R_s^{Fx}$. It is expressed in home (fund domicile) currency and corresponds (in its stock ordering) to the vector of portfolio weights $w_{j,t}$. Equity returns are measured as 'total returns' and generally account for stocks splits and dividend reinvestment. We separately estimate a second covariance matrix $\widehat{\Omega}_{j,t-1}^{Eq}$ based on equity returns R_s^{Eq} in local currency. The exchange rate risk covariance matrix $\widehat{\Omega}_{j,t-1}^{Fx}$ then represents the complementary matrix in the decomposition

$$\widehat{\Omega}_{j,t-1} = \widehat{\Omega}_{j,t-1}^{Eq} + \widehat{\Omega}_{j,t-1}^{Fx},$$

where

$$\begin{aligned}
\widehat{\Omega}_{j,t-1}^{Eq} &= \frac{1}{n}\sum_{s\in S} R_s^{Eq}(R_s^{Eq})^T \\
\widehat{\Omega}_{j,t-1}^{Fx} &= \frac{1}{n}\sum_{s\in S} R_s^{Fx}(R_s^{Eq})^T + \frac{1}{n}\sum_{s\in S} R_s^{Eq}(R_s^{Fx})^T + \frac{1}{n}\sum_{s\in S} R_s^{Fx}(R_s^{Fx})^T.
\end{aligned}$$

The covariances $\widehat{\Omega}_{j,t-1}$ and $\widehat{\Omega}_{j,t-1}^{Eq}$ are identical under the assumption that all exchange rates are constant. The covariance matrix $\widehat{\Omega}_{j,t-1}^{Fx}$ therefore captures the portfolio risk due to exchange rate movements.

We apply the same data filters with respect to the fund data as in the previous section on share rebalancing measures. However, estimating the covariance matrix for each fund poses additional challenges. In particular, the return data must be sufficiently complete. We include a matrix element in the calculation of the portfolio risk if we dispose of at least 150 non-missing return pairs of daily return observations over the 18 months data window. If too many return observations are missing, we replace the covariance element by the average covariance of the stock with all other stocks in the portfolio. Moreover, a fund is discarded from the sample if more than 20 percent of its stocks (in terms of the fund asset value) feature incomplete return data. We found that more stringent selection criteria like a 5 percent of 10 percent threshold for data completeness did not qualitatively change the main results, even though it reduced the number of available funds observations.

In a first step we document the relationship between the foreign portfolio share of a fund and its corresponding share of FX risk. The FX risk share is formally calculated as the standard deviation of the FX risk relative to the standard deviation of total risk, hence

$$FX\ risk\ share_j = \frac{\left|w_{j,t}\widehat{\Omega}_{j,t-1}^{Fx}w_{j,t}^T\right|^{\frac{1}{2}}}{\left|w_{j,t}\widehat{\Omega}_{j,t-1}w_{j,t}^T\right|^{\frac{1}{2}}} \times sign(w_{j,t}\widehat{\Omega}_{j,t-1}^{Fx}w_{j,t}^T),$$

where *sign* function adjusts for the sign of the FX risk

$$w_{j,t}\widehat{\Omega}^{Fx}_{j,t-1}w^T_{j,t} = w_{j,t}\widehat{\Omega}_{j,t-1}w^T_{j,t} - w_{j,t}\widehat{\Omega}^{Eq}_{j,t-1}w^T_{j,t}.$$

Figure 2 plots the FX risk share as a function of the foreign portfolio share w^f separately for the U.S., Canada, the U.K. and the Euro area. U.S. The FX risk share is very dispersed across different funds, though its fitted mean is generally increasing in the foreign portfolio share. There are also pronounced differences across countries. U.S. funds generally have small foreign portfolio shares and their FX risk share is close to zero. Only for a foreign portfolio share beyond 70 percent do we find an increase in the FX risk share. For the U.K. most sample funds have a foreign portfolio share between 80 and 100 percent and their mean FX risk share for those funds is above 30 percent. Canada stands out by its generally negative FX risk share which is just slowly increasing in the foreign portfolio share of a fund. Canadian funds are mostly invested in the U.S. (see Table 2). Hence their foreign exchange risk exposure is driven by the correlation between US equity returns and the Canadian dollar exchange rate. This correlation is negative at -0.0428 in our sample period. Therefore the Canadian exchange rate provides a natural hedge for Canadian investors. It is worth highlighting that a low or even negative level of fund exposure to FX risk does not imply that rebalancing with respect to changes in this risk is irrelevant. Canadian funds may rebalance after an increased in their FX risk component even though the level of the FX exposure remains negative. The situation is very different for the U.K. whose exchange rate is positively correlated with U.S. returns during the same period. As a result, foreign exchange risk exposure of U.K. funds increases with their foreign portfolio share. The increase in the FX risk share as a function of the foreign portfolio share is also steep for Euro area funds. Their FX risk share reaches almost 50 percent for the funds with the largest foreign investment weights.

While the structure of equity and FX risk is interesting in its own right, our study is focused on the dynamic aspect of risk choices. To what extent are valuation related portfolio risk changes reversed by active rebalancing? In accordance with proposition 4, the empirical portfolio risk changes due to valuation effects are defined as

$$\begin{aligned}
\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1}) &= \widehat{w}_{j,t}\widehat{\Omega}_{j,t-1}\widehat{w}^T_{j,t} - w_{j,t-1}\widehat{\Omega}_{j,t-1}w^T_{j,t-1} \\
\Delta Risk^{Fx}(\widehat{w}_{j,t}, w_{j,t-1}) &= \widehat{w}_{j,t}\widehat{\Omega}^{Fx}_{j,t-1}\widehat{w}^T_{j,t} - w_{j,t-1}\widehat{\Omega}^{Fx}_{j,t-1}w^T_{j,t-1}
\end{aligned}$$

for total and FX risk, respectively; and the portfolio risks change due to rebalancing is given by

$$\begin{aligned}
\Delta Risk(w_{j,t}, \widehat{w}_{j,t}) &= w_{j,t}\widehat{\Omega}_{j,t-1}w^T_{j,t} - \widehat{w}_{j,t}\widehat{\Omega}_{j,t-1}\widehat{w}^T_{j,t} \\
\Delta Risk^{Fx}(w_{j,t}, \widehat{w}_{j,t}) &= w_{j,t}\widehat{\Omega}^{Fx}_{j,t-1}w^T_{j,t} - \widehat{w}_{j,t}\widehat{\Omega}^{Fx}_{j,t-1}\widehat{w}^T_{j,t},
\end{aligned}$$

where $w_{j,t}$ denotes the vector of weights at the end of period t for fund j, respectively. The risk rebalancing hypothesis is tested through a linear regression given by

$$\begin{aligned}
\Delta Risk(w_{j,t}, \widehat{w}_{j,t}) &= c + \alpha \times \Delta Risk(\widehat{w}_{j,t}, w_{j,t-1}) + D_t + \varepsilon_{j,t} \\
\Delta Risk^{Fx}(w_{j,t}, \widehat{w}_{j,t}) &= c + \alpha^{Fx} \times \Delta Risk^{Fx}(\widehat{w}_{j,t}, w_{j,t-1}) + D_t + \varepsilon_{j,t}.
\end{aligned}$$

A negative coefficient $\alpha < 0$ indicates mean reversion for the total portfolio risk through active risk rebalancing and $\alpha^{Fx} < 0$ confirms active risk rebalancing for the foreign exchange rate risk component.

Table 5 reports the regression results for portfolio risk rebalancing. We report separate results for each of the four fund domiciles and pooled results in column (15). In order to reduce the importance of outliers, we eliminate the 1 percent lowest and higher observations of both the dependent and independent variables. Panel A presents evidence for the rebalancing of total risk and Panel B focuses on rebalancing for the FX risk component. The pooled OLS regressions in Panel A show strong evidence for a negative coefficient. A coefficient estimate of $\alpha = -0.25$ suggests that (on average) a quarter of any portfolio risk change resulting from valuation effects is reversed by active rebalancing over a half-year. The robust standard error of 0.02 on the estimate is very low, which implies a high level of statistical significance. Reported standard errors account for clustering effects at the fund level. The point estimates for the mean reversion parameter are more negative for funds domiciled in Canada and the Euro area. Only U.K. based funds provide no evidence for mean reversion of total portfolio risk. Controlling for fixed time effects slightly increases the adjusted R^2 without much impact on the respective point estimate. The evidence for exchange rate risk rebalancing in Panel B is very similar. The point estimates $\alpha^{Fx} = -0.24$ for the mean reversion parameter is almost identical to the parameter estimate in Panel A. Evidence in favor of FX risk rebalancing is uniform across the 4 different fund domiciles. For the U.K. we find the most negative point estimate of $\alpha^{Fx} = -0.45$. This finding is in line with the evidence in Figure 1 which shows a relatively large FX risk share for U.K. based funds. The stronger rebalancing of FX risk for U.K. domiciled funds may reflect a higher level of FX risk exposure.

An obvious concern about the regression analysis in risk changes is spurious negative correlation implied by measurement error. The term $\widehat{w}_{j,t}\widehat{\Omega}_{j,t-1}\widehat{w}_{j,t}^T$ represents the portfolio risk implied by a passive holding strategy and is only estimated. But it features on both the left-hand and right-hand side of the regression with opposite signs. A substantial measurement error would induce a negative estimation bias for α. Such measurement error is likely to be fund specific. An instrumental variable approach allows us to obtain an unbiased parameter estimate. We use fixed time effects interacted with domicile dummies as instruments to capture the portfolio risk changes common across all funds in a given fund domicile and half-year. The F-test of the first stage regression shows that such fixed time effects provide reasonably good instruments for the U.S. and Canadian fund sample. The pooled IV regression in Panel A implies a parameter estimate of $\alpha = -0.29$, which is very close to the OLS estimate. Eliminating fund specific measurement error from the right-hand side of the regression by projection of the portfolio risk change into a set of aggregate fixed effects does not qualitatively change the estimation result. We therefore conclude that our negative point estimate α is not due to fund specific measurement error of the portfolio risk. The corresponding IV estimates in Panel B also imply generally negative point estimates. However, the standard errors are large here given the poor quality of the instruments as indicated by the F-statistics of the first stage regression.

Next, we examine if the rebalancing effect differs across fund sizes. If rebalancing is predominantly concentrated in small funds it is unlikely to be of any macroeconomic significance. We therefore split the sample at the median of fund capitalization into a sample of small and large funds. The OLS regressions are now repeated separately for each subsample with the coefficient estimates reported in Table 6. We find that the risk rebalancing behavior is generally similar across fund size. The point estimate for the pooled sample in Panel A is $\alpha = -0.28$ for small funds and $\alpha = -0.22$ for large funds. The difference is statistically insignificant. Panel B shows that rebalancing with respect to FX risk is also not very size specific and concerns large and small funds alike.

4.3 Risk Rebalancing at the Stock Level

Portfolio rebalancing can be examined at the fund level, but also at the stock level. In order to reduce portfolio risk induced by valuation effects, a fund manager needs to reduce the risk contribution of certain stocks to the total portfolio risk. We can measure the risk contribution at the stock level as the marginal risk contribution of a given stock to the portfolio risk. The marginal risk contribution of a stock will depend on its weight in the portfolio and the volatility of its return but also on the covariances of its return with the other stocks of the portfolio. A passive change of the marginal risk contribution (due to valuation effects) of stock i in portfolio j is defined as

$$\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) = (\widehat{\Omega}_{j,t-1})_{i\bullet}(\widehat{w}_{j,t} - w_{j,t-1})^T,$$

where $(\widehat{\Omega}_{j,t-1})_i$ denotes row i of the variance covariance matrix $\widehat{\Omega}_{j,t-1}$ for fund j. Active portfolio management results in marginal risk changes characterized by

$$\Delta MRisk(i, w_{j,t}, \widehat{w}_{j,t}) = (\widehat{\Omega}_{j,t-1})_{i\bullet}(w_{j,t} - \widehat{w}_{j,t})^T.$$

The change in total risk of the portfolio of fund j is a weighted average of the changes in marginal risk contributions of all the stocks i of the portfolio. Rebalancing at the fund level will therefore imply rebalancing the marginal risk of some specific stocks. Imagine there is an increase in the marginal risk contribution of a specific stock i, which brings about an increase in aggregate risk at the fund level. We should see the marginal risk contribution of this stock decrease as a result of active rebalancing. This may consist in either reducing the portfolio weight of stock i itself or in reducing the weight of other stocks with high covariances with stock i. In contrast if we see an increase in the marginal risk contribution of a given stock i but at the same time a decrease in the aggregate portfolio risk (due to changes in marginal risks of other stocks), there is less reason to expect that active rebalancing of the marginal risk of stock i will occur. Hence the magnitude of the stock level rebalancing should be conditioned by the aggregate portfolio risk change. The rebalancing in the marginal risk contribution of a stock should occur if its marginal risk change, and the portfolio risk change have the same direction and not if they have opposite directions. The following regression captures the differential rebalancing at the stock level across these different states,

$$\Delta MRisk(i, w_{j,t}, \widehat{w}_{j,t}) = c + \alpha \times \Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) \times \times sign(\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})) \times sign(\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1})) + D_t + \varepsilon_{j,i,t},$$

where the product of the two sign functions takes the value of 1 if portfolio risk and marginal stock risk move in the same direction and -1 in the opposite case. We highlight that the coefficient α captures only *differences in the mean reversion* across the two conditioning states where marginal stock risk and portfolio risk move in either the same or opposite directions. Potential measurement errors in the marginal risk term $(\widehat{\Omega}_{j,t-1})_{i\bullet}\widehat{w}_{j,t}$ would bias the coefficient estimate for α in each of the four sign combinations towards a negative value, but not necessarily the differences in the mean reversion across the two states captured by the product of the sign functions. This stock level regression specification based on mean reversion differences should therefore be more robust to concern about measurement errors.

The evidence for marginal stock risk rebalancing is presented in Table 7. Panel A provides the regression results for total risk and Panel B for the marginal FX risk. We present again separate regression results for each fund domicile and split the regressor into the four conditional components: The dummy variables $1_{\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})\geq 0}$ and $1_{\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})<0}$ mark a portfolio risk increase and decrease, respectively. Similarly, we define dummies $1_{\Delta MRisk(i,\widehat{w}_{j,t}, w_{j,t-1})\geq 0}$ and $1_{\Delta MRisk(i,\widehat{w}_{j,t}, w_{j,t-1})<0}$ which condition on a marginal risk increase or decrease in stock i, respectively. The pooled results in Panel A, column (9) show very strong rebalancing in the case where marginal stock risk and portfolio risk both increase. The coefficient estimate of $\alpha = -1.05$ implies that the entire marginal risk increase of valuation effect is reversed by active portfolio management if overall portfolio risk increases. A negative coefficient of $\alpha = -0.52$ is also obtained for a marginal risk decrease combined with an overall portfolio risk decrease. In both cases, the direction of the marginal risk change and the portfolio risk change is the same and the product of the two sign functions is 1. The case where the two sign functions have opposite signs provides no evidence for rebalancing. The coefficient estimates here are significantly positive. The results are qualitatively similar across all 4 fund domiciles. The second regression for each fund domicile uses the sign function and therefore captures the difference in the mean reversion of marginal risk changes. The point estimates are uniformly negative at high levels of statistical significance. A qualitatively similar picture is obtained for the marginal FX risk rebalancing documented in Panel B. Some of the point estimates for marginal risk reversion are lower than 1. The pooled regression in Panel B, column (9) for example yields a point estimate of $\alpha = -1.37$ for the state $\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1}) \geq 0$ and $\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) \geq 0$. This implies that not only the marginal risk increase due to the valuation effect is completely reversed, but that the portfolio manager reduces the marginal risk contribution in stock i further conditional on an overall portfolio risk decrease. The quantitatively strongest effects for marginal FX risk rebalancing are found for funds from the U.K. and the Euro area. Both feature a relatively large FX risk share compared to funds in the U.S. and Canada.

5 Conclusions

Financial globalization has led to a large increase in cross-border assets and liabilities. This calls for a better understanding of cross-border equity investment and its dynamics. Historically, such analysis was first framed by the portfolio balance theory of international finance. But the latter has often been discarded due to a lack of microfoundations and the absence of empirical support in macroeconomic data. This paper revisits the portfolio rebalancing model with two new contributions to the literature.

First, we develop a simple international portfolio choice model which features incomplete exchange rate risk trading. Differential valuation effects driven by cash flow news then create different rebalancing motives for the home and foreign investor. The home investor does not face exchange rate risk with respect to home assets and their excess return will therefore increase his relative propensity to hold home assets. Under complete international exchange rate risk sharing, the marginal reaction to valuation effects should be equalized, but not if such risk trading is impaired. Thus, market incompleteness creates imperfect substitutability of home and foreign assets, which has testable implications for the dynamics of international portfolio choice. These fund level implications are specific to a market segmentation based on exchange rate risk as opposed to other dimension of market segmentation like differences of information or transactions costs.

Second, we use new data on the stock allocations of approximately 6,500 international equity funds from four different currency areas over 5 years. The portfolio rebalancing theory is tested on the fund and stock level using a variety of measures. We find evidence supporting rebalancing of the foreign portfolio share as well as rebalancing based on portfolio risk measures. Active risk rebalancing reverses between 25 and 30 percent of the risk change due to valuation effects in the same half-year. Moreover, it concerns both risk changes of the total equity risk as well as its FX component. We also confirm that rebalancing is of similar magnitude across small and large funds. The estimated magnitude of portfolio rebalancing should generate sizeable macroeconomic equity flows. The micro-evidence on fund level rebalancing is therefore consistent with international asset pricing effects like the 'equity parity condition' found in the recent literature (see Hau and Rey (2006)).

We finally highlight that limited international asset substitutability also casts some light on the international financial adjustment mechanism. The short and medium term adjustment to trade imbalance seems to rely to a considerable degree on valuation effects (Gourinchas and Rey (2007)). Increasing holdings in dollar denominated assets by foreign investors go hand in hand with a dollar depreciation. A depreciating dollar lowers the foreign investors' portfolio weight in U.S. assets and represents the adjustment to the new asset market equilibrium. A strong valuation channel for the process of external adjustment is therefore complementary to the evidence for portfolio rebalancing presented in this paper.

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Appendix

Proof of Proposition 1.

The notations mark with an overbar $\overline{X}$ the steady state value of a variable X . Variables referring to the foreign country are denoted by a star (*). The investment problem is strictly symmetric for the home and foreign investors in period 1. Hence, we can assume that the equilibrium in period 1 coincides with the steady state, that is $P_1^h = P_1^f = \overline{P}_1$ and $E_1 = \overline{E}_1 = 1$ since final payoffs $V^h + d^h$ and $V^f + d^f$ have identical distributions. Symmetric holdings imply $x_1^h = x_1^{f*}$ and $x_1^f = x_1^{h*}$. The returns for the home investor follow as

$$
\begin{aligned}
R^h &= P_3^h - (1+r)\overline{P}_1 \\
R^f &= P_3^f E_3 - (1+r)\overline{P}_1\overline{E}_1,
\end{aligned}
$$

and linearizing the second equation around the steady state gives

$$
\begin{aligned}
R^f &= \overline{P}_3^f\overline{E}_3 + \overline{P}_3^f\left(E_3 - \overline{E}_3\right) + \overline{E}_3\left(P_3^f - \overline{P}_3^f\right) - (1+r)\overline{P} \\
&= E_3 + P_3^f - (1+r)\overline{P} - \overline{E}_3\overline{P}_3^f \\
&= E_3 + P_3^f - (1+r)\overline{P} - 1.
\end{aligned}
$$

It is straightforward to derive the period 1 holdings as

$$
\begin{aligned}
x_1^h &= x_1^{f*} = \frac{\mathcal{E}_1(P_3^h - (1+r)\overline{P}_1)}{\rho\left(\sigma_d^2 + \sigma_V^2\right)} \\
x_1^f &= x_1^{h*} = \frac{\mathcal{E}_1(E_3 + P_3^f - (1+r)\overline{P}_1 - 1)}{\rho\left(\sigma_d^2 + \sigma_V^2 + \sigma_e^2\right)}
\end{aligned}
$$

or

$$
\begin{aligned}
x_1^h &= x_1^{f*} = \frac{(1 - (1+r)\overline{P}_1)}{\rho\left(\sigma_d^2 + \sigma_V^2\right)} = \frac{\sigma_d^2 + \sigma_V^2 + \sigma_e^2}{2\sigma_d^2 + 2\sigma_V^2 + \sigma_e^2} \\
x_1^f &= x_1^{h*} = \frac{(1 - (1+r)\overline{P}_1)}{\rho\left(\sigma_d^2 + \sigma_V^2 + \sigma_e^2\right)} = \frac{\sigma_d^2 + \sigma_V^2}{2\sigma_d^2 + 2\sigma_V^2 + \sigma_e^2},
\end{aligned}
$$

where we substituted the solution for $\overline{P}_1$ obtained from equity market clearing as

$$
\begin{aligned}
1 &= \frac{1 - (1+r)\overline{P}_1}{\rho\left(\sigma_d^2 + \sigma_V^2\right)} + \frac{1 - (1+r)\overline{P}_1}{\rho\left(\sigma_d^2 + \sigma_V^2 + \sigma_e^2\right)} \\
\overline{P}_1 &= \left[-\frac{\rho\left(\sigma_d^2 + \sigma_V^2 + \sigma_e^2\right)\left(\sigma_d^2 + \sigma_V^2\right)}{(1+r)\left[2\sigma_d^2 + 2\sigma_V^2 + \sigma_e^2\right]} + \frac{1}{(1+r)}\right].
\end{aligned}
$$

Proof of Proposition 2.

To solve for the equilibrium in period 2, we linearize again the foreign return equations to obtain

$$
\begin{aligned}
R^f &= \overline{P}_3^f\overline{E}_3 + \overline{P}_3^f\left(E_3 - \overline{E}_3\right) + \overline{E}_3\left(P_3^f - \overline{P}_3^f\right) \\
&\quad -(1+r)\left[\overline{P}_2^f\overline{E}_2 + \overline{P}_2^f\left(E_2 - \overline{E}_2\right) + \overline{E}_2\left(P_2^f - \overline{P}_2^f\right)\right] \\
&= E_3 + P_3^f - \overline{E}_3\overline{P}_3^f - (1+r)\left[\overline{P}_2^f E_2 + \overline{E}_2 P_2^f - \overline{E}_2\overline{P}_2^f\right] \\
&= E_3 + P_3^f - 1 - (1+r)\left[\overline{P}_2^f E_2 + \overline{E}_2 P_2^f - \overline{E}_2\overline{P}_2^f\right] \\
R^{h*} &= \overline{P}_3^h/\overline{E}_3 - \overline{P}_3^h\left(E_3 - \overline{E}_3\right)/\left(\overline{E}_3\right)^2 + \left(P_3^h - \overline{P}_3^h\right)/\overline{E}_3 \\
&\quad -(1+r)\left[\overline{P}_2^h/\overline{E}_2 - \overline{P}_2^h\left(E_2 - \overline{E}_2\right)/\left(\overline{E}_2\right)^2 + \left(P_2^h - \overline{P}_2^h\right)/\overline{E}_2\right] \\
&= -E_3 + P_3^h + 1 - (1+r)\left[-\overline{P}_2^h E_2 + P_2^h/\overline{E}_2 + \overline{P}_2^h/\overline{E}_2\right].
\end{aligned}
$$

Next, we conjecture a linear solution in the two state variables d^h and d^f, namely

$$
\begin{aligned}
P_2^h &= \overline{P}_2 + \gamma(d^h - d^f) + \beta(d^h + d^f) && (3)\\
P_2^f &= \overline{P}_2 - \gamma(d^h - d^f) + \beta(d^h + d^f) && (4)\\
E_2 &= \overline{E}_2 + \theta(d^h - d^f) && (5)
\end{aligned}
$$

where (γ, β, θ) represent coefficients to be determined using the market clearing conditions. Equity demand depends on the period 2 conditional return covariances. We note in particular that $cov(R^h, R^f|d^h, d^f) = 0$ and $cov(R^{h*}, R^{f*}|d^h, d^f) = 0$. The conditional return covariances therefore follow as

$$
\Omega_2 = \begin{pmatrix} \sigma_V^2 & 0 \\ 0 & \sigma_V^2 + (1+d^f)^2\sigma_e^2 \end{pmatrix} \qquad \Omega_2^* = \begin{pmatrix} \sigma_V^2 & 0 \\ 0 & \sigma_V^2 + (1+d^h)^2\sigma_e^2 \end{pmatrix}.
$$

Using market clearing for the equity markets, we can derive the following two equilibrium conditions for the parameters (γ, β, θ) given by

$$
\begin{aligned}
\theta &= \frac{(\gamma - \beta)\left(2\sigma_V^2 + \sigma_e^2\right)}{\overline{P}_2\sigma_V^2} && (6)\\
2(1+r)(\gamma - \beta) &= \frac{\sigma_V^2}{(2\sigma_V^2 + \sigma_e^2)} > 0. && (7)
\end{aligned}
$$

Eq. (7) shows that $\gamma - \beta > 0$ and it follows from eq. (6) that $\theta > 0$. We can also show that $\rho < (2\sigma_V^2 + \sigma_e^2)/2\sigma_V^2\sigma_e^2 = \overline{\rho}$ represents a sufficient condition for $\frac{1}{2} > \beta > 0$ and for $\gamma > 0$.

For the steady state values of the asset holdings, we have

$$
\begin{aligned}
\overline{x}_2^h &= \overline{x}_2^{f*} = \frac{(1 - (1+r)\overline{P}_2)}{\rho\sigma_V^2} = \frac{\sigma_V^2 + \sigma_e^2}{2\sigma_V^2 + \sigma_e^2} \\
\overline{x}_2^f &= \overline{x}_2^{h*} = \frac{(1 - (1+r)\overline{P}_2)}{\rho\left(\sigma_V^2 + \sigma_e^2\right)} = \frac{\sigma_V^2}{2\sigma_V^2 + \sigma_e^2},
\end{aligned}
$$

where we use $d^h = d^f = 0$ and

$$
\begin{aligned}
\overline{P}_2 &= -\frac{\rho\left(\sigma_V^2 + \sigma_e^2\right)\sigma_V^2}{(1+r)\left[2\sigma_V^2 + \sigma_e^2\right]} + \frac{1}{(1+r)} \\
1 - (1+r)\overline{P}_2 &= \frac{\rho\left(\sigma_V^2 + \sigma_e^2\right)\sigma_V^2}{\left[2\sigma_V^2 + \sigma_e^2\right]} > 0.
\end{aligned}
$$

Finally, market clearing in the currency market implies

$$(x_2^f - x_1^f)P_2^f E_2 - (x_2^{h*} - x_1^{h*})P_2^h = \eta(E_2 - 1).$$

Using the linear approximation $\overline{P}_2\overline{E}_2(x_2^f - x_1^f) - \overline{P}_2(x_2^{h*} - x_1^{h*}) = \eta(E_2 - 1)$ and $\overline{P}_2\overline{E}_2 x_1^f = \overline{P}_2 x_1^{h*}$, we get

$$(x_2^f - x_2^{h*}) = \frac{\eta\theta}{\overline{P}_2}(d^h - d^f)$$

with $\eta\theta > 0$. The relative foreign equity allocation $(x_2^f - x_2^{h*})$ of the home investor is therefore reduced by relatively higher foreign dividends, that is $(d^h - d^f) < 0$. Combining eqs. (3) and (4) to

$$P_2^f - P_2^h = -2\gamma(d^h - d^f)$$

implies for the covariance between differential equity price performance and the exchange rate

$$Cov\left[P_2^f - P_2^h, E_2\right] = -4\gamma\theta\sigma_d^2 < 0.$$

Generally, $\theta > 0$ and $\gamma > 0$ follows for sufficiently low risk aversion $\rho < \overline{\rho}$. Under a high risk aversion and a high exogenous exchange rate risk risk σ_e^2, the risk sharing equilibrium may no longer exist if the exchange rate risk is too large relative to the risk aversion of the agents. Then the only solution is the autarky solution in which every investor only holds his home equity.

Proof of Proposition 3: Portfolio Rebalancing Measures Based on Foreign Portfolio Shares The portfolio return for the home country investor can be stated as

$$r^P = w^h r^h + (1 - w^h)r^f = w^h\left[P_2^h/\overline{P}_1 - 1\right] + (1 - w^h)\left[E_2 P_2^f/\overline{P}_1 - 1\right].$$

Using the linear solution in eqs (3) to (5) and $\overline{E}_2 = 1$, we obtain

$$r^P = \frac{\overline{P}_2 - \overline{P}_1}{\overline{P}_1} + \frac{1}{\overline{P}_1}\beta(d^h + d^f) + \frac{1}{\overline{P}_1}\left[(-1 + 2w^h)\gamma + (1 - w^h)\overline{P}_2\theta\right](d^h - d^f)\ .$$

The home investor's return on his foreign and domestic portfolio component is given by

$$\begin{aligned} r^f &= \frac{1}{\overline{P}_1}\left[P_2^f - \overline{P}_1 + \overline{P}_2(E_2 - 1)\right] = \frac{\overline{P}_2 - \overline{P}_1}{\overline{P}_1} + \frac{1}{\overline{P}_1}\beta(d^h + d^f) - \frac{1}{\overline{P}_1}\left[\gamma - \overline{P}_2\theta\right](d^h - d^f) \\ r^h &= \frac{1}{\overline{P}_1}\left[P_2^h - \overline{P}_1\right] = \frac{\overline{P}_2 - \overline{P}_1}{\overline{P}_1} + \frac{1}{\overline{P}_1}\beta(d^h + d^f) + \frac{1}{\overline{P}_1}\gamma(d^h - d^f), \end{aligned}$$

respectively. The excess return of the foreign over the domestic foreign component is then

$$r^f - r^h = -\frac{1}{\overline{P}_1}\left[2\gamma - \overline{P}_2\theta\right](d^h - d^f). \tag{8}$$

We have $2\gamma - \overline{P}_2\theta > 0$, because

$$\theta = \frac{(\gamma - \beta)\left(2\sigma_V^2 + \sigma_e^2\right)}{\overline{P}_2\sigma_V^2} < \frac{2\gamma}{\overline{P}_2}.$$

News about high future foreign dividends imply high returns on the foreign equity. The term $\overline{P}_2\theta$ captures the diminished home currency return of the foreign country investment due to the depreciation of the foreign currency.

Next, we derive the implications for the portfolio shares of the home country investor. In period 1, we have $P^h = P^f = \overline{P}_1$ and therefore total equity wealth is $W = \overline{P}_1(\overline{x}_1^h + \overline{x}_1^f)$ and the wealth shares follow as

$$w_1^h = \frac{\overline{P}_1 \overline{x}_1^h}{\overline{P}_1(\overline{x}_1^h + \overline{x}_1^f)} = \overline{x}_1^h$$
$$w_1^f = \frac{\overline{P}_1 \overline{x}_1^f}{\overline{P}_1(\overline{x}_1^h + \overline{x}_1^f)} = \overline{x}_1^f = 1 - \overline{x}_1^h$$

Let $(\widehat{w}_2^h, \widehat{w}_2^f)$ denote the new period 2 wealth shares under the new prices, but absent any portfolio adjustments. These are

$$\widehat{w}_2^h = \frac{P_2^h \overline{x}_1^h}{P_2^h \overline{x}_1^h + P_2^f E_2 \overline{x}_1^f} = \frac{1}{1 + \frac{P_2^f E_2 \overline{x}_1^f}{P_2^h \overline{x}_1^h}}$$
$$\widehat{w}_2^f = \frac{P_2^f E_2 \overline{x}_1^f}{P_2^h \overline{x}_1^h + P_2^f E_2 \overline{x}_1^f} = \frac{1}{1 + \frac{P_2^h \overline{x}_1^h}{P_2^f E_2 \overline{x}_1^f}} = 1 - \widehat{w}_2^h$$

However, under period 2 prices, the home investor will also adjust his portfolio share. The observable wealth shares are given by

$$w_2^h = \frac{P_2^h x_2^h}{P_2^h x_2^h + P_2^f E_2 x_2^f} = \frac{1}{1 + \frac{P_2^f E_2 x_2^f}{P_2^h x_2^h}}$$
$$w_2^f = \frac{P_2^f x_2^f}{P_2^h x_2^h + P_2^f E_2 x_2^f} = \frac{1}{1 + \frac{P_2^h x_2^h}{P_2^f E_2 x_2^f}}$$

Linearization around $\overline{P}_2^f = \overline{P}_2^h$ and $\overline{E} = 1$ implies (using eq. (8))

$$\widehat{w}_2^h = \overline{x}_1^h + \frac{\overline{x}_1^f \overline{x}_1^h}{\overline{P}_2^h}\left(P_2^h - P_2^f\right) - \overline{x}_1^f \overline{x}_1^h (E_2 - 1) = \overline{x}_1^h + \frac{\overline{x}_1^f \overline{x}_1^h}{\overline{P}_2^h}\left[2\gamma - \overline{P}_2^h \theta\right](d^h - d^f)$$
$$= \overline{x}_1^h - \frac{\overline{x}_1^f \overline{x}_1^h \overline{P}_1}{\overline{P}_2^h}[r^f - r^h]$$
$$\widehat{w}_2^f = \overline{x}_1^f + \frac{\overline{x}_1^f \overline{x}_1^h \overline{P}_1}{\overline{P}_2^h}[r^f - r^h]$$

The terms w_2^h and w_2^f capture the total portfolio weight effect, which can be decomposed into the previous price effects $\widehat{w}_2^h$ and $\widehat{w}_2^f$ and the reallocation effects $w_2^h - \widehat{w}_2^h$ and $w_2^f - \widehat{w}_2^f$ due to changes in the holdings. Again, linearizing the total portfolio weight change effect implies

$$w_2^h = \widehat{w}_2^h + \frac{[1 - (1+r)(\beta + \gamma)]\, d^h}{\rho \sigma_V^2} - \frac{(1+r)(\beta - \gamma) d^f}{\rho \sigma_V^2}$$
$$w_2^f = 1 - w_2^h = \widehat{w}_2^f - \frac{[1 - (1+r)(\beta + \gamma)]}{\rho \sigma_V^2} d^h + \frac{(1+r)(\beta - \gamma)}{\rho \sigma_V^2} d^f.$$

The portfolio rebalancing statistics PB^f is simply given by

$$PB^f = w_2^f - \widehat{w}_2^f = -\frac{[1 - (1+r)(\beta + \gamma)]}{\rho \sigma_V^2} d^h + \frac{(1+r)(\beta - \gamma)}{\rho \sigma_V^2} d^f$$

and its covariance with the foreign excess return in eq. (8) follows as

$$Cov\left[PB^f, r^f(h) - r^h(h)\right] = Cov\left[w_2^f - \widehat{w}_2^f, r^f - r^h\right] = \frac{1}{\rho\sigma_V^2\overline{P}_1}\left[2\gamma - \overline{P}_2\theta\right]\left[1 - (1+r)2\gamma\right]\sigma_d^2 < 0$$

because

$$\begin{aligned} 2\gamma - \overline{P}_2\theta &> 0 \\ \left[1 - (1+r)2\gamma\right] &= \frac{2\rho\sigma_V^2\sigma_e^2\sigma_V^2 - \sigma_V^2\left[2\sigma_V^2 + \sigma_e^2\right]}{\left(2\sigma_V^2 + \sigma_e^2\right)^2} < 0 \text{ for } \rho < \frac{2\sigma_V^2 + \sigma_e^2}{2\sigma_V^2\sigma_e^2} = \overline{\rho}. \end{aligned}$$

Proof of Proposition 4: Portfolio Rebalancing Measures Based on Portfolio Risk
For portfolio risk changes defined in eqs. (1) and (2), we have to show that

$$\begin{aligned} Cov\left[\Delta Risk(w_2, \widehat{w}_2), \Delta Risk(\widehat{w}_2, w_1)\right] &< 0 \\ Cov\left[\Delta Risk^{Fx}(w_2, \widehat{w}_2), \Delta Risk^{Fx}(\widehat{w}_2, w_1)\right] &< 0. \end{aligned}$$

The matrices for the portfolio risks are

$$\begin{aligned} \Omega_1 &= \Omega_1^* = \begin{pmatrix} \sigma_d^2 + \sigma_V^2 & 0 \\ 0 & \sigma_d^2 + \sigma_V^2 + \sigma_e^2 \end{pmatrix} \\ \Omega_1^{Fx} &= \Omega_1^{Fx*} = \begin{pmatrix} 0 & 0 \\ 0 & \sigma_e^2 \end{pmatrix} \end{aligned}$$

$$\begin{aligned} \Omega_2 &= \begin{pmatrix} \sigma_V^2 & 0 \\ 0 & \sigma_V^2 + (1+d^f)^2\sigma_e^2 \end{pmatrix} & \Omega_2^* &= \begin{pmatrix} \sigma_V^2 & 0 \\ 0 & \sigma_V^2 + (1+d^h)^2\sigma_e^2 \end{pmatrix} \\ \Omega_2^{Fx} &= \begin{pmatrix} 0 & 0 \\ 0 & (1+d^f)^2\sigma_e^2 \end{pmatrix} & \Omega_2^{Fx*} &= \begin{pmatrix} 0 & 0 \\ 0 & (1+d^h)^2\sigma_e^2 \end{pmatrix}. \end{aligned}$$

A first order Taylor expansion around the steady state with $d^h = d^f = 0$ gives

$$\begin{aligned} \Delta Risk^{Fx}(\widehat{w}_2, w_1)/\sigma_e^2 &= \left(\widehat{w}_2\Omega_2^{Fx}\widehat{w}_2^T - w_1\Omega_1^{Fx}w_1^T\right)/\sigma_e^2 \\ &\approx \left(2(\overline{x}_1^f)^2 + 2\overline{x}_1^f\frac{\overline{x}_1^f\overline{x}_1^h}{\overline{P}_2^h}\left[2\gamma - \overline{P}_2^h\theta\right]\right)(d^f - 0) - 2\overline{x}_1^f\frac{\overline{x}_1^f\overline{x}_1^h}{\overline{P}_2^h}\left[2\gamma - \overline{P}_2^h\theta\right](d^h - 0) \\ \Delta Risk^{Fx}(w_2, \widehat{w}_2)/\sigma_e^2 &= \left(w_2\Omega_2^{Fx}w_2^T - \widehat{w}_2\Omega_2^{Fx}\widehat{w}_2^T\right)/\sigma_e^2 = \\ &\approx -2\overline{x}_1^f\frac{\left[1 - (1+r)\left(\beta + \gamma\right)\right]}{\rho\sigma_V^2}(d^h - 0) + 2\overline{x}_1^f\frac{(1+r)(\beta - \gamma)}{\rho\sigma_V^2}(d^f - 0). \end{aligned}$$

The covariance of the exchange rate risk change (around the steady state with $d^h = d^f = 0$) follows as

$$\begin{aligned} Cov\left[\Delta Risk^{Fx}(w_2, \widehat{w}_2), \Delta Risk^{Fx}(\widehat{w}_2, w_1)\right]/\sigma_e^4 &= \mathcal{E}\left[\Delta Risk^{Fx}(w_2, \widehat{w}_2) \times \Delta Risk^{Fx}(\widehat{w}_2, w_1)\right] \\ &= \frac{4(\overline{x}_1^f)^3{\sigma_d}^2}{\rho\sigma_V^2}\left[(1+r)(\beta - \gamma) + \frac{\overline{x}_1^h}{\overline{P}_2^h}\left[2\gamma - \overline{P}_2^h\theta\right]\left[1 - (1+r)2\gamma\right]\right]. \end{aligned}$$

The covariance of the full equity risk change is given by

$$\begin{aligned} Cov\left[\Delta Risk(w_2, \widehat{w}_2), \Delta Risk(\widehat{w}_2, w_1)\right] &= \mathcal{E}\left[\Delta Risk(w_2, \widehat{w}_2) \times \Delta Risk(\widehat{w}_2, w_1)\right] \\ &= 2\left(\overline{x}_1^h - \overline{x}_1^f\right)4\sigma_V^2(\overline{x}_1^h)^2\frac{\overline{x}_1^f}{\overline{P}_2^h}\left[2\gamma - \overline{P}_2^h\theta\right]\left[1 - (1+r)2\gamma\right]\frac{\sigma_d^2}{\rho}. \end{aligned}$$

Both covariances are negative because $\beta - \gamma < 0$, $2\gamma - \overline{P}_2^h\theta > 0$, $\overline{x}_1^h - \overline{x}_1^f > 0$, and $1 - (1+r)2\gamma < 0$ for $\rho < \overline{\rho}$.

Data Appendix

Thomson Financial Securities provided us with the following four data files: (i) the 'Holding Master File', containing the fund number, fund name, management company name, country code of the fund incorporation, reporting date, stock identifier, country code of the stock, and stock position (number of stocks held); (ii) the 'Security Price File', containing the stock identifier, the currency denomination of the stock price, reporting dates for which holding data is available, security price on the reporting date and the security price on the closest previous days in case the reporting date had no price information on the security; (iii) the 'Return File' containing the stock identifier, the country code of the stock, the total return index (including dividend reinvestments) in local currency; (iv) 'Exchange Rate File' containing daily dollar exchange rates for all investment destinations.

In a first step, we match holding data for each fund with holding data in the same fund in the two previous half-years. Holding data for which no holding date is reported in the previous half-year is discarded. Additional holding data from half-year $t-2$ is matched whenever available. For each fund we retain only the latest reporting date within a half-year as long as this reporting date is within 100 day from the end of the half-year. The price from the 'Security Price File', the return data from the 'Return File' and the exchange rate data from the 'Exchange Rate File' is matched for the same reporting date as the holding data. If the price or return data is not available, we search for the nearest previous date with available data.

Similar to Calvet and Campbell (2007), we use a sequence of data filters to eliminate the role of reporting errors in the data. We focus on the 4 largest fund domiciles, namely the U.S., Canada, U.K. and the Euro area. All small funds with a capitalization of less than \$10 million are deleted. These small funds might represent incubator funds or other non-representative entities. Funds with a growth in total assets growth over the half-year of more than 200 percent or less than -50 percent are also discarded. Finally we treat as missing those stock observations for which the return exceeds 500 percent or is below -80 percent. Missing observations do not enter into the calculation of the stock weights or the foreign excess returns. Two additional selection criteria guarantee a minimal degree of fund diversification. We ignore funds with less and 5 foreign stocks and less than 5 domestic stocks in their portfolio. Pure country funds or pure domestic funds are thereby excluded from the sample. Secondly, all funds with a Herfindahl-Hirschman index over all stock weights above 20 percent are discarded. This fund concentration threshold is surpassed if a fund holds more than $\sqrt{0.2} \approx 0.447$ percent in a single stock. Funds with such extreme stock weights are unlikely to exhibit risk diversification considerations. The latter criterion eliminates approximately 4,100 fund periods from the sample. We verify that the qualitative conclusions of our analysis is robust to changes in the fund concentration threshold.

Additional computational consideration are required for the calculation of the covariance matrix for each fund period. For a fund period t, we use a covariance estimate based on (log) return data over consecutive trading days in the 3 half-years $S = \{t-1, t-2, t-3\}$. Such a data window implies typically up to $n = 380$ return observations for the estimation of each covariance element of the matrix. We discard as data outliers daily log returns above 50 percent and below -50 percent for both the exchange rate and the equity returns. Separate covariances are calculated for stock returns measured under constant exchange rates and for stock return converted into the currency of the fund domicile. This allows the calculation of the FX component of the portfolio risk as the difference of the two covariances. The incompleteness of the return sequence for some stocks and exchange rates requires that each covariance element be calculated individually. If the number of common return pairs for any covariance element dropped below 50 observations, we marked the corresponding covariance element as missing. Missing elements are replaced be the average covariance of the row vector. To track the degree of incompleteness of the covariance matrix, we created a quality matrix Q_{jt-1} which marks all missing elements by one and all computable elements by zero. The risk based analysis in Tables 5 to 7 uses the matrix Q_{jt-1} as an additional censoring criterion for fund inclusion. We only used fund periods for which the products $\widehat{w}_{j,t}Q_{j,t-1}\widehat{w}_{j,t}^T$, $\widehat{w}_{j,t}Q_{j,t-1}\widehat{w}_{j,t}^T, w_{j,t-1}Q_{j,t-1}w_{j,t-1}^T$ remains below 0.2. Funds with more than 20 percent (value weighted) missing covariance elements are discarded. Again we check that the results are qualitatively stable with respect to modifications of this quality threshold for estimation of the covariance matrix.

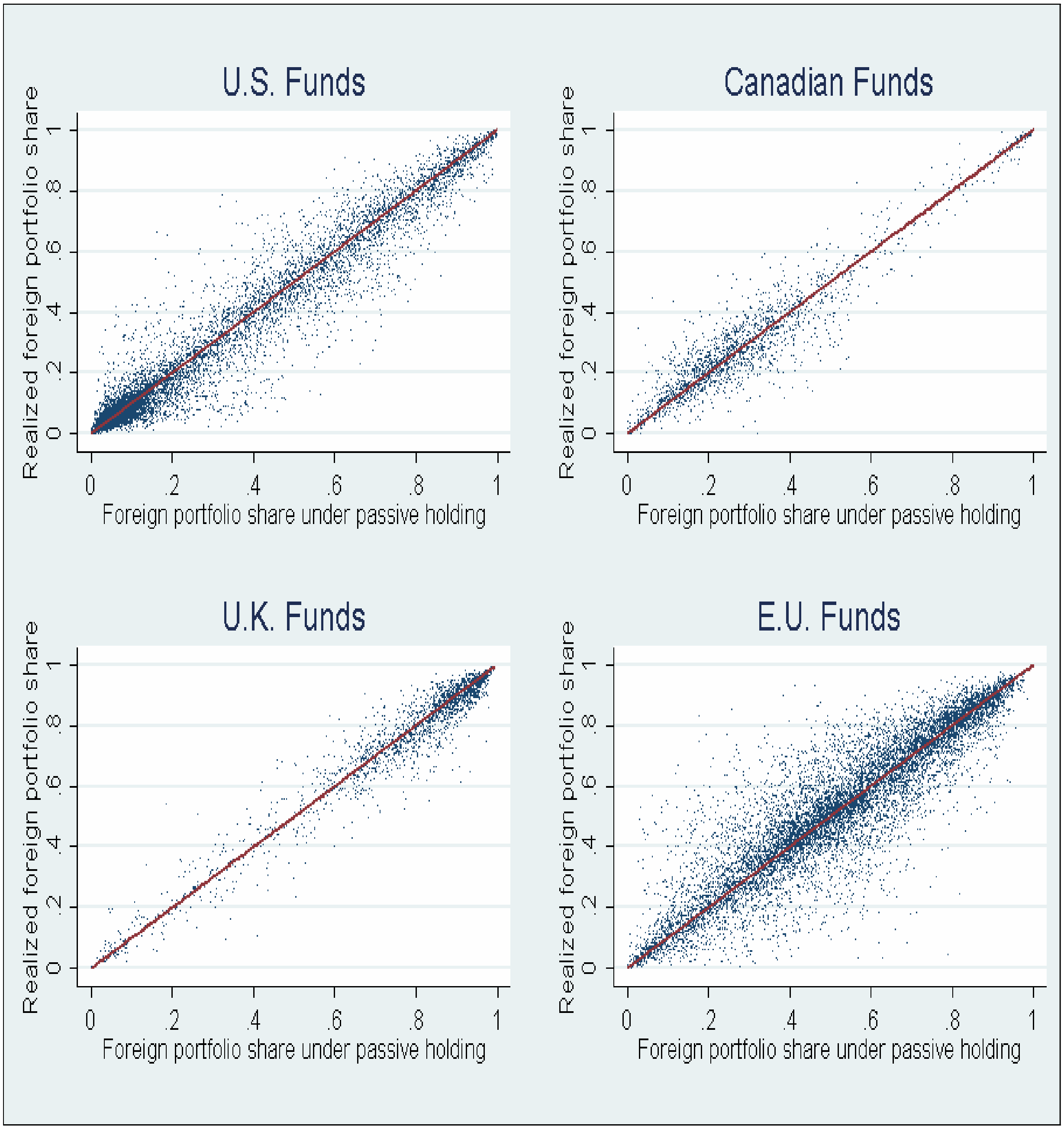

Figure 1: We plot the realized foreign portfolio share w_t relative to the portfolio share $\widehat{w}_t$ implied by a passive holding strategy for funds domiciled in the U.S., Canada, U.K. and the Euro area. The vertical distance from the 45 degree line characterizes active rebalancing measure $RB^f_{j,t}$.

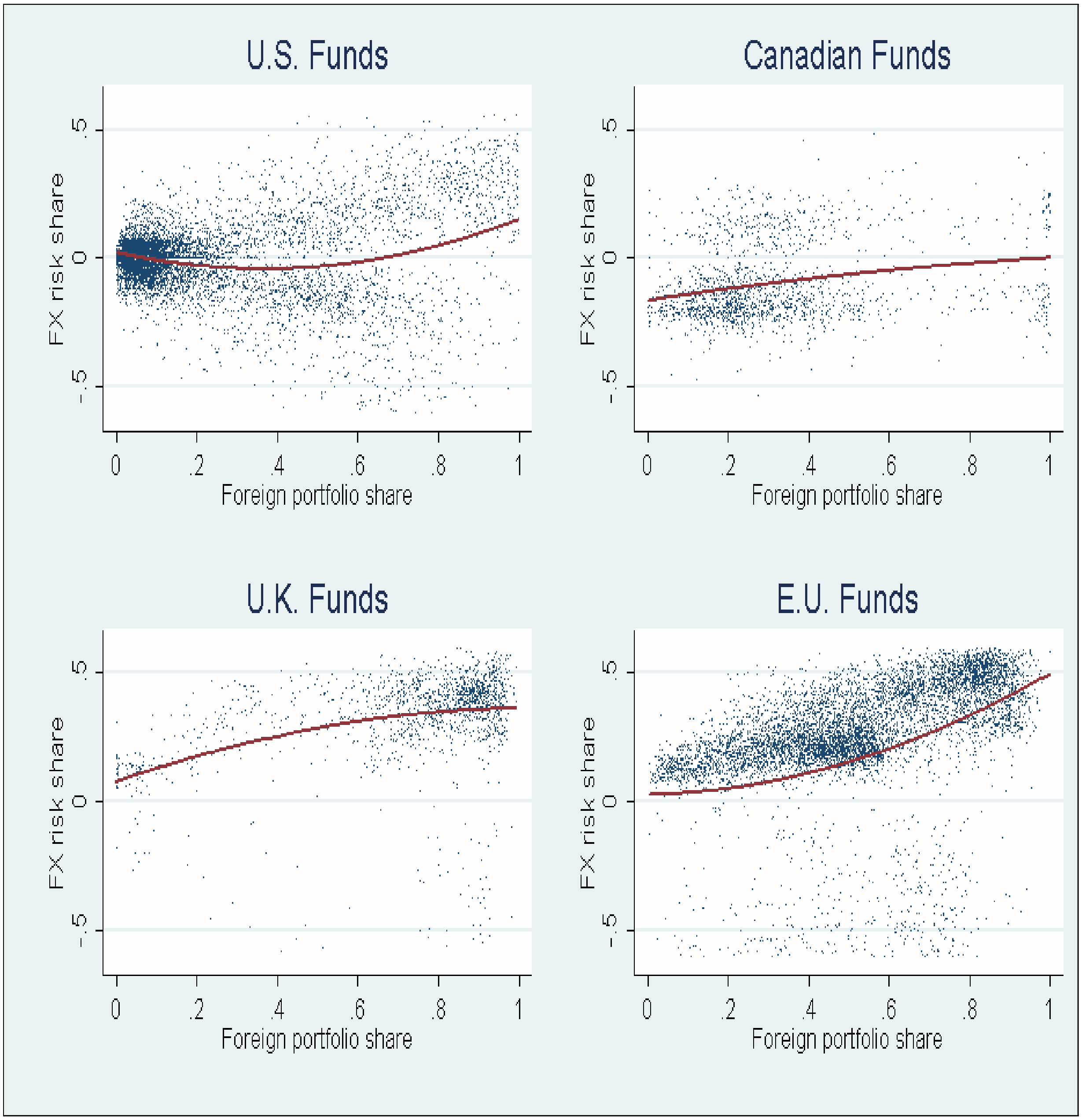

Figure 2: We define the FX risk share of a fund as the percentage contribution of FX risk to the standard deviation of total portfolio risk. It is plotted against the fund's foreign portfolio shares. The graphs pool half-annual observations from 10 semesters from 1998 to 2002. The fitted red line denotes the estimated conditional mean.

Table 1: Geographic Holding Correlation with IMF Data

For funds domiciled in the United States (US), Canada (CA), the United Kingdom (UK) and the Euro area (EU) we correlate the end of the year aggregate asset holdings in each of 97 investment destination countries with the corresponding asset holdings reported in 'Coordinated Portfolio Investment Survey' of the IMF.

Country of Fund Registration	Correlations	
	Year 2001	Year 2002
US	0.93	0.94
CA	0.99	0.99
UK	0.95	0.97
EU	0.81	0.73
Average	0.92	0.91

Table 2: Summary Statistics on Fund Holdings

For funds domiciled in the United States (US), Canada (CA), the United Kingdom (UK) and the Euro area (EU) we report by half-year (Panel A) and by investment destination (Panel B) the number of funds, their total number of stock positions, and the corresponding asset value (in $billion).

Panel A: Summary Statistics by Semester

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Fund domicile	US			CA			UK			EU			Pooled		
Half-year	Funds	Positions	Value	Funds	Positions	Value	Funds	Positions	Value	Funds	Positions	Value	Funds	Positions	Value
1998/1	955	199,113	2,436	144	17,195	57	135	20,153	147	348	31,201	162	1,582	267,662	2,803
1998/2	943	199,101	2,377	163	17,506	56	137	17,750	117	426	35,709	205	1,669	270,066	2,755
1999/1	962	212,884	2,360	179	19,596	65	147	21,414	184	663	62,177	267	1,951	316,071	2,876
1999/2	1,028	231,287	2,533	191	21,197	69	188	28,999	179	950	89,843	348	2,357	371,326	3,130
2000/1	1,140	271,970	2,588	188	23,831	66	201	34,790	168	1,084	105,281	390	2,613	435,872	3,212
2000/2	1,288	310,916	2,383	202	25,431	65	209	35,193	148	1,085	101,203	331	2,784	472,743	2,927
2001/1	1,212	327,133	1,897	191	25,654	51	235	44,160	104	1,091	106,511	165	2,729	503,458	2,217
2001/2	1,328	349,364	1,731	191	27,137	48	269	48,261	91	1,532	148,140	190	3,320	572,902	2,060
2002/1	1,422	390,849	1,658	232	28,712	56	322	53,821	108	1,782	175,611	205	3,758	648,993	2,028
2002/2	1,276	318,963	1,180	244	24,537	52	368	63,366	94	1,784	177,159	182	3,672	584,025	1,509
Total	11,554	2,811,580	21,143	1,925	230,796	586	2,211	367,907	1,341	10,745	1,032,835	2,447	26,435	4,443,118	25,517

Panel B: Summary Statistics by Investment Destination

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Fund domicile.	US			CA			UK			EU			Pooled		
Investment destination	Funds	Positions	Value	Funds	Positions	Value	Funds	Positions	Value	Funds	Positions	Value	Funds	Positions	Value
US	11,554	2,373,630	17,612	1,924	109,805	124	1,745	81,543	205	7,273	217,955	343	22,496	2,782,933	18,284
CA	10,764	54,082	330	1,925	86,046	409	1,209	5,039	20	3,972	9,114	9	17,870	154,281	768
UK	9,290	72,029	488	1,096	6,648	7	2,211	88,511	243	10,408	138,512	230	23,005	305,700	968
EU	11,031	122,584	907	1,233	11,801	14	2,205	81,351	323	10,745	463,940	974	25,214	679,676	2,217
Other OECD	8,203	114,773	1,394	1,051	11,560	26	2,115	77,951	491	10,617	169,880	859	21,986	374,164	2,770
Off-shore	9,089	20,166	106	922	1,576	1	1,669	9,199	19	3,010	8,228	7	14,690	39,169	133
Emerg. Mkts	10,149	54,316	306	1,167	3,360	3	1,820	24,313	40	3,731	25,206	26	16,867	107,195	375
Total	70,080	2,811,580	21,143	9,318	230,796	586	12,974	367,907	1,341	49,756	1,032,835	2,447	142,128	4,443,118	25,517

Table 3: Summary statistics on regression variables

For each of the 4 fund domiciles (US, CA, UK, EU) we report summary statistics on all regresssion variables. The rebalancing statistices $RB^f_{j,t}$ for fund j in semester t states the aggregate weight change of the foreign investment share relative to the weight of a passive holding strategy. The term $r^f_{j,t} - r^h{}_{j,t}$ denotes the excess return performance of the foreign portfolio share over the domestic share. Portfolio risk changes $\Delta Risk(w_{j,t}, \widehat{w}_{j,t})$ characterize the portfolio risk difference between the observed weights $w_{j,t}$ and weights $\widehat{w}_{j,t}$ of a passive holding strategy. The change in the marginal risk contribution of stock i to the portfolio risk of fund j due to rebalancing from weights $\widehat{w}_{j,t}$ to $w_{j,t}$ is denoted by $\Delta MRisk(i, w_{j,t}, \widehat{w}_{j,t})$. In each case we distinguish the foreign exchange risk component of the total portfolio risk by a superscript Fx. For all regression variables the 1 percent highest and lowest values are discarded.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Fund Reg.	US			CA			UK			EU			Pooled		
Variable	Obs.	Mean	S.D.	Obs.	Mean	S.D.	Obs.	Mean	S.D.	Obs.	Mean	S.D.	Obs.	Mean	S.D.
Total Assets (USD millions)	11,554	1,830	8,224	1,925	304	502	2,211	607	2,744	10,745	228	837	26,435	965	5,576
Home Assets (USD millions)	11,554	1,524	6,727	1,925	213	386	2,211	110	338	10,745	91	303	26,435	728	4,509
Foreign Assets (USD millions)	11,554	306	2,271	1,925	92	157	2,211	497	2,546	10,745	137	619	26,435	237	1,723
$RB^f_{j,t}$	11,554	−0.420	6.091	1,925	0.331	6.972	2,211	−0.654	5.453	10,745	0.883	10.093	26,435	0.145	8.004
$\left[r^f_{j,t} - r^h{}_{j,t}\right]$	11,554	−0.022	0.176	1,925	−0.021	0.191	2,211	−0.012	0.148	10,745	0.002	0.142	26,435	−0.011	0.162
$\left[r^f_{j,t} - r^h{}_{j,t}\right] \times 1_{\Delta r \geq 0}$	11,554	0.055	0.098	1,925	0.060	0.122	2,211	0.048	0.088	10,745	0.054	0.083	26,435	0.054	0.094
$\left[r^f_{j,t} - r^h{}_{j,t}\right] \times 1_{\Delta r \leq 0}$	11,554	−0.078	0.113	1,925	−0.080	0.109	2,211	−0.060	0.092	10,745	−0.052	0.088	26,435	−0.066	0.102
$\left[r^f_{j,t-1} - r^h{}_{j,t-1}\right]$	10,562	−0.034	0.223	1,759	−0.037	0.228	1,822	−0.024	0.185	8,883	0.000	0.169	23,026	−0.020	0.202
$\Delta Risk(w_{j,t}, \widehat{w}_{j,t})$	9,462	−0.045	0.321	1,609	−0.042	0.219	1,468	−0.034	0.300	7,286	−0.029	0.298	19,821	−0.038	0.302
$\Delta Risk^{Fx}(w_{j,t}, \widehat{w}_{j,t})$	9,462	0.001	0.021	1,609	0.000	0.018	1,468	0.002	0.063	7,286	−0.001	0.084	19,821	0.000	0.049
$\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})$	9,462	−0.022	0.225	1,609	0.016	0.156	1,468	0.003	0.105	7,286	0.005	0.109	19,821	−0.006	0.168
$\Delta Risk^{Fx}(\widehat{w}_{j,t}, w_{j,t-1})$	9,462	−0.000	0.007	1,609	0.001	0.007	1,468	−0.002	0.020	7,286	0.001	0.024	19,821	0.000	0.015
$\Delta MRisk(i, w_{j,t}, \widehat{w}_{j,t})$	3,767,383	−0.005	0.150	310,063	−0.004	0.121	408,072	0.007	0.141	1,070,933	0.005	0.168	5,556,447	−0.002	0.151
$\Delta MRisk^{Fx}(i, w_{j,t}, \widehat{w}_{j,t})$	3,767,383	0.000	0.010	310,063	−0.000	0.015	408,072	0.001	0.035	1,070,933	−0.001	0.045	5,556,447	0.000	0.020
$\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1})$	3,767,383	−0.031	0.124	310,063	−0.013	0.082	408,072	−0.001	0.038	1,070,933	−0.002	0.051	5,556,447	−0.021	0.102
$\Delta MRisk^{Fx}(i, \widehat{w}_{j,t}, w_{j,t-1})$	3,767,383	−0.000	0.003	310,063	0.000	0.005	408,072	−0.000	0.010	1,070,933	0.001	0.012	5,556,447	0.000	0.006

Table 4: Rebalancing of the Foreign Portfolio Share

The portfolio rebalancing statistics $RB_{j,t} = w^f_{jt} - \widehat{w}^f_{jt}$ of fund j in semester t is defined as the observed foreign portfolio share w^f_{jt} at the end of a semester minus the implied foreign portfolio share $\widehat{w}^f_{jt}$ under passive asset holding strategy over the same semester. We regress $RB_{j,t}$ on the excess return $r^f_{j,t-k} - r^h{}_{j,t-k}$ of the foreign over the home component of the portfolio and also its decomposition into positive and negative excess returns using dummy variables for positive ($1_{\Delta r \geq 0}$) and negative ($1_{\Delta r \leq 0}$) excess returns, respectively. Separate regressions results are reported for funds registered in the United States (US), Canada (CA), the United Kingdom (UK).and the Euro currency area (EU). Our sample spans each semester between 1998 and 2002. We also include fixed time effects (unreported) for each half-year. The IV regression used the foreign portfolio share of each fund in $t-1$ interacted with fixed time effects as instruments. Robust standard errors are stated below the coefficients. We mark significance on a 5 percent level (*) and a 1 percent level (**).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Fund domicile	US				CA				UK				EU				Pooled			
Regression type	OLS	OLS	OLS	IV	OLS	OLS	OLS	IV	OLS	OLS	OLS	IV	OLS	OLS	OLS	IV	OLS	OLS	OLS	IV
$\left[r^f_{j,t} - r^h{}_{j,t}\right]$	−3.63**			−12.25**	−9.54**			−8.11**	−3.74**			1.15	−6.04**			−1.92	−4.94**			−11.10**
	(0.31)			(1.53)	(0.97)			(1.86)	(0.96)			(6.28)	(0.87)			(6.19)	(0.32)			(1.34)
$\left[r^f_{j,t} - r^h{}_{j,t}\right] \times 1_{\Delta r \geq 0}$		−5.29**				−11.47**				−1.72				−10.66**				−6.79**		
		(0.66)				(1.83)				(1.55)				(1.51)				(1.3)		
$\left[r^f_{j,t} - r^h{}_{j,t}\right] \times 1_{\Delta r \leq 0}$		−2.31**				−7.73**				−5.72**				−1.74				−3.37**		
		(0.53)				(1.57)				(1.79)				(1.49)				(1.1)		
$\left[r^f_{j,t-1} - r^h{}_{j,t-1}\right]$			−2.43**				−4.00**				−2.42**				−2.81**				−2.62**	
			(0.28)				(0.86)				(0.84)				(0.76)				(0.28)	
Constant	−0.46**	−0.28**	−0.57**	−1.27**	0.11	0.36	0.26	0.38	−0.70**	−0.90**	−0.68**	−0.27	0.87**	1.30**	0.79**	0.88	0.07	0.26**	0.01	−0.91
	(0.05)	(0.08)	(0.05)	(0.19)	(0.14)	(0.22)	(0.15)	(0.51)	(0.10)	(0.16)	(0.11)	(0.42)	(0.08)	(0.14)	(0.09)	(1.21)	(0.04)	(0.07)	(0.04)	(0.71)
Fixed time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	11, 102	11, 102	10, 149	10, 149	1, 850	1, 850	1, 692	1, 692	2, 126	2, 126	1, 757	1, 757	10, 321	10, 321	8, 539	8, 539	25, 388	25, 388	22, 136	22, 136
Adjusted R^2	0.025	0.025	0.018	0.000	0.084	0.085	0.054	0.089	0.038	0.038	0.042	0.036	0.046	0.047	0.044	0.047	0.045	0.045	0.040	0.030
F-statistic first stage				111.58				43.03				28.14				153.53				77.46

Table 5: Portfolio Risk Rebalancing

The risk rebalancing measure $\Delta Risk(w_{j,t}, \widehat{w}_{j,t})$ for fund j in semester t is regressed on the risk change $\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})$ between weights $\widehat{w}_{j,t}$ implied by a passive holding strategy and the risk of the the original weights $w_{j,t-1}$ observed at the end of semester $t-1$. We undertake separate regressions for funds domiciled in the United States (US), Canada (CA), the United Kingdom (UK) and the Euro currency area (EU), respectively. The IV regression uses time fixed effects interacted with fund domicile dummies as instruments. Panel A reports the risk rebalancing regression for the total equity risk $\Delta Risk$ measured in local currency of the fund domicile and Panel B reports risk rebalancing regression for the exchange rate component $\Delta Risk^{Fx}$ of the portfolio risk. The unbalanced panel includes fund data for 10 semesters over the period 1998 to 2002. All regressions include fixed effects for each half-year and report standard errors which allow for clustering of the error structure on the fund level. Robust standard errors are stated below the coefficients. We mark significance on a 5 percent level (*) and a 1 percent level (**).

Panel A: Equity Risk Rebalancing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Fund domicile	US			CA			UK			EU			Pooled		
Regression type	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV
$\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})$	−0.17**	−0.20**	−0.31**	−0.39**	−0.36**	−0.28**	−0.07	−0.05	0.06	−0.44**	−0.43**	−0.26	−0.24**	−0.25**	−0.29**
	(0.03)	(0.02)	(0.03)	(0.07)	(0.06)	(0.08)	(0.14)	(0.14)	(0.27)	(0.05)	(0.05)	(0.16)	(0.02)	(0.02)	(0.03)
Fixed time effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Obs.	9,323	9,323	9,323	1,583	1,583	1,583	1,452	1,452	1,452	7,181	7,181	7,181	19,520	19,520	19,520
Funds	2,614	2,614	2,614	349	349	349	552	552	552	2,963	2,963	2,963	6,485	6,485	6,485
Adjusted R^2	0.046	0.020	0.014	0.092	0.070	0.066	0.027	0.000	0.000	0.033	0.027	0.021	0.038	0.020	0.019
F-statistic first stage			264.94			62.27			16.18			46.82			107.63

Panel B: FX Portfolio Risk Rebalancing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Fund domicile.	US			CA			UK			EU			Pooled		
Regression type	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV
$\Delta Risk^{Fx}(\widehat{w}_{j,t}, w_{j,t-1})$	−0.34**	−0.35**	−0.47	−0.27**	−0.27**	−0.41	−0.45**	−0.48**	−0.64	−0.21*	−0.21**	−0.36	−0.23**	−0.24**	−0.35
	(0.10)	(0.10)	(0.30)	(0.10)	(0.10)	(0.30)	(0.17)	(0.17)	(0.38)	(0.09)	(0.08)	(0.53)	(0.06)	(0.06)	(0.24)
Fixed time effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Obs.	9,347	9,347	9,347	1,587	1,587	1,587	1,450	1,450	1,450	7,164	7,164	7,164	19,531	19,531	19,531
Funds	2,599	2,599	2,599	350	350	350	551	551	551	2,946	2,946	2,946	6,421	6,421	6,421
Adjusted R^2	0.028	0.013	0.011	0.024	0.014	0.011	0.037	0.024	0.021	0.008	0.004	0.002	0.013	0.005	0.004
F-statistic first stage			30.45			12.29			33.49			17.08			25.34

Table 6: Portfolio Risk Rebalancing by Fund Size

Similar to Table 5, the risk rebalancing measure $\Delta Risk(w_{j,t}, \widehat{w}_{j,t})$ for fund j in semester t is regressed on the risk change $\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})$ between weights $\widehat{w}_{j,t}$ implied by a passive holding strategy and the risk of the the original weights $w_{j,t-1}$ observed at the end of semester $t-1$. We undertake separate regressions for funds domiciled in the United States (US), Canada (CA), the United Kingdom (UK) and the Euro currency area (EU), respectively. Funds are grouped in the small or large group based on a fund capitalization below or above the 50 percent quantile in a given semester. Panel A reports the risk rebalancing regression for the total equity risk $\Delta Risk$ measured in local currency of the fund domicile and Panel B reports risk rebalancing regressions for the exchange rate component $\Delta Risk^{Fx}$ of the portfolio risk. The unbalanced panel includes fund data for 10 semesters over the period 1998 to 2002. All regressions include fixed effects for each half-year and report standard errors which allow for clustering of the error structure on the fund level. Robust standard errors are stated below the coefficients. We mark significance on a 5 percent level (*) and a 1 percent level (**).

Panel A: Equity Risk Rebalancing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Fund domicile.		US			CA			UK			EU			Pooled	
Fund size	Small	Large	All	Small	Large	All	Small	Large	All	Small	Large	All	Small	Large	All
$\Delta Risk(\widehat{w}_{j,t}, w_{j,t-1})$	-0.20^{**}	-0.15^{**}	-0.17^{**}	-0.41^{**}	-0.38^{**}	-0.39^{**}	0.05	-0.19	-0.07	-0.45^{**}	-0.44^{**}	-0.44^{**}	-0.28^{**}	-0.22^{**}	-0.24^{**}
	(0.04)	(0.04)	(0.03)	(0.10)	(0.09)	(0.07)	(0.19)	(0.20)	(0.14)	(0.07)	(0.07)	(0.05)	(0.03)	(0.03)	(0.02)
Fixed time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	4,407	4,916	9,323	797	786	1,583	722	730	1,452	3,646	3,535	7,181	9,172	10,348	19,520
Funds	1,608	1,267	2,614	230	176	349	331	271	552	1,747	1,424	2,963	3,904	3,183	6,485
Adjusted R^2	0.044	0.051	0.046	0.093	0.099	0.092	0.026	0.041	0.027	0.033	0.036	0.033	0.036	0.045	0.038

Panel B: FX Portfolio Risk Rebalancing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Fund domicile.		US			CA			UK			EU			Pooled	
Fund size	Small	Large	All	Small	Large	All	Small	Large	All	Small	Large	All	Small	Large	All
$\Delta Risk^{Fx}(\widehat{w}_{j,t}, w_{j,t-1})$	-0.40^{**}	-0.26	-0.34^{**}	-0.24	-0.28^{*}	-0.27^{**}	-0.33	-0.56^{*}	-0.45^{**}	-0.25^{*}	-0.14	-0.21^{*}	-0.26^{**}	-0.16^{*}	-0.23^{**}
	(0.14)	(0.13)	(0.10)	(0.16)	(0.13)	(0.10)	(0.24)	(0.24)	(0.17)	(0.11)	(0.13)	(0.09)	(0.08)	(0.08)	(0.06)
Fixed time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	4,436	4,911	9,347	800	787	1,587	724	726	1,450	3,622	3,542	7,164	9,103	10,428	19,531
Funds	1,609	1,258	2,599	230	176	350	330	270	551	1,735	1,421	2,946	3,852	3,175	6,421
R^2	0.022	0.022	0.028	0.017	0.042	0.024	0.023	0.27	0.037	0.011	0.008	0.008	0.018	0.015	0.013

Table 7: Marginal Stock Risk Rebalancing Conditional on Marginal RiskDirection and Portfolio Risk Direction

For each stock i held by each fund j the marginal risk change $\Delta MRisk(i, w_{j,t}, \widehat{w}_{j,t})$ in stock i due to rebalancing is regressed on the marginal risk change under a passive holding strategy denoted by $\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1})$. The latter is interacted with a set of dummy variables for the sign of the passive marginal risk change $\Delta MRisk$ in stock i and the passive portfolio risk change $\Delta Risk$ of fund j. Panel A reports regressions for the the total marginal risk changes in the currency of the fund domicile and Panel B reports the corresponding regressions on for the FX component of the marginal risk, where the covariance matrix is replaced by a covariance matrix capturing only the FX risk. Formally the dependent variables are defined as

$$\begin{aligned} \Delta MRisk(i, w_{j,t}, \widehat{w}_{j,t}) &= (\widehat{\Omega}_{j,t-1})_{i\bullet}(\widehat{w}_{j,t+1} - w_{j,t})^T \\ \Delta MRisk^{Fx}(i, w_{j,t}, \widehat{w}_{j,t}) &= (\widehat{\Omega}_{j,t-1})^{Fx}_{i\bullet}(\widehat{w}_{j,t+1} - w_{j,t})^T \end{aligned}$$

where $(\widehat{\Omega}_{j,t})_{i\bullet}$ represents the i-th row of the covariance matrix of stocks held by fund j. A marginal risk increase in stock i is marked by a dummy $1_{\Delta MRisk\geq 0}$ and a marginal risk decrease by the dummy $1_{\Delta MRisk<0}$. These dummies are interacted with a second conditioning dummy $1_{\Delta Risk\geq 0}$ denoting a passive portfolio risk increase in portfolio j or a dummy $1_{\Delta Risk<0}$ denoting a passive portfolio risk decrease. Panel A reports regressions for the the total marginal risk changes measured in the currency of the fund domicile and Panel B reports the corresponding regressions for the FX component of the marginal risk. All regressions include fixed effects for each half-year and report standard errors which allow for clustering of the error structure on the fund level. Robust standard errors are stated below the coefficients. We mark significance on a 5 percent level (*) and a 1 percent level(**).

Panel A: Marginal Stock Risk Rebalancing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fund Reg.	US		CA		UK		EU		Pooled	
Symmetry Imposed?	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
$\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk\geq 0} \times 1_{\Delta Risk\geq 0}$	-1.01^{**}		-0.92^{**}		-1.00^{**}		-1.30^{**}		-1.05^{**}	
	(0.03)		(0.06)		(0.17)		(0.05)		(0.03)	
$\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk<0} \times 1_{\Delta Risk\geq 0}$	0.39^{**}		0.28^{**}		0.65^{**}		0.79^{**}		0.41^{**}	
	(0.06)		(0.04)		(0.17)		(0.05)		(0.02)	
$\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk\geq 0} \times 1_{\Delta Risk<0}$	0.50^{**}		0.20^{**}		0.69^{**}		0.81^{**}		0.55^{**}	
	(0.04)		(0.07)		(0.14)		(0.05)		(0.03)	
$\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk<0} \times 1_{\Delta Risk<0}$	-0.48^{**}		-0.44^{**}		-1.13^{**}		-1.03^{**}		-0.52^{**}	
	(0.02)		(0.06)		(0.10)		(0.04)		(0.02)	
$\Delta MRisk(i, \widehat{w}_{j,t}, w_{j,t-1}) \times sign(\Delta MRisk) \times sign(\Delta Risk)$		-0.46^{**}		-0.41^{**}		-0.88^{**}		-0.99^{**}		-0.51^{**}
		(0.01)		(0.04)		(0.06)		(0.02)		(0.01)
Fixed time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	3,709,512	3,709,512	305,444	305,444	402,145	402,145	1,054,530	1,054,530	5,470,427	5,470,427
Funds	2,637	2,637	349	349	548	548	2,964	2,964	6,498	6,498
R^2	0.197	0.181	0.103	0.085	0.061	0.057	0.095	0.092	0.151	0.138

Panel B: Marginal FX Risk Rebalancing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fund Reg.	US		CA		UK		EU		Pooled	
Symmetry Imposed	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
$\Delta MRisk^{Fx}(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk\geq 0} \times 1_{\Delta Risk\geq 0}$	-0.48^{**}		-0.77^{**}		-1.61^{**}		-1.91^{**}		-1.37^{**}	
	(0.07)		(0.17)		(0.17)		(0.09)		(0.05)	
$\Delta MRisk^{Fx}(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk<0} \times 1_{\Delta Risk\geq 0}$	0.32^{**}		0.30^{*}		1.07^{**}		1.53^{**}		0.98^{**}	
	(0.08)		(0.14)		(0.16)		(0.08)		(0.06)	
$\Delta MRisk^{Fx}(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk\geq 0} \times 1_{\Delta Risk<0}$	0.73^{**}		0.48^{**}		0.83^{**}		1.54^{**}		1.08^{**}	
	(0.06)		(0.12)		(0.14)		(0.07)		(0.04)	
$\Delta MRisk^{Fx}(i, \widehat{w}_{j,t}, w_{j,t-1}) \times 1_{\Delta MRisk<0} \times 1_{\Delta Risk<0}$	-1.02^{**}		-1.25^{**}		-1.40^{**}		-1.64^{**}		-1.34^{**}	
	(0.08)		(0.12)		(0.12)		(0.06)		(0.05)	
$\Delta MRisk^{Fx}(i, \widehat{w}_{j,t}, w_{j,t-1}) \times sign(\Delta MRisk^{Fx}) \times sign(\Delta Risk^{Fx})$		-0.67^{**}		-0.71^{**}		-1.24^{**}		-1.67^{**}		-1.20^{**}
		(0.03)		(0.07)		(0.07)		(0.04)		(0.03)
Fixed time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	3,721,244	3,721,244	306,147	306,147	402,167	402,167	1,053,575	1,053,575	5,479,996	5,479,996
Funds	2,637	2,637	349	349	548	548	2,964	2,964	6,498	6,498
R^2	0.051	0.045	0.086	0.072	0.143	0.137	0.200	0.198	0.125	0.123