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**Global Asset Pricing**\*

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**Abstract**

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Financial markets have become increasingly global in recent decades, yet the pricing of internationally traded assets continues to depend strongly upon local risk factors, leading to several observations that are difficult to explain with standard frameworks. Equity returns depend upon both domestic and global risk factors. Further, local investors tend to overweight their asset portfolios in local equity. The stock prices of firms that begin to trade across borders increase in response to this information. Foreign exchange markets also display anomalous relationships. The forward rate predicts the wrong sign of future movements in the exchange rate, implying that traders can make profits by borrowing in lower interest rate currencies and investing in higher interest rate currencies. Furthermore, the sign of the foreign exchange premium changes over time, a fact difficult to reconcile with consumption variability. In this review, I describe the implications of the current body of research for addressing these and other global asset pricing challenges.

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## 1 Introduction

Financial markets have become increasingly global in recent decades. Indeed, the recent financial crisis highlighted the strong interlinkages among global capital markets. Therefore, the casual observer might logically presume that internationally traded assets are globally priced. Nevertheless, the body of international financial research shows that prices of globally traded assets depend upon local country-specific risks. While the importance of these local factors may be diminishing over time, studies continue to point to the significance of both global and local effects.

What are the country-specific effects that matter in a global financial market? These factors naturally surround differences in capital markets that are inherently national. First, many countries maintain their own monetary policy. Therefore, asset prices across countries often incorporate aspects of currency risk. Moreover, these differences in aggregate price policy can affect asset pricing relationships in models without money through real exchange rate changes. Second, countries often differ in the openness of the capital markets. These differences can either be explicit as in the case of a government policy to restrict capital movements. Or they can arise in more subtle forms due to higher informational costs to foreigners. Collectively, these differences are often called segmented capital markets. Finally, countries differ through government fiscal policy, affecting returns in various ways. For example, the government may tax returns directly or increase the perceived risk of future taxes. Alternatively, the government's fiscal behavior may generate perceived sovereign risk that impacts the returns of all securities from that country.

While monetary policy, fiscal policy, and segmented markets identify convenient groupings of factors affecting international asset pricing, they are by no means mutually exclusive. For example, international investors may perceive greater sovereign risk in a country with a large fiscal deficit and that country may also have more segmented capital markets.

Incorporating country-specific differences across countries into standard asset pricing relation-

ships leads to several observations that are difficult to explain with standard models. For example, equity returns depend upon both domestic and global risk factors. Moreover, this dependence on local factors is mirrored by a tendency for local investors to overweight their asset portfolios in local equity, an observation called the "home equity bias." Equity cross-listing events across international borders are also cited as evidence for segmentation. The stock price on these cross-listed firms increase around the listing date. Foreign exchange markets also display anomalous relationships. The most studied of these relationships is the "forward discount bias." The forward rate predicts the wrong sign of future movements in the exchange rate. Since forwards are tied to interest differences across countries, this bias implies that traders can make profits by borrowing at lower interest rate currencies and investing in higher interest rate currencies, generating a money-making strategy called the "carry trade." Furthermore, the sign of the foreign exchange premium changes over time, a fact difficult to reconcile with consumption variability.

In Section 2, I describe the literature on international equity markets and its relationship to the anomalies above. In Section 3, I illustrate the forward discount bias relationship along with proposed explanations. Section 4 provides a short discussion of research that has attempted to bring together different markets. Concluding remarks are provided in Section 5.

## 2 International Equity Pricing

To frame the discussion of international asset returns, consider a canonical framework based upon the seminal Lucas (1982) model. Representative consumer-investors live in  $J$  countries indexed by  $j$ , each endowed with a "tree" that pays out dividends in units of non-durable goods. The dividend payout at time  $t$  to investors in country  $j$  is defined as  $Y_t^j$ . Further, investors in each country  $j$  have common time additive utility, with period utility,  $U(C_t)$ , and discount factor  $\rho$ .<sup>1</sup> Thus, the intertemporal marginal rate of substitution of investor of country  $j$ , hereafter called the stochastic discount factor (SDF), is defined as:  $q_{t+1}^j = \rho U'(C_{t+1}^j)/U'(C_t^j)$  and the discount factor between time  $t$  and any future period period  $\tau$  is defined as:  $\delta_{t,\tau}^j \equiv \prod_{h=1}^{\tau} q_{t+h}^j = \rho U'(C_{t+\tau}^j)/U'(C_t^j)$ .

If the economy is fully segmented so that  $C_t^j = Y_t^j$ , the stock price of this country,  $\hat{z}_t^j$ , is given

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<sup>1</sup>Below I describe the implications of relaxing the time-additive utility assumption. To match many features of asset pricing data both in the closed and open economy, recursive utility such as in Epstein and Zin (1989) is required along with low frequency uncertainty in consumption.

by the standard closed-economy pricing relationship:

$$\widehat{z}_t^j = E_t \sum_{\tau=1}^{\infty} \widehat{\delta}_{t,\tau}^j Y_{t+\tau}^j \quad (1)$$

where in the closed-economy case the discount factor depends only on domestic output:  $\widehat{\delta}_{t,\tau}^j = \prod_{h=1}^{\tau} \widehat{q}_{t+h}^j = \rho U'(C_{t+\tau}^j)/U'(C_t^j) = [\rho U'(Y_{t+\tau}^j)/U'(Y_t^j)]$ .

Assume now that capital markets are open so that investors can trade claims on the endowment streams from other countries. If investors share the same time-additive isoelastic utility function such as CRRA and the endowments follow stationary processes, investors optimally choose to hold a world mutual fund paying out dividends from the aggregate endowments across countries:  $\bar{Y}_t \equiv \sum_{j=1}^J Y_t^j$ . Thus, the consumption of the investor in country  $j$  is now equal to its equity share in world output and is therefore proportional to world output so that  $C_t^j = \mu^j \bar{Y}_t$ .<sup>2</sup> In this case, the open economy price of country  $j$  in world markets,  $\bar{z}_t^j$ , is:

$$\bar{z}_t^j = E_t \sum_{\tau=1}^{\infty} \bar{\delta}_{t+\tau} Y_{t+\tau}^j \quad (2)$$

where the stochastic discount factor is now shared across countries so that  $\bar{\delta}_{t+\tau} = \prod_{h=1}^{\tau} \bar{q}_{t+h} = \rho U'(C_{t+\tau}^j)/U'(C_t^j) = [\rho U'(\bar{Y}_{t+\tau})/U'(\bar{Y}_t)]$ .

This very simple framework illustrates a key feature of the canonical international equity pricing. Under segmented markets, the equity price is determined by the stochastic discount factor derived from domestic output alone. In this case, relationships between equity prices simply depend upon the exogenous correlation of the endowment processes,  $Y_t^j$ . On the other hand, integrated markets imply that prices endogenously comove according to the common stochastic discount factor,  $\bar{q}_t$ .

This straightforward implication was one of the first international asset pricing relationships considered in the literature using excess returns of equities across countries. Defining the gross real return on equity as  $R_{t+1}^i \equiv [(z_{t+1}^i + Y_{t+1}^i)/z_t^i]$  and the gross real risk free rate as  $R_t^{rf}$ , the Euler equation implies:

$$E_t [r_{t+1}^i q_{t+1}^j] = 0 \quad (3)$$

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<sup>2</sup>For more discussion of this result, see for example Obstfeld (1994) and Lewis (2000). The share of consumption in world output is constant only under certain assumptions such as common time-additive iso-elastic utility and i.i.d. consumption growth. Below, I describe recent approaches that extend these assumptions.

where  $r_{t+1}^i \equiv R_{t+1}^i - R_t^{rf}$ , the excess return. Thus, when international equity markets are integrated, equation (3) and equation (2) imply that returns are priced by the covariance with a common global factor. By contrast, when markets are segmented as in equation (1) excess returns will be priced according to their covariance with local factors, potentially generating  $J$  many factors.

In this section, I review the literature on these relationships in three steps. First, I summarize the extensive literature that rejects the hypothesis that returns depend upon a set of common world factors in favor of models including local factors. Second, I discuss models that have attempted to relate these local factors to sources of country-specific idiosyncratic risk and to behavioral and informational asymmetries. Finally, I describe other features related to these models such as portfolio holdings and capital flows.

## 2.1 Global and Local Factors: The Empirical Evidence

The potential for a common global risk factor to determine international expected equity returns carries an obvious appeal. In early work, Solnik (1974b) and Grauer, Litzenberger, and Stehle (1976) described a world capital asset pricing model in which the standard Sharpe-Littner CAPM holds but the world market portfolio replaces the domestic market. Stulz (1981b) developed an intertemporal version of this model showing that all returns are determined by a common global source of risk under purchasing power parity. Solnik (1974a) and Stehle (1977) found that the World CAPM pricing relationship could not be rejected based upon unconditional mean returns. However, subsequent papers using conditional models found that the simple framework can be rejected and that local risks are important.<sup>3</sup> Nevertheless, the appeal of the simple model continues until today as the World CAPM is often used as a benchmark.<sup>4</sup>

To understand the implication of these rejections for international equity pricing, I next describe three groups of papers that empirically evaluate the World CAPM either directly or indirectly through global factors. The first group of papers analyzes the expected equity returns across countries at an aggregate market index level. The second group considers international equity pricing at the firm level. The third group of empirical studies assesses the importance of global

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<sup>3</sup>See Karolyi and Stulz (2003) for a survey.

<sup>4</sup>For example, the World CAPM is used as a benchmark in some studies of home bias (e.g., Ahearne, Grierer, and Warnock (2004)).

relative to local or country level risks. The results from these three different angles give a profile of international equity return behavior that have motivated various international asset pricing models I describe later in this review.

### 2.1.1 Explaining Aggregate International Equity Returns

Some of the earliest conditional tests of international equity returns were based upon the Euler equation relationship given in equation (3) following the pioneering work in foreign exchange by Hansen and Hodrick (1983). Rewriting the investor's Euler equation in terms of covariances and dropping the superscript on  $q$  without loss of generality implies:

$$E_t r_{t+1}^i = -Cov_t(R_{t+1}^i, q_{t+1}) R_t^{rf}. \quad (4)$$

Since equation (4) holds for any asset, the risk free rate can be substituted out to obtain the relationship:

$$E_t r_{t+1}^i = \frac{Cov_t(R_{t+1}^i, q_{t+1})}{Cov_t(R_{t+1}^b, q_{t+1})} E_t r_{t+1}^b \quad (5)$$

where  $r_{t+1}^b$  is the excess return on an arbitrary benchmark asset. A number of authors including Cumby (1990), Lewis (1991), Campbell and Hamao (1992), and Bekaert and Hodrick (1992) tested these restrictions across several international asset markets including equity. These papers generally rejected the hypothesis of a priced risk factor structure across markets that could be attributed to a common stochastic discount factor.

An independent but related line of research examined the factor pricing relationships in excess returns using the World CAPM as a benchmark. The first set of studies assumed purchasing power parity. Harvey (1991) and Ferson and Harvey (1993) considered whether expected excess returns of market indices across a set of industrialized countries could be explained by their covariance with the world equity return. They found that the model had explanatory power for returns. However, the latter paper showed that the expected returns were better explained by multiple factor models that include local sources of risk.

Dumas and Solnik (1995) estimated both unconditional and conditional versions of the world CAPM. They found that while the unconditional version of the model was not rejected, the

conditional version was rejected. Their results are reported in Table 1, Panel A. The unconditional version of the model is not rejected at a p-value of 0.16, but the conditional version is strongly rejected at a p-value less than 0.001. Furthermore, they strongly reject the hypothesis that the price of global and currency risks are constant, suggesting that the unconditional tests lack power. When they consider the same hypotheses for an asset pricing model that allows for exchange rate risk, the "international asset pricing model" (Adler and Dumas (1983)), they find that the unconditional version is only marginally rejected at 5% while the conditional version is not rejected. Moreover, the hypothesis that exchange rate risk is not priced is strongly rejected. The general conclusions that exchange rate risk is priced and that the price of risk is time-varying appears in a number of papers including De Santis and Gerard (1997) and Vassalou (2000).

### **2.1.2 Explaining Firm-Level International Equity Returns**

Firm-level stock return behavior presents another dimension of international equity pricing. The World CAPM represents a straightforward extension of the domestic CAPM to the international market. However, as has been demonstrated in the domestic empirical literature (e.g., Fama and French (1992), Carhart (1997)), this model does not explain the cross-section of returns as well as a model augmented by factors that depend upon size, the value of the firm, and possibly momentum.

The obvious question raised by this evidence is: What model best explains firm-level returns internationally? Since no empirically implementable theoretical model has yet been derived to explain the importance of factors such as size and value, papers that address this question typically rely on a simple factor structure to explain returns.<sup>5</sup> The effect on expected equity returns from risk exposure to these factors are measured empirically by the sensitivity or "factor loadings" to factor-mimicking portfolios

Fama and French (1998) studied an international cross-section of firm equity returns using a global market factor and a factor based upon book value relative to market value. They found that the value premium, characteristic of US firm returns, is pervasive in the 13 countries studied. Griffin (2002) included the size factor and also considered whether the effects on equity returns differ depending on whether the factors are domestic or foreign. He found that country-specific versions

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<sup>5</sup>On the other hand, Gomes, Kogan, and Zhang (2003) developed a theoretical model that matches the domestic empirical findings.



of the three-factor model were more useful at explaining portfolio and individual stock returns than a world three-factor model. Hou, Karolyi, and Kho (2011) provide an extensive analysis of 27,000 stocks from 49 countries to investigate the factors that drive firm-level returns across countries. The model that best explains variation in returns across these stocks is a multifactor model that depends upon the ratio of cash-flow to price as well as momentum. Fama and French (2010) examine returns using size, value, and momentum factors for four regions, considering both integrated and local models. They find that the local model explains returns best across three regions.

### 2.1.3 Global versus Local Factors: The Scope for Diversification

Although studies find that local factors are important to explain cross-sectional expected returns, the restriction that intercepts equal zero is usually rejected. Therefore, expected foreign equity returns often cannot be measured with much precision. Nevertheless, the importance of local and country risks in international equity returns together with the low correlation across markets suggests that holding foreign equity can help to reduce the risk of the domestic equity portfolio.

Along these lines, Heston and Rouwenhorst (1994), hereafter HR, asked whether firm-level returns are driven by country or industry effects. For this purpose, they studied all of the firms in the Morgan Stanley Capital International (MSCI) indices of 12 European countries. They grouped these firms into industries and then considered cross-sectional regressions for each firm's return,  $R_t^j$ , according to:

$$R_t^j = \alpha_t + \phi_t^i + \gamma_t^k + e_t^j \quad (6)$$

where  $\alpha_t$  is a time fixed effect and thus a base level of return at time  $t$ , and where  $\phi_t^i$  and  $\gamma_t^k$  are coefficients on dummy variables if the firm operates in industry  $i$ , or comes from country  $k$ , respectively, and  $e_t^j$  is the firm-specific shock. Instead of choosing country and industry returns as benchmark factors for these returns, they constructed an "average firm" from an equally weighted portfolio. Using these estimates, they found that the country effect explained an average of 24% across industries while the industry effect only explained an average of 5% across countries. They also discovered that 62% of the variance on an average stock can be eliminated by diversifying across industries within a country, while diversifying across countries within an industry eliminates

80% of this variance. They concluded that country diversification is more important than industry diversification.

Bekaert, Hodrick, and Zhang (2009) considered various factor models to ask which one best explains the variation in international equity returns for all of the firms in the MSCI world index. Since first moments of equity returns are imprecisely estimated, they focused upon time-varying second moments. They then ran a horse-race both with and without local factors for four different models: the world CAPM, the model augmented with Fama-French factors, an APT model estimated by principal components, and the HR model.

Table 1 B provides some summary information about these tests. The table reports t-statistics for the difference in Mean-Squared-Errors (MSE)<sup>6</sup> of the model in the row minus the MSE of the model in the column. Thus, the first line shows that the MSE of the World CAPM is significantly higher than both the MSE of the World Fama French (-6.77) and the World APT (-3.10) models. Clearly, the World CAPM is dominated by these other models. However, the second line shows that all of these models are improved by adding local factors. As such, all the versions of models with local factors significantly dominate world-only factor models. Since the HR model inherently imposes the restriction that the factor loadings are effectively one, it does not explain returns as well as any of the other models except the World CAPM.

A number of papers have suggested that industry effects are becoming more important than country effects. These papers include Cavaglia, Brightman, and Aked (2000), Ferreira and Gama (2005), Carrieri, Errunza, and Hogan (2007) and Carrieri, Errunza, and Sarkissian (2008). Bekaert, Hodrick and Zhang (2009) reconciled their results with this literature by testing for differences in trend correlations over time. Using more recent data, they found that country effects are still significantly important in explaining international equity returns even after controlling for industry effects

Another feature of global and local factors is the relatively high comovement between company returns and local factors, as demonstrated by the coefficients on the World plus Local CAPM model. This factor sensitivity affects the ability to diversify internationally. Although Bekaert, Hodrick and Zhang (2009) showed that other models explain returns better, this simple two factor model continues to be a benchmark for many studies that consider international events such as

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<sup>6</sup>The Mean Squared Error is the time-series weighted mean of errors between the sample data and the model.

cross-listings. To illustrate this relationships, Panel C1 reports the cross-sectional mean of a set of time series regressions for all foreign multinational companies that have listed on a US equity exchange since 1975 through 2010, approximately 1100 total. These companies are important because they are the most likely to be globally priced. Nevertheless, a simple mean of coefficients from return regressions of these foreign companies on the US market suggest they would be an excellent hedge since the beta is essentially zero while the coefficient on the local market is about 0.8.

This simple statistic ignores the correlation across US and foreign returns as well as the increase in that correlation over time, however. Even early studies such as Longin and Solnick (1995) showed that the correlation across major countries increased from 1960 to 1990. The evolution toward more integrated equity return exposures has been substantiated in later studies (e.g., Baele (2005), Eun and Lee (2010), Bekaert, Harvey, Lundblad, and Siegel (2007)). This relationship is likely to hold true in firm returns as well. Indeed, as Panel C shows under section 2, the relationship between the firm returns and the market returns changes significantly after cross-listing. The table reports results from Chua, Lai, and Lewis (2010) for a market-weighted set of firms that are listed on US exchanges in 2004. Using a test that endogenously chooses break dates, they found that the foreign firm betas on the US market increased over time after cross-listing. These results corroborate evidence from a number of authors that condition on cross-listing dates, beginning with Foerster and Karolyi (1999,2000). Section 3 of Panel C restates some of their estimates showing that the average global beta increased after cross-listing while the local beta even declined.<sup>7</sup> Thus, while foreign firms tend to have low betas against the US and other world markets, these betas appear to be increasing over time.

## **2.2 Local Market Risks and International Equity Pricing Models**

Overall, the evidence on international equity returns shows that the standard world CAPM and the associated single factor model of returns is rejected by the data. Empirical international equity pricing studies show that returns depend upon more than a single factor and that at least some of these additional factors depend upon local sources of risk. Developing models to explain both global and local sources of risk is challenging since the two are typically associated with different

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<sup>7</sup>Karolyi (2006) provides a review of the literature and describes the robustness of these relationships.

views of market integration. In the simple framework above, equity prices are either priced in completely segmented markets as in equation (1) so that all factors are local or else they are priced in fully integrated markets as in equation (2) so that all factors are global. The evidence, therefore, poses a challenge to develop models that allow for investors to have access to international markets yet retain exposure to local shocks that cannot be diversified away.

### **2.2.1 Purchasing power parity deviations and exchange rate risk**

Purchasing power parity deviations generate one potential answer to this challenge. In a seminal paper, Adler and Dumas (1983) showed how purchasing power parity deviations affect equity returns. Even though investors may trade in fully open capital markets, purchasing power parity deviations imply that the real return to investors vary across countries. As a result, investors view the expected return and risk from investing in securities differently depending upon their country of residence. The pricing of international securities therefore depends upon the covariance of the security returns with the home investor's inflation, a "local" risk factor, and also the covariance of this security's returns with all the rest of the world's purchasing power parity deviations, a set of "global" risk factors.

A necessary condition for this model to hold in the data is that exchange rate risk be priced, a condition established in the literature I described above. However, since individual equity returns also depend upon other local factors, currency appears to be only part of the explanation for international equity returns.

### **2.2.2 Emerging markets and capital market liberalizations**

Some governments restrict access to their countries' capital markets. Since these restrictions segment global capital markets, they provide another reason for local factors to affect equity returns. This explanation was described in theoretical papers as early as Black (1974) and Stulz (1981a). These papers considered the impact on equity returns if the domestic investor must pay extra costs on the foreign relative to domestic investments. Errunza and Losq (1985,1989) developed a framework to consider more direct capital market restrictions among countries. While these papers did not relate the equity returns directly to a world and local factor model, they generally found that the capital market equilibrium returns differ across countries and, as emphasized by

Stulz (1981a), need not correspond to a completely segmented or integrated model.

Bekaert and Harvey (1995) examined this relationship in equity returns of emerging markets. They considered an empirical model that switched between two regimes. In the first, markets are completely integrated as in equation (2). Rewriting the stochastic discount factor into components of the world price of risk, the Euler equation (3) under integration implies that the market returns for country  $j$  depend upon the covariance with the world according to:<sup>8</sup>

$$E_t r_{t+1}^j = \lambda_t Cov_t(r_{t+1}^j, r_{t+1}^W) \quad (7)$$

where  $r_{t+1}^W$  is the return on the world market and  $\lambda_t$  is the time  $t$  expected world price of risk. Alternatively, for an emerging market with closed capital markets, the returns within a country are determined solely by their covariance with the domestic market as in equation (1). In this case, the stock market return for country  $j$  is given by:

$$E_t r_{t+1}^j = \lambda_t^j Var_t(r_{t+1}^j) \quad (8)$$

where  $\lambda_t^j$  is the corresponding price of country  $j$  risk. They pointed out that an econometrician analyzing emerging market returns would observe data over both regimes. Thus, the returns would be explained by both the integrated world factor in equation (7) and the segmented local market factor in equation (8) according to:

$$E_t r_{t+1}^j = \pi_t^j \lambda_t Cov_t(r_{t+1}^j, r_{t+1}^W) + (1 - \pi_t^j) \lambda_t^j Var_t(r_{t+1}^j) \quad (9)$$

where  $\pi_t^j$  is the probability of country  $j$  being in an integrated regime based upon time  $t$  information. They estimated this model and found that indeed there is time-varying integration generated by the probability of being in the two regimes.

The potential for time-varying integration poses issues for valuing assets in emerging markets. Bekaert and Harvey (1997) considered the implications for measuring volatility and pricing behavior. Henry (2000) and Chari and Henry (2008) looked at the impact on aggregate and individual stock returns when markets announce a liberalization. Bekaert and Harvey (2000) consider a

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<sup>8</sup>Dumas and Solnik (1995) describe the steps required for this rewriting.

present value model based upon dividend yields to measure the effects on cost of capital from liberalization. Bekaert, Harvey, and Lumsdaine (2002) used data on stock market returns together with macroeconomic variables to estimate the date of the liberalization across a number of episodes. They found that the dates estimated with returns align well with the announcements. Surveys of the implications of liberalization on equity pricing and on capital markets perspective are given in Bekaert and Harvey (2003) and in Henry (2007), respectively.

Overall, the empirical equity pricing literature on emerging markets and liberalizations provides one explanation for the presence of global and local factors in returns. These two sets of factors co-exist in returns as countries transition to more open markets. However, transition to openness seems less likely to explain the importance of local and global factors in equity returns of developed countries.

### **2.2.3 Information Differences across Markets**

Equity returns depend upon both global and local sources of risk. These sources of risk can result from differing real returns as with purchasing power parity deviations or explicit restrictions to capital movements as with emerging markets. However, these sources of risk can also arise from more subtle impediments such as informational differences across international markets.

Several papers developed asymmetric information models to consider international investment flows. The basic model in Brennan and Cao (1997) has become a benchmark for this literature. In this model, domestic and foreign investors receive public and private signals about payoffs on investments in the home and foreign market. The precision of the signals to investors is higher in their own market, capturing the idea that these investors have more information about home securities. A random supply of exogenous "liquidity traders" arrive every period, purchase the assets, and help determine the price. Thus, the equilibrium price depends upon the signals of the two sets of investors. While the models in this literature are developed to explain investment flows rather than returns *per se*, the stock price solutions illustrate the intuition that asymmetric information will generate both local and foreign risk factors in returns.

Dumas, Lewis and Osambela (2010) considered whether differences in the ability to assess information across countries can generate an asset pricing model with local and global risk factors, among other empirical regularities. In their model, domestic and foreign investors observe signals

about the expected growth of dividends. In contrast to the asymmetric information literature, all signals are public but domestic investors understand better how to use that information to forecast future dividends. Since investors react to the same information differently, this behavior induces an additional source of risk. The model implies that returns have a two-factor structure that depends upon both home consumption and foreign consumption. Moreover, the equilibrium equity returns depend upon all of the state variables in their model, including up to seven factors, consistent with the number of factors found in Bekaert, Hodrick, and Zhang (2009).

#### **2.2.4 International Equity Pricing Overview**

No single asset pricing model appears to fit the empirical result that returns are simultaneously priced with local and global factors across a wide range of countries and firms. Nevertheless, there is some support for each explanation. Equity returns appear to include the pricing of foreign exchange, consistent with the importance of inflation differences. Equity returns from emerging markets depend upon a combination of segmented and integrated market risks and the shifts in these patterns correspond to liberalization dates. Finally, differences in information across markets generate sources of domestic and foreign risks that should theoretically be priced in equilibrium, though these risks are difficult to measure.

### **2.3 Other Implications of Equity Pricing Models**

So far, I have described research related to international equity pricing relationships. But many of the models used to describe these relationships have other capital market implications as well. I next highlight three of these: home equity preference by investors; the relationship between international capital flows and returns; and equity responses to international cross-listing.

#### **2.3.1 Home Equity Preference**

Domestic investors hold a disproportionate share of their equity portfolio in domestic firms. This observation was noted in the US at least as early as Grubel (1968) and Levy and Sarnat (1970) and was shown in a data set across several developed countries by French and Poterba (1991). Moreover, Ahearne, Grier, and Warnock (2004) have shown that the proportion of foreign equity

holdings in the US portfolio is only about 12%, while the foreign portfolio share in world markets is about 50%. Thus, the so-called "home bias" phenomenon appears to persist.

Whether this phenomenon is puzzling clearly depends upon how well the domestically-biased portfolios achieve the objectives of home investors. If international equity returns are determined by a single factor model such as the World CAPM, then domestic investment in foreign equities indeed fall short of the optimal holdings implied by a market-weighted share of foreign equities in the world portfolio. However, as described above, the literature on international equity pricing demonstrates that this simple version of the model is rejected by the data. Thus, whether home equity preference is surprising must be put into the context of other asset pricing models that can potentially fit the data better. Toward this purpose, I now reconsider home equity preference in the context of the asset pricing models described above.<sup>9</sup>

One reason why investors may hold different portfolio allocations than the world market portfolio is that returns differ according to the country of residence. In their seminal paper, Adler and Dumas (1983) derived the equilibrium portfolio holdings for investors facing purchasing power parity deviations and, hence, real exchange rate risk. The desired portfolio for an investor in a given country depends upon two components: a common portfolio across investor that maximizes the log of mean gross returns and a country-specific portfolio that hedges the real exchange rate risk. Cooper and Kaplanis (1994) combined moments of equity returns and portfolio holdings to ask whether currency risk can explain home bias. They found that it cannot. They then used their estimates to back out the size of implicit transactions costs required to prevent investors from holding these positions. These estimates appear unrealistically high.

While country-specific risk in the form of real exchange rate variation may not be sufficient to explain home bias, investors may consider other idiosyncratic risks that may be diversified with foreign assets. These country-specific risks may include shocks to non-tradeable goods (Baxter, Jermann, and King (1998)) and human capital (Baxter and Jermann (1997), Jermann (2002)).

Whether these argument help or hurt the home equity bias explanation depends upon how well foreign assets hedge these country-specific risks relative to domestic assets. If domestically traded assets can provide diversification opportunities without the need to directly invest in foreign assets,

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<sup>9</sup>A full survey of home equity preference is beyond the scope of this paper. For a longer but dated survey, see Lewis (1999). Coeurdacier and Rey (2010) give an excellent recent survey of home bias in macroeconomic models.



even small transactions costs and informational asymmetries may induce investors to overweight domestic equities. To investigate this possibility, Errunza, Hogan, and Hung (1999) constructed optimally weighted portfolios of US-traded securities that are likely to have foreign risk components, securities such as US multinationals, foreign stocks listed on US exchanges (ADRs), and country funds. They then tested whether these US-traded portfolios span the risk in foreign market indices. Interestingly, they could not reject this hypothesis except for some of the emerging markets. Their results call into question the benefits of holding foreign equities directly on foreign stock exchanges since this diversification can be duplicated on the domestic exchange with lower transactions costs. Stocks from emerging markets form an exception to this result, but for these stocks capital market restrictions may be more significant.

Another potential problem with the standard home equity preference argument involves the time-varying variances of international equity returns. A number of papers such as King, Sentana, and Wadhvani (1994), and Longin and Solnik (1995, 2001) showed that the correlation between international equity returns are higher when the market declines than when it increases. If so, argued Ang and Bekaert (2002), the diversification potential of foreign equity may be diminished since correlations are high when hedging motives are most needed. Nevertheless, these authors showed that the benefits of international diversification remained during bear markets as well as bull markets. On the other hand, Chua, Lai, and Lewis (2010) showed that foreign equities traded in the US would not have provided diversification benefits during the recent financial crisis.

Finally, asymmetric information between domestic and foreign investors may generate a tendency to hold domestic assets. Gehrig (1993) showed that if domestic investors have more precise information about home equity compared to foreign investors, they will choose to hold relatively more domestic equity. Intuitively, foreign stocks will seem riskier because domestic investors are less informed about them. In this framework, home bias stems from the assumption that domestic investors are more informed about domestic securities, leading one to ask why foreign investors do not become more informed about the domestic securities.

To address this question, Van Nieuwerburgh and Veldkamp (2009,2010) developed a model in which investors choose how informed they wish to be about a group of assets. In this model, domestic investors have more initial information about the domestic asset so that they have a comparative advantage in local information acquisition. In equilibrium, they endogenously choose

to remain less informed about the foreign assets in favor of domestic assets.

This line of research would seem to suggest that home bias results simply from an informational disadvantage in foreign assets. However, Dumas, Lewis, and Osambela (2011) showed that this view is too simplistic. In their model, foreign investors have an informational disadvantage in processing domestic signals.<sup>10</sup> As such, they overreact to domestic dividend changes. The foreign investor views the domestic equity as being riskier because he does not understand how to interpret all the publically available information. The presence of confused foreign investors creates sentiment risk in domestic equity returns, thereby reducing desired domestic equity holdings by domestic investors. Dumas, Lewis, and Osambela (2011) found that the informational advantage effect dominates the foreign sentiment risk effect on average, but that these two effects generate time-varying home bias.

### **2.3.2 Foreign capital inflows and equity returns**

The relationship between capital flows and equity returns is another relationship that depends upon global asset pricing. Bohn and Tesar (1996) found that monthly US portfolio flows are positively related to contemporaneous flows in most large equity markets. The standard asset pricing model with complete information and markets provides little guidance about capital flows since prices can equilibrate without any associated capital flows. By contrast, asset pricing models based upon asymmetric information generate capital flow predictions as investors attempt to trade on their private information.

Brennan and Cao (1997) developed these implications by assuming that investors in the home country have access to more precise private signals about domestic dividend pay-outs. As a result, foreign investors over-react to common public signals, thereby creating a positive correlation between domestic returns and foreign capital inflows. They empirically studied this relationship for both developed and emerging markets. Similar to Bohn and Tesar(1996), they found that the purchases of US equities by foreign developed countries and US purchases of equities in these same countries were generally positively related to returns, though the results were more mixed for emerging markets. Using a model with international differences in opinion described above, Dumas, Lewis, and Osambela (2011) also generate covariation between domestic returns and foreign

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<sup>10</sup>This informational assumption builds on the frameworks in Dumas, Kurshev, and Uppal (2009) and Scheinkman and Xiong (2003).

capital inflows.

While the Brennan and Cao (1997) model implies a contemporaneous movement between returns and capital flows, in practice empirical studies relate lagged capital flows to contemporaneous returns in order to adjust for information lags. As such, the relationship is typically associated with "trend-following" behavior by foreigners, as found in several papers.<sup>11</sup> Brennan, Cao, Strong, and Xu (2005) argued that differences in lags of portfolio flows make the trend-following evidence difficult to interpret. Instead, they used surveys of institutional investors to study how market returns across countries affect the "bullishness" of these investors. Consistent with their model, they found that the fraction of foreign institutional investors that are bullish about a given market increases with the return on that market. However, Curcuru, Thomas, Warnock, and Wongswan (2011) examined newly available data on country allocations and showed that U.S. investor trades are consistent with portfolio rebalancing, not with an informational advantage.

Baker, Wurgler and Yuan (2010) examined more directly the empirical implications of potential differences of opinion on international returns. Following the approach taken by Baker and Wurgler (2006) for US alone, they constructed a "Sentiment Index" for six developed countries using principal components of several data variables related to bullishness of the market. They then used the common component across these markets to characterize a global sentiment index. They found that the global sentiment index rather than the local sentiment index was important for explaining the cross-section of returns. As they argued, capital flows are one mechanism for this sentiment to spread across countries.

### **2.3.3 International equity cross-listing**

The stock price response of firms that cross-list in other markets is often cited as evidence of market segmentation. For example, Table 1 Panel C3 reports the abnormal returns from Foerster and Karolyi (1999) for the window of one year prior to the cross-listing event at about 15 basis points weekly or about 7% annually. The listing week displays another 12 basis point increase (not shown), and then the returns decline by about 14 basis point, though not significantly. As

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<sup>11</sup>See for example, Froot, O'Connell, and Seasholes (2001), Choe, Kho, and Stulz (1999, 2005), Grinblatt and Keloharju (2000), Griffen, Nardari, and Stulz (2004), Edison and Warnock (2008), and Dahlquist and Robertsson (2004). However, Grinblatt and Keloharju (2000) find that foreign institutional investors make more profits on their investments.

surveyed in Karolyi (2006), this pattern is robust. Across a variety of studies, returns on stocks tend to be abnormally high around their cross-listing event with estimates ranging from 1.5% and 7% per annum. Even with an event window as long as ten years, Sarkissian and Schill (2009) found significant abnormal returns.

The dramatic effect on firm returns raises obvious questions about the reason. Obvious explanations such as risk-sharing are easily ruled out. As described by Karolyi (2006), firms do not appear to be motivated by lower beta in the US. Indeed, most of the cross-listed firms come from countries such as Canada that already comove strongly with the US. However, the biggest price effects are documented for firms from countries with more lax disclosure requirements than the US.

Coffee (2002) argued that these effects are generated by a "bonding" effect. Foreign cross-listed companies bond themselves to a more stringent set of disclosure requirements by committing to abide by US GAAP and regulations from the SEC. As a result, the market views these firms as less risky and accordingly their stock price rises.

## **2.4 International Equity Market Summary**

Equities comprise an important global asset market. Despite the increase in integration across countries over time, equity returns continue to depend strongly on local factors. Models developed to understand this codependency range from country-specific risks, like exchange rates, to capital market restrictions and informational asymmetries. These models also highlight some well-known regularities in these markets such as home bias, the comovement of returns and foreign capital flows, and international equity cross-listing. These models provide a context for considering other global asset markets such as currency and fixed income.

## **3 Foreign Exchange and International Bond Returns**

Currency is an obvious risk characteristic that distinguishes one country's return from another. Indeed, exchange rate risk appears to be priced in international equity returns, as described above. The price of exchange rate risk can be addressed directly by analyzing the expected return from borrowing in one currency and investing in another currency. Standard foreign exchange risk models treat the borrowing and investing interest rates as short term risk-free rates. However, as

recent concerns regarding Europe have shown, returns across countries can also embody sovereign default risk as well as potential credit risk differences. In this section, I begin by describing the behavior of foreign exchange returns and its associated literature before turning to the implications for sovereign default risk.

### 3.1 Foreign Exchange Returns: Structure and Empirical Evidence

Foreign exchange returns are typically characterized by a long-short strategy often used to motivate interest parity. The investor borrows at a domestic currency nominal risk free rate, owing gross return  $\tilde{R}_t^{rf}$ , and then invests the proceeds per unit of domestic currency in a foreign nominal risk-free asset earning gross return  $\tilde{R}_t^{rf*}$  in foreign currency units. Thus, the investor engaged in such a strategy will earn  $(S_{t+1}\tilde{R}_t^{rf*}) / (S_t\tilde{R}_t^{rf})$  in units of domestic currency, where  $S_t$  is the spot domestic currency price of foreign currency. Defining the nominal home and foreign currency risk-free rates as  $i_t$  and  $i_t^*$ , respectively the logarithm of this strategy can be written as:

$$r_t^{fx} \equiv s_{t+1} - s_t + (i_t - i_t^*),$$

where  $1 + i_t \approx \ln(\tilde{R}_t^{rf})$ ,  $1 + i_t^* \approx \ln(\tilde{R}_t^{rf*})$ , and where lower-case letters refer to the logarithm of the variable. The forward premium equals the difference between the domestic and foreign interest rate by covered interest parity; that is,  $f_t - s_t = i_t - i_t^*$ . Rewriting this strategy in terms of the forward rate implied by covered interest arbitrage, the excess returns from the strategy becomes:

$$r_t^{fx} \equiv s_{t+1} - f_t \tag{10}$$

The foreign exchange return is therefore equivalent to taking a long position in the foreign currency and short position in the domestic currency. If the foreign currency appreciates relative to the forward rate, the future spot price of foreign currency exceeds the forward rate so that the position generates profits.

If the forward rate is an unbiased predictor of the future exchange rate, then interest parity holds and foreign exchange returns earn zero profits on average. Studies find that interest parity holds over long horizons, but shorter term deviations can be significant conditional on interest rates.

To provide a structure to describe this phenomenon, I first restate the Euler equation structure in Section 2. I then use this structure to consider the empirical evidence.

### 3.1.1 Euler Equation Implications

To consider the foreign exchange return using the Euler equation above, I rewrite the stochastic discount factor in nominal terms<sup>12</sup>. Defining the price index of the consumption good in the home country as  $P_t$  and that of the foreign country as  $P_t^*$ , the nominal stochastic discount factor for domestic and foreign currency can be written as  $Q_t$  and  $Q_t^*$  where:

$$\begin{aligned} E_t Q_{t+1} &\equiv E_t \left[ \frac{\delta U'(C_{t+1})/P_{t+1}}{U'(C_t)/P_t} \right] = 1/\tilde{R}_t^{rf} \\ E_t Q_{t+1}^* &\equiv E_t \left[ \frac{\delta U'(C_{t+1}^*)/P_{t+1}^*}{U'(C_t^*)/P_t^*} \right] = 1/\tilde{R}_t^{rf*} \end{aligned} \quad (11)$$

Thus,  $Q_{t+1}$  is the intertemporal marginal rate of substitution of one unit of domestic currency between period  $t$  and  $t + 1$ , and similarly for  $Q_{t+1}^*$ . The spot rate is simply the contemporaneous ratio of nominal rates of substitution in consumption implying:

$$(S_{t+1}/S_t) = (Q_{t+1}^*/Q_{t+1}) \quad (12)$$

Using the risk-free rates in equation (11) and the spot rates in equation (12) the foreign exchange risk premium can be rewritten as:<sup>13</sup>

$$\left( \frac{E_t S_{t+1} - F_t}{S_t} \right) = E_t \left( \frac{Q_{t+1}^*}{Q_{t+1}} \right) - \frac{E_t Q_{t+1}^*}{E_t Q_{t+1}} \quad (13)$$

In other words, the risk premium depends upon the difference between the expected ratio of SDFs and the ratio of their expectations. Euler equation-based explanations must depend upon variation in this relationship.

<sup>12</sup>See for example Backus, Gregory and Telmer (1993). The approach can also be written in real terms by including two goods that provide a role for real exchange rate variability. For an early example, see Hodrick and Srivastava (1984).

<sup>13</sup>Taking the expectation of eqn (12) implies that  $E_t S_{t+1}/S_t = E_t (Q_{t+1}^*/Q_{t+1})$ . Using the fact that  $F_t/S_t = R_t^{rf}/R_t^{rf*}$  by covered interest parity, equation (11) implies that  $F_t/S_t = E_t Q_{t+1}^*/E_t Q_{t+1}$ . Then,  $\left( \frac{E_t S_{t+1} - F_t}{S_t} \right) = E_t (Q_{t+1}^*/Q_{t+1}) - E_t Q_{t+1}^*/E_t Q_{t+1}$ . verifying equation (13).

### 3.1.2 The Fama Result

Early papers on interest parity noted that the forward rate is not an unbiased predictor of the future exchange rate (e.g., Bilson (1981)). Subsequent papers explored the nature of deviations from interest parity. In an influential paper, Fama (1984) used a regression test to demonstrate the significance of these deviations. The test regresses the change in the spot rate on the forward premium,  $f_t - s_t$ , as given by:

$$\Delta s_{t+1} = \beta_0 + \beta_1 (f_t - s_t) + u_{t+1} \quad (14)$$

where  $\Delta$  is the lagged difference,  $\beta_i$  are regression coefficients and  $u_{t+1}$  is the residual. The probability limit of the coefficient on the forward premium can be written:

$$\beta_1 = \frac{Cov [E_t \Delta s_{t+1}, (f_t - s_t)]}{Var (f_t - s_t)} \quad (15)$$

Fama (1984) showed that if the coefficient is less than a half, then the variance of expected returns exceeds the variance of the expected change in the exchange rate. In other words, if  $\beta_1 < \frac{1}{2}$ , then  $Var (E_t r_t^{fx}) > Var (E_t \Delta s_{t+1})$ .<sup>14</sup>

Studies typically find that the estimate of  $\beta_1$  is not only less than  $(1/2)$  but negative.<sup>15</sup> Negative  $\beta_1$  implies that the exchange rate is predicted to move in the opposite direction of the forward premium. Panel A of Table 2 illustrates the basic result for monthly returns between August 1978 and October 2010 for the US dollar relative to three representative currencies, the Japanese Yen, the Swiss Franc, and the British Pound.<sup>16</sup> The estimate of  $\beta_1$  is significantly negative for all three currencies. As a result, the hypothesis that  $\beta_1$  is less than  $1/2$  is rejected at marginal significance levels less than 1%.

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<sup>14</sup>To see why, note that the predicted return on foreign exchange can be written as  $E_t r_{t+1}^{fx} \equiv E_t [\Delta s_{t+1} + (f_t - s_t)]$ , and the variance of the forward premium can be related to the variance of the expected return on the foreign exchange strategy according to:  $Var (E_t r_t^{fx}) = Var (E_t \Delta s_{t+1}) - 2Cov [E_t \Delta s_{t+1}, (f_t - s_t)] + Var (f_t - s_t)$ . Substituting equation (15) into this expression and rewriting implies:  $Var (E_t r_t^{fx}) = Var (E_t \Delta s_{t+1}) + (1 - 2\beta_1) Var (f_t - s_t)$ . Then considering  $\beta_1 < \frac{1}{2}$  shows the result.

<sup>15</sup>Surveys of this literature can be found in Lewis (1995), and Engel (1996). Bansal and Dahlquist (2000) and Burnside, Eichenbaum and Rebelo (2007) found that emerging market returns display different behavior than developed country returns, although deposit rates in these countries may exhibit sovereign risk making the connection to foreign exchange risk alone unclear.

<sup>16</sup>All spot rate data are from MSCI through Data stream and forward rates are implied through covered interest parity using Datastream Eurocurrency 30 day deposit rates.

Figure 1A reports the predicted returns for the Yen and Pound against the Dollar based upon this simple regression along with 90% significance bands. The magnitude of the predictable returns is large, sometimes reaching 30% per annum, and changes sign over time.

These two sets of results highlight the challenges for models explaining the foreign-exchange risk premium. First, the model must deliver a negative relationship between the forward premia and future exchange rates, further requiring the variance of the risk premium to exceed the variance of the exchange rate change. In other words, the variance of nominal SDFs in equation (13) must exceed the variance of the ratio of expected nominal SDFs themselves in equation (12). Second, the model must produce the alternating sign pattern of foreign exchange returns found in the data. Therefore, the conditional relationship between SDFs in equation (13) must change signs in a pattern consistent with predictable foreign exchange returns.

For standard consumption-based models to explain the foreign exchange relationship, the consumption growth rate must be relatively volatile. However, Panel C of Table 2 shows that the variability of US consumption is only about 1.765% and standard studies find this variance is fairly stationary. On the other hand, the variances of foreign exchange returns are typically greater than 20%. The challenge for risk-based models of the foreign exchange risk premium is therefore to generate greater stochastic volatility in the SDFs than readily apparent from casual observation.

### 3.1.3 The Carry Trade

The negative relationship between the forward premium and the subsequent exchange rate change suggests a simple strategy often called the "carry trade." The forward premium equals the difference between the domestic and foreign interest rate by covered interest parity, i.e.,  $f_t - s_t = i_t - i_t^*$  where  $i_t$  and  $i_t^*$  are the nominal home and foreign currency risk free rates, respectively.<sup>17</sup> Thus, the Fama result says that if the foreign interest rate is higher than the domestic interest rate, the foreign currency is likely to appreciate. The "carry trade" strategy then consists of borrowing in the low-interest rate currencies and investing in the high-interest rate currencies. The carry trade return can therefore be rewritten as:  $sign(f_t - s_t) * (s_{t+1} - f_t)$ .

Table 2 Panel B reports the results from regressing these carry trade returns on the absolute

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<sup>17</sup>These rates are related to the gross returns according to:  $i_t - i_t^* \approx \ln(\tilde{R}_t^{rf}) - \ln(\tilde{R}_t^{rf*})$ .



value of the forward premium.<sup>18</sup> The coefficients are significant and the mean returns are positive, as reported in the final column. Figure 1B illustrates the predicted values of this regression over time for the dollar relative to the Yen and the Pound, while Figure 1C shows the level of interest rates behind this trade. Despite some reversals, the carry trade exhibits prolonged periods of gains. While these figures report the returns using the dollar interest rate alone, in reality speculators typically use a much wider range of currencies to implement the strategy. Nevertheless, the returns from the strategy are clearly risky.

## 3.2 Predictable Foreign Exchange Returns Models

Much of the literature has sought to develop models that can generate these relationships between expected returns and interest rate differentials across countries. I begin by describing the models based upon risk-based explanations before considering alternative explanations including rare events, crash risk, and informational asymmetries.

### 3.2.1 The Foreign Exchange Risk Premium

Any consumption-based model of the foreign exchange risk premium must confront the two challenges I noted above: the higher variance of conditional covariances of SDFs across currencies than the variance of these SDFs themselves; and the changing sign pattern of conditional covariances of SDFs.<sup>19</sup> Both of these results require high variability in the marginal utility of consumption. However, early studies beginning with Mark (1985) found that standard consumption volatility is not sufficient to generate this foreign exchange risk premium. Backus, Gregory, and Telmer (1993) and Backus, Foresi and Telmer (1993) considered a model with habit persistence that implicitly increased marginal utility variability, but still rejected the model. Bekaert (1996) combined a variety of modifications to the standard model including habit persistence and heteroskedasticity, that improved the ability of the model to fit the data. However, the model still could not account for the foreign exchange risk premium. Moreover, as described in Section 2, Euler equation models

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<sup>18</sup>Similarly, Bansal (1997) found that the coefficient depends on the sign of interest differentials. He also relates this phenomenon to a term structure model.

<sup>19</sup>Spot exchange rates provide another problem with these types of models. As a long literature beginning with Meese and Rogoff (1983) has shown, exchange rates cannot be explained by standard fundamentals. As labeled by Obstfeld and Rogoff (2001), this "exchange rate disconnect problem" continues to plague international macroeconomic models. I do not discuss this literature in the text since exchange rate pricing is inherently a macroeconomic issue and, hence, beyond this review's scope.

imply a single latent variable generated by a common SDF, while a large body of research rejects these restrictions.

These early papers focused upon bilateral returns from borrowing in one country and investing in another. However, Lustig and Verdelhan (2007) (LV) formed portfolios of carry trade portfolios according to low relative to high interest rates, rebalanced each year. They found a generally increasing Sharpe ratio in the currencies with higher interest rates. They then used a utility function that nests several different versions of utility including durables and non-durables and Epstein and Zin (1989) preferences. Based upon this model, they estimated a factor model using US consumption data, finding that it explains up to 87% of the cross-sectional variation in annual returns on the portfolios. To obtain this result, Lustig, Roussanov, and Verdelhan (2011) showed that the time-varying covariation between the SDF and the global factor is important.

While the LV model focused upon the cross-sectional variation in the predictable excess returns, Lustig, Roussanov, and Verdelhan (2010) examined the time variation in similar portfolios. They found that the predicted foreign currency excess returns are counter-cyclical, using US macro variables. As a result, they demonstrated that the foreign exchange returns portfolios can provide a hedge against cyclical variations so that the predictable returns are, indeed, compensation for risk

Overall, these more recent results suggest that portfolios of foreign exchange returns may have more power to uncover risk-based explanations than the earlier bilateral time series relationships

### **3.2.2 Rare Events, Crash Premia, and Skewed Returns**

Currency markets have a long history of infrequent realignments, as a matter of either explicit or anticipated government reactions. Perhaps not surprisingly, therefore, the impact of rare events on asset prices was first noted in foreign exchange markets. According to standard folklore, Milton Friedman coined the term "peso problem" in the early 1970s to describe why Mexican peso interest rates remained substantially higher than the US dollar interest rates even though the exchange rate had been fixed for a decade. The forward rates continued to predict a weaker Mexican peso than was realized until the peso was devalued in the late 1970s.<sup>20</sup>

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<sup>20</sup>Empirical analysis of this phenomenon first appeared in Rogoff (1980) and Krasker (1980). Lizondo (1983) provided a theoretical model.

Clearly, the potential for rare devaluations appears most prominent in currencies with fixed exchange rates. However, the term has also been applied when discrete changes are anticipated in asset prices other than currency.<sup>21</sup> Moreover, flexible exchange rates also appear to experience infrequent shifts. For example, studies such as Engel and Hamilton (1990) and Kaminsky (1993) found that the dollar exchange rate follows persistent regimes of appreciation and depreciation. Therefore, Evans and Lewis (1995) asked whether anticipated discrete shifts in exchange rate regimes could explain the forward discount bias. They found that the anticipated switch from an appreciating to a depreciating regime does, indeed, bias downward the  $\beta_1$  coefficient in the Fama regression by as much as  $-1$  and increases the bias in measured risk premium by 3% to 20%. Still, the hypothesis that the true  $\beta_1$  is equal to 1 is strongly rejected.

If investors anticipate an infrequent shift in rates, those with exposure to this event would like to buy insurance against adverse effects on utility. Thus, the price of options against this event would be driven up in equilibrium. This relationship is the insight of Bates (1996a,1996b). He showed that infrequent exchange rate jumps are necessary to explain the higher price of out-of-the-money options, the so-called "volatility smile." However, the jumps priced in the options do not appear to predict actual rates, though this finding may reflect the short sample period. A number of studies also found that hedges against jumps appear to be priced in currency and other option prices.<sup>22</sup>

More recently, Burnside, Eichenbaum, Kleshchelski, and Rebelo (2011) and Jurek (2009) used options data to reexamine the foreign exchange return by combining it with hedged positions. They characterized the position as the combination of a "carry trade", borrowing in the low interest rate and investing in the high interest rate currency, plus an option to hedge against the possible depreciation in the high interest rate currency. Burnside, et al (2011) examined these returns using at-the-money options for a sample ending before the financial crisis, finding significant positive gains. Jurek conducted his analysis over various out-of-the-money strike prices and included a sample extended through the financial crisis period of 2008. While the hedged carry trades earned positive Sharpe ratios through 2007, he found that excess returns to cross-neutral carry trades were

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<sup>21</sup>The peso problem has been considered as an explanation of asset pricing behavior ranging from the term premium (Bekaert, Hodrick, and Marshall (2001), Evans and Lewis (1994), to IPO underpricing (Ang, Gu, and Hochberg (2007). For more references see Lewis (2008).

<sup>22</sup>See for example, Bates (1991) for stocks and Bakshi, Carr and Wu (2008) for currency.

insignificantly different from zero once the crisis was taken into account. The pattern of positive returns that are eliminated once an infrequent event occurs is consistent with a peso problem explanation.

The original Mexican "peso problem" was envisioned as an effect on the forward premium that would arise even with risk neutral investors. As such, the early literature typically treated the risk premium as an exogenous persistent component to predictable excess returns or as an empirical characterization of the risk-neutral distribution in options. However, risk averse agents would want to hedge against the utility loss from a rare disaster event, thus generating a premium to positions that bear the risk. This observation was made in the context of the equity premium puzzle by Rietz (1988) and more recently restated by Barro (2006). Along these lines, Farhi and Gabaix (2009) proposed a model of a rare global event that affects all countries, but with a differing mean-reverting risk exposure by country.<sup>23</sup> They combined these two ingredients to show that those countries more exposed to disaster risk commanded higher risk premia manifested in a depreciated exchange rate and higher interest rate. As the risk premium mean reverts, the exchange rate appreciates so that currencies with higher interest rates appreciate, consistent with the Fama result.

Farhi, Fraiberger, Gabaix, Ranciere and Verdelhan (2009) developed a framework for assessing the importance of disaster risk in currency markets using currency options and foreign exchange returns. They combined both the insights from the cross-sectional behavior of portfolios of carry trades as in Lustig, Roussanov, and Verdelhan (2009) and the disaster risk story in Farhi and Gabaix (2009) to evaluate disaster risk. For this purpose, they used a two country, two period model of disaster risk and considered both hedged and unhedged carry trade returns as in Jurek (2009). They found evidence in favor of the link between exchange rates and asymmetries in the option prices, but more limited evidence of exchange rate predictability, similar to Bates (1996a,b).

Brunnermeier, Nagel, and Pedersen (2009) showed that carry trades exhibit negative skewness. That is, most of the time carry trades earn a positive return but infrequently there are large reversals. One interpretation of their results is that carry trade positions are subject to "liquidity spirals" (Brunnermeier and Pedersen (2009)). According to this explanation, speculators invest in these positions because they have positive average return. However, these positions are also

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<sup>23</sup>In the standard model, exchange rates are simply determined by the contemporaneous marginal utility between goods. To generate a forward-looking exchange rate, Farhi and Gabaix (2009) assumed that the exchange rate is a discounted present value of future export productivity.

subject to "crash risk" captured by negative skewness in these returns. Since these speculators have funding constraints, shocks that lead to losses are amplified as they unwind their positions. The authors indeed found that carry trade positions are positively related with trading volume in futures positions, consistent with their story.

### **3.2.3 Heterogeneous Investors**

The endurance of the forward discount bias and the apparent profitability of the carry trade has led some researchers to consider models with heterogeneous investors.

Alvarez, Atkeson, and Kehoe (2008) considered a model that assumes investors differ in their financial market participation. In their model, households must pay a fixed cost to participate in the financial market. Those who pay the cost are active, but the others simply consume current real balances. The model generates a relationship between money growth and the risk premium though it is unclear how much of the forward discount bias can be explained by this relationship.

Osambela (2010) develops a model that allows for domestic and foreign investors to differ in their beliefs about the information content of publicly observed signals. He shows that the Fama regression omits one regressor: a heterogeneous beliefs risk premium, which compensates for deviations in beliefs about the expected exchange rate depreciation. He then simulates his model and reruns the Fama regression, finding that the slope coefficient is biased downward away from one.

### **3.2.4 Other Low Frequency Movement Explanations**

Infrequent crashes in currency markets with or without consumption-based micro-foundations form the basis for the models described above. These stories suggest that a low frequency factor may help explain foreign exchange returns. Similarly, motivations for persistent underlying risk in asset markets have been proposed to help explain well-known domestic market anomalies such as the equity premium puzzle (Mehra and Prescott (1985)) and the risk-free rate puzzle (Weil (1989)). The two main approaches in this line of work are based upon the habit-persistence framework of Campbell and Cochrane (1999) and the long-run risk specification of Bansal and Yaron (2004). While the two approaches differ, they both generate low-frequency variability in the stochastic discount factor. Given the importance of low-frequency risk in currency markets, researchers have

been led to ask whether these approaches may plausibly help resolve the forward discount puzzle.

Using the habit-persistence framework, Verdelhan (2010) developed a two country model in which the consumption-surplus ratio induced by the habit is correlated across countries. In this framework, the exchange rate change depends upon both consumption and the interaction of consumption and interest differentials. As a result, when the foreign interest rate is higher than the domestic rate, the domestic investor faces more consumption growth risk. Accordingly, the model generates the Fama relationship as well as the equity premium.

Using long run risk, Colacito and Croce (2010b) considered a two-country model with an exogenous endowment process in each country that has a long-run risk component. The two endowments are combined to create a consumption good in each country and each country has a bias toward their own endowment. Among other empirical regularities, this model generates a negative Fama coefficient and the attendant excess volatility of the risk premium relative to expected exchange rates. This relationship arises endogenously through the time-varying market prices of risk across the two countries.

Bansal and Shaliastovich (2010) also used a two country model with long run risk but focused upon regularities in the term premium in the bonds market and the equity premium. They found that the slope coefficients in the foreign exchange projections are negative at one month horizons though they increase with maturity, becoming positive at one year.

### **3.3 Foreign Bonds and Sovereign Risk**

So far, I have discussed research on international equity markets and foreign exchange, reflecting the concentration of the literature. However, a growing literature examines aspects related to bond markets. Recent events concerning sovereign risk have highlighted the importance of these studies. The potential pricing of bonds in international markets was described by Stulz (1983) and Adler and Dumas (1983), who showed that foreign bonds provide a means to hedge currency risk. However, these papers treat bonds as risk-free, similar to the foreign exchange literature above.

The history of sovereign debt has been anything but risk-free, however. As Reinhart and Rogoff (2009) showed over many centuries and countries, governments can and do default on government debt. This default risk generates differences in yield spreads across countries. Erb, Harvey, and Viskanta (1999) and Arellano and Ramanarayanan (2010), among others, studied the yields

on spreads in emerging markets. Aguiar and Gopinath (2006) and Arellano (2008) examined the spreads on sovereign lending in the presence of default assuming risk-neutral investors. By contrast, Borri and Verdelhan (2010) analyzed these spreads from the perspective of risk-averse investors, finding that the returns can be explained by a risk-based model.

While the literature has largely focused upon sovereign bond yields, the more recent credit default swap market provides direct evidence on the pricing of credit risk. Longstaff, Pan, Pedersen, and Singleton (2011) used CDS spreads across countries to analyze whether the risks priced in these spreads are primarily country-specific or driven by global factors. They found that the excess returns from investing in sovereign credit are largely compensation for bearing global risk. This result suggests that sovereign credit risk is largely influenced by an integrated world market, unlike the relationships we have seen in equity markets above. More recently, Dieckman and Plank (2011) used CDS spreads during the recent financial crisis to evaluate the implied risk of a group of mostly OECD countries. Since they discovered that the risk is positively related to the size of banking in the economy, they argued that market participants incorporate expectations about financial industry bailouts into the pricing of CDFs.

The literature has largely focused upon international fixed income asset pricing in the form of short term risk-free rates or sovereign default risk and not international corporate credit risk. However, recent papers have considered the implications of foreign bonds for domestic investors. Using data for forty countries, Burger and Warnock (2007) found that foreigners shun bonds from countries with high variance. Liu (2010) analyzed the return dynamics of international corporate bonds, finding that foreign bonds provided a significantly better hedge against US risk factors than did foreign equity during the recent crisis.

### **3.4 Foreign Exchange and International Bond Returns: Summary**

The large literature on foreign exchange returns has generated a number of challenges for typical asset pricing models. Currency forward rates conditionally predict a change in the exchange rate in the opposite direction and excess foreign exchange returns change sign over time. However, standard models based upon constant relative risk aversion and i.i.d. consumption cannot explain this behavior. The variance of consumption volatility is too low and the covariance of consumption growth rates across countries do not change signs in a pattern that matches predictable returns.

Studies have more success when these standard conditions are modified. Carry-trade portfolios appear to be priced with risk-based measures in the cross-section and over the cycle. Moreover, the skewness in carry trade returns appear to be priced in options so that there are no long term gains, consistent with a crash-risk interpretation. Successes have also been found when allowing for heterogeneity in investor responses to financial market information through limited participation or differences in opinion. Similarly, allowing for low frequency movements in consumption risk can generate some features of the forward premium anomaly.

Since foreign exchange risk depends upon interest rate differentials, foreign bonds can provide a hedge against this exchange rate risk. On the other hand, foreign fixed income securities may depend upon sovereign debt risk. While sovereign debt risk appears to be priced in global markets, the size of the banking sector also appears to be important.

## 4 Integrating Financial Markets and Consumption Risk-Sharing

So far, I have discussed the equity markets and the fixed income-foreign exchange markets separately. From an asset pricing perspective, these markets are related, of course. A common component across all markets is the intertemporal consumption decision of each country investor embodied in the Euler equation (3). As shown above, the common SDF implied by such a model is rejected for returns across markets. Also, as pointed out by Backus, Kehoe and Kydland (1992), under complete markets and constant relative risk aversion utility, consumption should be perfectly correlated across countries though it typically has a lower correlation than output.<sup>24</sup> Using data across a wide cross-section of countries, Lewis (1996) showed that not only is the first-order condition for consumption risk-sharing rejected for standard non-durable consumption, this rejection cannot be explained by the country-specific effects of non-tradeable and durables consumption. Brandt, Cochrane, and Santa-Clara (2006) used the Euler equation relationship between exchange rates and SDFs in equation (12) as a benchmark for consumption risk-sharing. Using data on stock returns and exchange rates, they noted that the variance of exchange rates is high but the volatility of SDFs implicit in stock returns is even higher implying that risk-sharing is relatively high or, alternatively, exchange rates are not variable enough. However, their result is based upon

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<sup>24</sup>A full survey of the voluminous literature on international consumption risk-sharing is beyond the scope of this paper. Lewis (1999) provides a partial survey.



asset prices and not consumption. Indeed, when the authors used consumption data to recompute their risk-sharing index, they found the standard result that consumption risk sharing is quite low.

Another way to assess the degree of global integration using information across markets is to analyze the correlations, as proposed in Dumas, Harvey, and Ruiz (2003). They showed that the correlation of stock returns can be used to evaluate integration only after conditioning on macroeconomic fundamentals such as income. They found that the correlations in the data are more consistent with integration than segmentation of markets.

These papers focus upon analyzing the second moments of returns without addressing the first moments. As noted above, one approach toward explaining risk premia levels is to incorporate low frequency risk in consumption. Colacito and Croce (2011) analyzed the SDFs across countries by incorporating a long run risk as in Bansal and Yaron (2004), using data for the US and the UK. Assuming each country consumes a unique good, they extracted the low frequency component in consumption and found that they could match both the correlation between exchange rates and equity returns as well as individual variances.

While rejection of the Euler equation implies a rejection of perfect risk-sharing under the canonical model, it does not provide direct evidence for the reason behind this rejection. One possible source of rejection is that the gains from risk-sharing are not very large. If so, even small transactions costs can generate imperfect risk-sharing. Consumption-based models tend to find that the gains are modest (Tesar (1995), van Wincoop (1994), Hoxha, Kalemli-Ozcan, and Vollrath (2009)), while models using financial data as in Brandt, Cochrane, and Santa-Clara (2006) suggest the gains are large. Indeed, Lewis (2000) showed that the differences chiefly reflect the discrepancy between consumption-based models and the behavior of SDFs required to match asset pricing returns. Colacito and Croce (2010c) used a two-good model with long run risk to consider the implications on gains from risk-sharing. They found that the gains can be high over plausible parameter ranges. Lewis and Liu (2010) also used a long run risk model to evaluate the gains from risk-sharing using a single composite good. They found that the gains from risk-sharing depend strongly upon the correlation of long-run risk across countries. While the verdict is still out on the appropriate model for relating consumption to asset returns, the international risk-sharing gains appear to exceed the apparently low costs of international diversification.

Another problem with tests that reject risk sharing derives from the utility and stochastic as-

assumptions of the model. In particular, risk-sharing tests typically assume time-additive iso-elastic utility either implicitly or explicitly. On the other hand, recent research that reconciles consumption and asset price behavior requires preferences that are either recursive or habit dependent, as discussed above. Furthermore, early work using recursive preferences to look at international risk sharing as in Obstfeld (1994) assumed i.i.d. processes for consumption. However, recent models that attempt to match the asset pricing behavior with consumption data typically assume persistent consumption growth together with recursive preferences. In these models, consumption growth rates need not be perfectly correlated even when there is perfect risk-sharing.<sup>25</sup> Indeed, Colacito and Croce (2010a) show in a two-country model that even with iid output processes the time-variation in consumption weights can generate significant movements in the mean and variances of returns.

Heterogeneous beliefs present another set of models that can generate imperfectly correlated consumption, even with perfect risk-sharing. For example, Dumas, Lewis, and Osambela (2010) showed that the risk generated by foreign reaction to public signals implies the consumption correlations across countries are less than one, even under complete international risk-sharing.

## 5 Concluding Remarks

Despite decades of increased globalization, the prices of many internationally traded assets continue to depend upon local risk factors. Some of these local factors, such as exchange rate risk, are consistent with fully integrated markets. However, other local risk factors seem to suggest that international asset markets are still segmented. For example, firm-level equity returns depend significantly on domestic equity risk factors such as value, size, and market return, even when conditioned on global equity counterparts. At the aggregate market-index level, the dependence of equity returns on local factors seems most pronounced for emerging markets, suggesting some degree of market segmentation.

The continuation of market segmentation does not imply that globalization has had no impact, however. Indeed, a number of studies document the increasing trend toward integration across

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<sup>25</sup>Even if the investor's preferences are recursive, the social planner's problem is not recursive leading to possibly time varying consumption allocation weights across investors. See, for example, Dumas, Uppal, and Wang (2000) and Duffie, Geoffard, and Skiadas (1994).

a variety of capital markets. This trend has increased correlations in returns and other sources of risk-sensitivities, thereby reducing the gains to international portfolio diversification. While diversification gains still appear to be important at this time, increasing globalization of asset markets will likely reduce their importance in the future.

Globalization has yet to eliminate other well-known international asset market anomalies that may be related to market segmentation. Foreign assets, fixed income securities and equity alike, continue to provide substantial diversification opportunities yet these assets are underweighted in the standard domestic investor portfolio. Stocks that are cross-listed across international borders experience abnormal returns at the time of listing. Deviations from uncovered interest parity continue to be predictable in the short run as forward premia predict the wrong direction of future exchange rates. Whether these anomalies are due to explicit barriers to capital flows or more implicit effects such as heterogeneous information processing will only be revealed over time as capital market restrictions are removed.

Even if asset markets could be considered fully integrated across countries, models of global asset pricing face a number of challenges beyond the standard closed economy models. For example, a typical closed-economy problem is that the investor's intertemporal marginal utility is not large or variable enough to explain asset return premia or their volatility. Open economy asset pricing models confront even more dimensions since the differences in marginal utility across countries must explain cross-country phenomena such as the exchange rate risk premium or the correlation of stock returns. Some promising research has emerged by allowing for low frequency variation in consumption risk to address pieces of this global asset pricing picture. As these research pieces come together, a clearer picture will surely emerge.

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Table 1: Global and Local Factors in Equity Pricing

Panel A: World and International Asset Pricing Model			
Model Version	World	International	No Priced Currency Risk
Unconditional	0.161	<b>0.049</b>	0.740
Conditional	< <b>0.001</b>	0.228	< <b>0.001</b>
Panel B: Firm-Return Factor Models			
	World CAPM	World FF	World APT
World CAPM	—	<b>-6.77</b>	<b>-3.10</b>
World+Local	<b>-5.50</b>	<b>-5.53</b>	<b>-8.38</b>
Heston-Rouwenhorst	<b>-2.84</b>	-0.29	0.29
	World + Local CAPM	World + Local FF	World + Local APT
Heston-Rouwenhorst	<b>5.00</b>	<b>7.28</b>	<b>7.31</b>
Panel C: Loadings for Foreign MNC Returns on US+Local Market			
$r_t^{i\ell} = \alpha + \beta^{US} r_t^u + \beta^{local} r_t^\ell$			
1. Equally-Weighted Means			
Total Foreign MNCs in US	$\beta$ on US	$\beta$ on Local	R-Sq
Full Sample	-0.024	<b>0.760</b>	0.200
2. Market-Weighted Means			
US Exchange Subset in 2004	$\beta$ on US	$\beta$ on Local	Corr( $R^u, R^\ell$ )
Before Cross-Listing	<b>0.486</b>	<b>0.647</b>	0.198
After Cross-Listing	<b>0.740</b>	<b>0.766</b>	0.289
3. Based on Cross-Listing Event			
Abnormal Returns*		Change in Beta	
Prelisting and Listing	Postlisting	Local	Global
<b>0.17</b>	-0.14	<b>-0.321</b>	<b>0.135</b>

Notes: \* Returns in weekly percent. Numbers in bold are significantly different from zero at 5% MSL.

Sources: Panel A-Dumas and Solnik (1995), Table III and VI. The cells report the p-value for the hypothesis in the column. Panel B-Bekaert, Hodrick, and Zhang (2009), Table IIA., reporting t-stats for MSE difference for model in row minus model in column. Panel C 1 and 2- Chua, Lai, and Lewis (2010) Table 7 and authors calculations.

Panel C3-Foerster, and Karolyi (1999) Table VI.

Table 2: Foreign Exchange Return Regressions and Consumption Covariations			
Panel A: Fama Regressions Estimates $\Delta s_{t+1} = \beta_0 + \beta_1 (f_t - s_t) + u_{t+1}$			
Currency	$\beta_0$	$\beta_1$	MSL $H_0: \beta_1 < \frac{1}{2}$
Japanese Yen	<b>0.009</b>	<b>-2.57</b>	0.0001
British Pound	-0.004	<b>-1.94</b>	0.0016
Swiss Franc	0.005	<b>-1.30</b>	0.0032
Panel B: Carry Trade Regression Estimates			
$sign(f_t - s_t) * (s_{t+1} - f_t) = b_0 + b_1 abs(f_t - s_t) + e_{t+1}$			
	Coefficients		Predicted Carry Trade
Currency	$b_0$	$b_1$	Mean (Std Dev)
Japanese Yen	-0.006	<b>3.02</b>	3.02 (7.16)
British Pound	-0.002	<b>2.68</b>	3.54 (5.17)
Swiss Franc	<b>-0.006</b>	<b>2.83</b>	2.20 (7.88)
Panel C: Implied Risk Premium and Consumption Variances			
Japanese Yen	British Pound	Swiss Franc	US Consumption
46.87	20.07	19.46	1.76
Notes: Numbers in bold are significantly different from zero at 5% MSL.			
Source: Author's calculations using MSCI exchange rate data and Datastream			
Eurocurrency deposit rates from August 1978 to October 2010. Consumption is US			
Real Consumption Expenditure from National Income and Product Accounts for 1978 Q3 to 2010 Q3			



