Alexander G. Michaelides

International portfolio choice, liquidity constraints and the home equity bias puzzle

Originally published in Journal of economic dynamics and control, 28 (3). pp. 555-594 © 2003 Elsevier B.V.

International Portfolio Choice, Liquidity Constraints and the Home Equity Bias Puzzle*

Alexander Michaelides†

London School of Economics, CEPR and FMG

January 9, 2003

*I would like to thank Paolo Pesenti for an early discussion on this topic, Paolo Vitale for helpful comments, an anonymous referee for thoughtful suggestions and participants at the May 2001 CEPR European Summer Symposium in International Macroeconomics and at the June 2001 Society of Computational Economics conference for helpful comments. Any remaining errors or omissions are my own. This paper was mostly written while I was a lecturer at the Department of Economics, University of Cyprus. Partial funding from the Research Committee at the University of Cyprus and European Union funding through the HERMES Center of Excellence in Computational Finance and Economics at the University of Cyprus is gratefully acknowledged.

†Address: Department of Economics, London School of Economics, Houghton Street, London, WC2A 2AE. E-mail: A.Michaelides@lse.ac.uk. Tel: +44 (0)20 7955 6857. Fax: +44 (0)20 7831 1840.

Abstract

This paper solves for optimal international portfolio choice in the presence of liquidity constraints and undiversifiable labor income risk. Optimal portfolios are internationally diversified while positive correlation between domestic stock market returns and permanent labor income shocks can generate a complete portfolio specialization in foreign stocks. Nevertheless, either small costs associated with investing abroad or a slightly positive domestic to foreign equity premium differential are sufficient to either deter households from participating in a foreign market or generate a substantial bias for home equities. The benefits of international diversification are limited because consumption fluctuations can be smoothed with a small amount of buffer stock saving, while exchange rate risk makes foreign investments less appealing to risk averse investors.

JEL Classification: E2, F39, G11.

Key Words: International Portfolio Choice, Home Equity Bias, Liquidity Constraints, Information Costs.

1 Introduction

International finance theory emphasizes the effectiveness of global diversification in achieving a higher expected return at a lower risk (Levy and Sarnat (1970))[1]. This theoretical prediction contrasts sharply with the available evidence on international portfolio positions that concludes in favor of a widespread lack of diversification across countries. Specifically, French and Poterba (1991) and Tesar and Werner (1995) estimated the percentages of aggregate stock market wealth invested in domestic equities in the beginning of the 1990s to have been well above 90% for the U.S. and Japan and around 80% for the U.K. and Germany.[2] Tesar and Werner (1998) further show that foreign equity participation by U.S. investors has increased in the 1990s, but it still remains at low levels (in 1996 only around ten percent of total U.S. equity holdings was invested abroad). In a related empirical puzzle, Feldstein and Horioka (1980) have argued that domestic investment is highly correlated with domestic savings, a fact which could be interpreted as the manifestation of home bias in the real economy.

What can potentially explain this divergence of economic theory from economic reality? Lewis (1999) offers an extensive survey of potential explanations that have been put forth to date, ranging from the potential for domestic stocks to better hedge home risks than foreign stocks, the presence of non-tradeable consumption goods, diversification costs exceeding the gains, and the effects of uncertainty about the economic environment. Lewis concludes that "overall, equity home bias in portfolio levels remains a puzzle" (p.590).

This paper develops a potential explanation for home bias in domestic equities by certain investors. The basic ingredients of the model are undiversifiable labor income risk and liquidity constraints. Recently, there has been substantial interest in drawing out the implications of this model in a number of areas. Deaton (1991) and Carroll (1992, 1997)[3] have used this model to explain why consumption tracks income while at the same time consumption is smoother than labor income; buffer stock savers can smooth idiosyncratic earnings fluctuations with a small buffer stock of wealth, thereby explaining why consumption tracks income over time (Carroll and Summers, 1991). Constantinides et. al. (2002) and Storesletten et. al. (2001) argue that borrowing constraints and undiversifiable labor income risk over the life cycle explain a substantial component of the equity premium. Moreover, the evidence adduced by Gourinchas and Parker (2002) and Cagetti (2001) from microeconomic data and Ludvigson and Michaelides (2001) from macroeconomic data, respectively, is generally supportive of the buffer stock saving model as a plausible alternative to the classic Permanent Income Hypothesis in explaining consumption dynamics.

It is probably important at this point to isolate the differences between the treatment of human capital under this approach and the way non-tradeable human wealth has been used to date in the home equity bias literature. Baxter and Jermann (1997) show that domestic human capital returns are more positively correlated with domestic stock rather than with foreign stock returns, an observation that forces their two country general equilibrium real business cycle model to conclude that "the international diversification puzzle is worse than you think." Bottazzi, Pesenti and van Wincoop (1996) argue instead that focussing on the correlation between productivity shocks among different countries might be misleading since other shocks that lead to a redistribution of total income between labor and capital might make foreign securities a less attractive hedge against labor income uncertainty. Using OECD data, they argue that redistributive shocks are sufficiently important to generate a bias towards home equities but the model falls short from matching the magnitude of the home equity bias. This paper differs from these studies in a number of important dimensions. First, undiversifiable labor income risk generates an ex post heterogeneous population of consumers/investors. Second, labor income risk is calibrated to be consistent with microeconometric studies rather than being calibrated from macroeconomic data. Finally, liquidity constraints are explicitly imposed and are an integral part of the analysis[4].

This paper begins by analyzing the theoretical predictions of the buffer stock saving model for international portfolio choice; this is the direct generalization of Heaton and Lucas (1997) in an international context[5]. In this setup we analyze how exchange rate risk affects international portfolio choice and assess the magnitude of hedging demands generated by either positive correlation between foreign and domestic stock markets or by a positive correlation between labor income risk and domestic stock market returns. The model predicts, for reasonably calibrated parameters, a complete portfolio specialization in stocks, the manifestation of the equity premium puzzle from the portfolio demand side.[6] Moreover, the agent holds a diversified portfolio with positive amounts of both the domestic and foreign equities given the benefits of international diversification. In fact, to the extent that permanent idiosyncratic labor income shocks are positively correlated with domestic stock market returns, the model predicts a complete portfolio specialization in foreign stocks, reflecting the Baxter and Jermann (1997) message that "the international portfolio diversification puzzle is worse than you think."

Given these counterfactual predictions, the model is adjusted to include the possibility that domestic investors are better informed about domestic rather than foreign investment opportunities, or might face a higher transaction cost from investing abroad. The idea that domestic residents might be facing a cost when investing abroad, or simply be better informed about domestic markets, is not new; see Gehrig (1993), Brennan and Cao (1997), Portes and Rey (1999), Hau (2001) and Ahearne et. al. (2000), for instance. We model this informational asymmetry in two different ways. First, investors perceive that they can earn a slightly higher return by investing domestically rather than abroad. We then ask how high must this perceived mean equity differential between domestic and foreign stocks be, to generate home equity bias. For empirically plausible parameter configurations, a mere two percent differential is sufficient to generate a home equity bias. Second, we ask whether small costs associated with investing abroad can generate a home equity bias, even if the expected return from investing abroad is the same as that from investing domestically. Small costs are shown to be sufficient in generating a bias for home equities.[7]

Why do such small costs or such small changes in the mean expected return in the foreign market generate such a sharp change in the predictions of the model? The answer lies with the fundamental mechanisms of consumption smoothing in the model. Agents expect high future earnings growth against which they cannot borrow. Asset accumulation is therefore costly and households only accumulate a small buffer stock of assets that is sufficient to smooth the idiosyncratic labor income shocks they face. Given the small magnitude of buffer stock wealth and the exchange rate risk associated with foreign investing, small costs are sufficient to deter foreign investments.

What are the empirical implications of this analysis? To the extent that stock market wealth is owned by small investors, the model predicts a substantial home equity bias and therefore offers one component in the list of explanations that might potentially rationalize the home equity bias puzzle. Specifically, young households starting with low initial assets or households that expect high future earnings against which they cannot borrow, or impatient households that never accumulate large quantities of wealth, will not diversify internationally when faced with small costs of investing abroad. Empirical evidence from the U.S. Survey of Consumer Finances (SCF) is offered to support this explanation for households with head aged less than 44; typically stockholders in these age groups do not directly hold large amounts of stocks. On the other hand, in the data some investors (typically those aged above 44 in the SCF) hold much larger quantities of equity than the model implies and their behavior is not being captured adequately by the infinite horizons buffer stock model since saving for retirement begins to take place at around that point in the life cycle (Cagetti (2001) and Gourinchas and Parker (2002)). In a life-cycle model with a retirement saving motive, wealth accumulation is higher and the welfare gains from diversifying internationally will therefore be larger. Nevertheless, the infinite horizons model does illustrate that for a certain fraction of the population, small costs can alter the predictions of the frictionless model dramatically and can generate a large bias towards domestic investments.

The paper is organized as follows. Section 2 describes the international portfolio choice model. Section 3 discusses the numerical solution method that generalizes in an international context the method proposed by Haliassos and Michaelides (2003) for solving the domestic portfolio choice model. Section 4 discusses the optimal international portfolio choice policy rules under different assumptions about the economic environment and computes the time series moments for consumption, domestic and foreign stock and bond holdings, and the portfolio share of domestic and foreign risky assets. Section 5 asks what information cost is necessary to generate a bias for domestic equities and Section 6 concludes.

2 The Model

We consider the problem of an infinitely-lived household that maximizes expected intertemporal utility faced with a menu of a domestic and foreign risky asset and a riskless domestic investment opportunity (cash). The household solves

$$MAX_{\{B_t,S_t^d,S_t^f\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t U(C_t), \tag{1}$$

subject to

$$C_t + B_t + S_t^d + S_t^f \leq X_t \tag{2}$$

$$X_{t+1} = S_t^d \widetilde{R^d}_{t+1} + S_t^f \widetilde{R^f}_{t+1} \widetilde{E}_{t+1} + B_t R_f + Y_{t+1} \tag{3}$$

$$B_t \geq 0 \tag{4}$$

$$S_t^d \geq 0 \tag{5}$$

$$S_t^f \geq 0 \tag{6}$$

All variables are in real terms. B_t, S_t^d and S_t^f are real amounts of the riskless asset (cash), of the risky domestic asset (domestic stocks) and of the risky foreign asset (foreign stocks), respectively, that are held between the beginning of period t and the beginning of period $t+1$. E_t denotes the mathematical expectation operator based on information available up to the beginning of period t, while β is the discount factor that satisfies $0 < \beta < 1$. $U(C_t)$ is the felicity derived from consumption in period t, X_t is cash on hand at the beginning of period t, $\{\widetilde{R}_{t+1}^d = 1 + \mu^d + \varepsilon_{t+1}^d\}$ is the risky gross return on domestic stocks held between the beginning of period t and that of period $t+1$, $\{\widetilde{R}_{t+1}^f = 1 + \mu^f + \varepsilon_{t+1}^f\}$ is the risky gross return on foreign stocks held between the beginning of period t and that of period $t+1$, $\{\widetilde{E}_{t+1} = 1 + \widetilde{e}_{t+1}\}$ is the stochastic exchange rate that will be used to translate foreign investments into domestic cash on hand in period $(t+1)$, $\{R_f = 1 + r\}$ is the gross riskless rate which is assumed time-invariant, and Y_t is labor income received at the beginning of period t. All the innovations $\{\varepsilon_{t+1}^d, \varepsilon_{t+1}^f, \widetilde{e}_{t+1}\}$ have mean zero and can have an arbitrary correlation structure between them. $\widetilde{E}$ denotes U.S. dollars per unit of the foreign currency so that foreign returns can be transated to (domestic) U.S. dollars. An increase in random variable $\widetilde{E}$ therefore denotes an appreciation of the foreign currency vis-a-vis the U.S. dollar.

The budget constraint (2) will hold with equality, given the assumption of non-satiation. The period-by-period felicity function is of the constant relative risk aversion (CRRA) form $U(C_t) = \frac{C_t^{1-\rho}-1}{1-\rho}$, $\rho \neq 1$, $\rho > 0$ and $U(C_t) = \ln C_t$ when $\rho = 1$. Constraint (6) is a direct generalization of the no short sales constraints imposed by Heaton and Lucas (1997) in a single, domestic, risky asset model.

2.1 Labor Income

Labor income risk is nondiversifiable because of moral hazard and adverse selection considerations, and it cannot be ignored by households concerned about their consumption paths. Labor income of household i follows:

$$Y_{it} = P_{it} U_{it}, \tag{7}$$

$$P_{it} = G P_{it-1} N_{it} \tag{8}$$

This process, first used in a nearly identical form by Carroll (1992), is decomposed into a "permanent" component, P_{it}, and a transitory component, U_{it}. We assume that $\ln U_{it}$ and $\ln N_{it}$ are each independent and identically (normally) distributed with means $\{-.5 * \sigma_u^2$, $-.5 * \sigma_n^2\}$, and variances σ_u^2 and σ_n^2, respectively[8].

The log of P_{it}, evolves as a random walk with a deterministic drift, $\mu_g = \ln G$, assumed to be common to all individuals. Given these assumptions, the growth in individual labor income follows

$$\Delta \ln Y_{it} = \ln G + \ln N_{it} + \ln U_{it} - \ln U_{it-1}, \tag{9}$$

where the unconditional mean growth for individual earnings is $\mu_g - .5 * \sigma_n^2$, and the unconditional variance equals $(\sigma_n^2 + 2\sigma_u^2)$. Individual income growth in (9) has a single Wold representation that is equivalent to the MA(1) process for individual earnings growth estimated using household level data (MaCurdy [1981], Abowd and Card [1989], and Pischke [1995]).[9]

2.1.1 Calibration of Parameters

The frequency that the model is calibrated for is annual. We set the rate of time preference, δ, equal to 0.05, and the constant real interest rate, r, equal to 0.02. Carroll (1992) estimates the variances of the idiosyncratic shocks using data from the *Panel Study of Income Dynamics*, and our benchmark simulations use values close to those: $\sigma_u = 0.1$ and $\sigma_n = 0.08$.[10] We set μ_g equal to 0.03 and the benchmark coefficient of relative risk aversion is set to either 2 or 5.

In order to calibrate the parameters of the model, an annual frequency data set for stock and exchange rate returns was created. End of year net return stock indices from MSCI international were used to construct stock returns for various developed OECD economies. Real exchange rate returns were also constructed using end of year exchange rates and end of year consumer price indices from the IFS database. Appendix A contains further details on the relevant variables. All exchange rates are denoted as U.S. dollars per foreign currency. The convention is chosen because the model is solved from the perspective of a U.S. investor and foreign local currency stock returns need to be translated to domestic returns using the U.S. dollar per foreign currency rate.

Table 1 reports descriptive statistics for annual real stock returns and real exchange rate returns for these OECD economies. A number of interesting characteristics merit further discussion. First, the standard deviation of real U.S. stock returns is the lowest among these OECD economies, whereas the Sharpe ratio (assuming a two percent annual riskless rate) is also quite high, indicating that investments in the U.S. might be favored by investors according to this measure. The standard deviation and mean return of both domestic and foreign stock returns is set at 18 percent and 8 percent per annum respectively (the U.S. values). Home bias will therefore not be generated artificially by choosing a more favorable risk-return tradeoff for U.S. investments. Second, the standard deviation of exchange rate changes is around half the standard deviation of the respective country's stock return. We therefore calibrate the standard deviation of exchange rate returns to be 9 percent per annum. Third, unlike the evidence from higher frequency data, the normality assumption is not rejected for most stock return series; the Jarque-Bera statistic rejects normality for four (Austria, Great Britain, Norway and Sweden) out of the sixteen OECD countries in the sample. For the exchange rate returns, there is no evidence for non-normality in any exchange rate pair at the five percent level of statistical significance. These findings justify using a normal distribution for net returns and exchange rate changes in the calibration. It is also useful to point out that nominal returns for the same series yield similar conclusions (except that the mean nominal return is around 5.5 percent higher over the period for all countries).[11] Fourth, the constructed real return series (both for stocks and exchange rates) are stationary and have no statistically significant first (or higher) order autocorrelation, justifying the no serial correlation assumption in the model.

Another important input in the calibration is the correlation structure between the various random variables. Table 2 reports the contemporaneous correlation between real annual U.S. stock returns, real foreign stock returns and real exchange rate changes. Panel A reports the correlations between real U.S. stock returns and real, foreign (in local currency) stock returns. The correlation varies between 0.34 (Austria) and 0.83 (Holland) indicating a substantial positive correlation between stock returns at an annual frequency. Notably, the correlation is quite low with the Japanese returns (0.37) and quite high with Great Britain (0.82) and Canada (0.67) while the correlation with the European markets is around 0.5. Given the range between around 0.3 and 0.8, we choose as the benchmark the 0.5 value but also report results for the extreme correlation values, 0.3 and 0.8.

Panel B reports the correlations between real U.S. stock returns and exchange rate changes. The correlation varies between around zero (-0.04 for Australia is the lowest correlation) and 0.4 (for Canada). Most correlations fall in the range between 0.15 and 0.3 with Japan at 0.25, Great Britain at 0.24 and Germany at 0.15. We therefore set this parameter to equal 0.15 in the benchmark case but also report results from varying this parameter between its lower (0.0) and upper (0.4) bounds. Panel C reports the correlations between exchange rate changes and the foreign stock returns with the variables of interest from the point of view of the U.S. investor highlighted in bold face. These correlations seem to vary between -0.09 (Sweden) and 0.41 (France) with most correlations in the range $0.0-0.3$. We therefore set the benchmark value equal to 0.0 and conduct robustness experiments varying the correlation between -0.1 and 0.4. Once more, comparing correlations for the nominal return series yields similar conclusions.[12]

Finally, another important correlation is that between labor income shocks and stock, or exchange rate, returns. Given that there are two earnings shocks, the first issue arises with the correlation between the transitory earnings shock and stock, or exchange rate, returns. Viceira (2001) and Haliassos and Michaelides (2003) show that varying the correlation between the transitory earnings shock and the stock return does not affect the portfolio choice allocation in a domestic setup; similar results hold here and are therefore omitted. Substantial hedging demands do arise, however, when the correlation between permanent earnings shocks and stock returns is positive (especially for higher risk aversion coefficients). The microeconometric evidence on this correlation is scant, however, partly because micro data might not offer a long enough panel to compute the necessary time series correlations with aggregate stock returns. The decomposition of individual earnings growth rates into permanent and transitory shocks, for instance, relies on the cross-sectional moments (see Abowd and Card (1989), for instance). Computing the correlation of the idiosyncratic earnings innovation with stock returns, however, will need to rely on time series moments, and will probably suffer from a finite sample bias problem (Jermann, (1999)). As a first step, Davis and Willen (2001) have estimated this correlation, and offer estimates between approximately zero and 0.3. On the other hand, Campbell et al. (2001) and Heaton and Lucas (2000a) only find such results when considering small subgroups of the population (for instance, self-employed households or households with private businesses). A priori, given that aggregate shocks are a small component of total individual earnings volatility (Pischke (1995)), we might expect the correlation of permanent idiosyncratic earnings innovations and aggregate stock returns to be low. Given the small component of aggregate uncertainty in individual earnings histories and the available empirical evidence to date, we view the zero correlation as a reasonable hypothesis and use it as the benchmark correlation. Results are also offered for the case where the correlation is higher (0.3). The correlation between the permanent earnings shocks and foreign stock returns and exchange rate changes is also set to zero.[13]

To summarize, the benchmark correlation parameters are as follows. The mean equity premium equals 6 percent and its standard deviation is 18 percent (both for domestic and foreign stocks). That is $\mu^d = \mu^f = .08$ and $\sigma_{\varepsilon^d} = \sigma_{\varepsilon^f} = .18$. The exchange rate innovation $\widetilde{e}$ has mean zero and its standard deviation is set to approximately half of the equity premium standard deviation (its standard deviation is therefore 0.09). The correlation between domestic and foreign stock returns equals 0.5, the correlation between U.S. stock returns and exchange rate changes equals 0.15, the correlation between exchange rate changes and foreign stock returns is set equal to 0.0 and the correlation between permanent earnings shocks and stock returns (both domestic and foreign) is set to zero. Comparative statics results from varying the contemporaneous correlations between stock returns, exchange rates and labor income shocks are reported in Section 4. Numerical quadrature is used to take expectations, in the spirit of Tauchen and Hussey (1991).

3 The Euler Equations

There is no analytical solution to the model and we therefore proceed with a numerical solution. Analytical first order conditions for bonds and for stocks respectively can be written as follows:

$$U'(C_t) = \frac{1+r}{1+\delta} E_t U'(C_{t+1}) + \lambda_B \tag{10}$$

and

$$U'(C_t) = \frac{1}{1+\delta} E_t \left[U'(C_{t+1}) \, \widetilde{R}^d_{t+1} \right] + \lambda^d_S \tag{11}$$

and

$$U'(C_t) = \frac{1}{1+\delta} E_t \left[U'(C_{t+1}) \widetilde{E}_{t+1} \, \widetilde{R}^f_{t+1} \right] + \lambda^f_S \tag{12}$$

where λ_B, λ^d_S and λ^f_S refer to the Lagrange multipliers for the no short sales constraints on bonds, domestic stocks and foreign stocks, respectively. Recalling that the budget constraint in period t is

$$C_t = X_t - B_t - S^d_t - S^f_t \tag{13}$$

where X_t is cash on hand, a binding short sales constraint on bonds, implies that $C_t = X_t - S^d_t - S^f_t$. Similarly, when the constraint preventing short sales of domestic stocks is binding, (13) implies that $C_t = X_t - B_t - S^f_t$, while a binding constraint on foreign stock short selling implies that $C_t = X_t - B_t - S^d_t$.

The numerical solution algorithm and the theoretical conditions that are sufficient for a unique solution to exist are outlined in Appendix B.

4 Comparative Statics

4.1 Labor Income Uncorrelated to Stock Returns

The policy functions for $\{\rho = 2, 5\}$ are given in figures $1 - 4$. We first note that the consumption policy rule has the same shape as in the buffer stock saving literature (figure 1). Consumption equals cash on hand until a target cash on hand to income ratio (no saving region). Once saving takes place, the marginal propensity to consume out of extra cash on hand rapidly falls. In terms of optimal portfolio choice, complete portfolio specialization in stocks arises once positive saving takes place. This result, first derived by Heaton and Lucas (1997) for the domestic portfolio choice problem, is the portfolio demand manifestation of the equity premium puzzle (figure 4 shows that no savings is allocated in the riskless asset market). Moreover, the total amount of savings is not substantially affected by varying the risk aversion parameter (see figure 1), even though there are some changes in the portfolio composition (see figures 2 and 3). The benefits of international diversification can be clearly seen since the portfolio contains both domestic and foreign investments once saving takes place (figures 2 and 3). With international portfolio choice the foreign asset is riskier than the domestic asset, since exchange rate risk is not hedged, and this riskiness generates a small bias towards domestic investments (the share of wealth in the domestic market is higher than the share of wealth invested in the foreign market).

Table 3 uses the invariant distribution of normalized cash on hand (see Appendix C) to emphasize that mean and median bondholding are both zero. Table 3 also illustrates that consumption smoothing is achieved, with individual normalized consumption having half the standard deviation of individual normalized earnings. The time series results also show that (for either $\rho = 2$ or $\rho = 5$) there is a bias towards domestic investments with both the mean and median share of wealth invested domestically being greater than the share of wealth invested abroad. Computing medians yields a similar bias towards domestic equities. Even though there is a bias towards domestic investments, however, this is not sufficient to generate the bias observed in the data. It is of interest to note that when risk aversion is increased from $\rho = 2$ to $\rho = 5$, the mean share of wealth invested in foreign stocks slightly rises (from 0.33 to 0.37) since the benefits from international diversification are higher for more risk averse investors. It is also of interest to note that in the stationary equilibrium, mean total savings is around 15 to 17 percent of mean labor income; consumption smoothing is achieved with a relatively small amount of buffer stock saving.

It is instructive to use the Euler equations to investigate the source of portfolio diversification and its robustness to different levels of risk aversion. This can be seen using the different shadow values of the two short-sales constraints on domestic and foreign stock holding. Combining (11) and (12) yields

$$\frac{1}{1+\delta} E_t \left[U'(C_{t+1}) \left(\widetilde{R}^d_{t+1} - \widetilde{E}_{t+1} \widetilde{R}^f_{t+1} \right) \right] = \lambda^d_S - \lambda^f_S. \tag{14}$$

Under no stockholding (for this model, no saving), no correlation between earnings and stock returns and no correlation between stock returns and exchange rate risk, equation (14) can be rewritten as

$$\frac{1}{1+\delta} E_t \left[U'(C_{t+1}) \right] \; E_t \left[\widetilde{R}^d_{t+1} - \widetilde{E}_{t+1} \widetilde{R}^f_{t+1} \right] = \lambda^d_S - \lambda^f_S \tag{15}$$

Given the same expected return on the domestic and foreign investment, as assumed up to this point, the left hand side of (15) is zero. Since $\lambda^d_S = \lambda^f_S$ at zero saving, households that start saving would like to invest in both the domestic and foreign stock market since the shadow value of investing is the same in both markets. Thus, even the smallest amount of positive savings is allocated in both stock markets, despite casual empiricism that suggests that investors first enter the domestic market and then move on to other markets.

4.2 Correlation between domestic stock market returns and labor income risk

In this section we investigate the effect of positive correlation between permanent labor income shocks and stock returns on the international portfolio choice decision. In the domestic portfolio choice model, positive correlation between permanent labor income shocks and stock returns can generate co-existence between bonds and stocks in the portfolio for sufficiently risk averse households (Heaton and Lucas (2000b)), a co-existence that is hard to generate given the equity premium. Varying this correlation does not affect the shape (and level) of the consumption policy rule while the complete portfolio specialization in stocks persists. Strikingly, however, there is now a complete portfolio specialization in foreign stocks, illustrating clearly the Baxter and Jermann (1997) message that "The international portfolio diversification puzzle is worse than you think". The results are corroborated by the time series averages from the invariant distribution but are omitted due to space considerations. This result has two implications. First, to the extent that positive correlation between earnings shocks and stock returns exists in the data, the home equity bias becomes much more difficult to explain. Specifically, given the evidence in Heaton and Lucas (2000a) that small business proprietors are more likely to be stock holders and that their business income might be positively correlated with the domestic stock market, the home equity bias puzzle is worsened. Second, positive correlation between stock returns and labor income shocks could be used to explain the co-existence of bonds and stocks in the portfolio, thereby avoiding the complete portfolio specialization in stocks prediction of the domestic portfolio choice model (see Heaton and Lucas (2000b)). If this route is taken, however, then co-existence of bonds and stocks in the portfolio is replaced in the international portfolio choice model by a complete portfolio specialization in foreign stocks.

4.3 Does International Diversification Pay when Stock Markets are Positively Correlated?

The next comparative statics exercise investigates the benefits from international diversification when stock markets are positively correlated. I have used two correlation coefficients: 0.3 and 0.8 that capture the range of representative correlations among developed equity markets, as reported in the data section. Varying this correlation does not affect the shape or level of the consumption policy rule while complete portfolio specialization in stocks persists. Nevertheless, the correlation has a substantial effect on the portfolio decision between domestic and foreign assets (figures 5 and 6)[14]. Specifically, increasing the correlation between domestic and foreign stock markets makes the preference for domestic stocks stronger since the benefits of diversification are reduced as this correlation increases (figure 5). International diversification continues to pay, however, since for either correlation both domestic and foreign assets are included in the portfolio, once saving is undertaken.

Is high domestic to foreign stock market correlation a reasonable explanation of the home equity bias puzzle? From Table 2 (Panel A), the highest correlation of US stock market returns is that with Great Britain (0.82) whereas the one with Canada is also very high (0.67). The correlation with Japan is very low on the other hand (0.37). The model would therefore predict that a U.S. based investor should have a domestic equity bias against the UK and Canada but would rather invest in Japan. Is this the case empirically? Bohn and Tesar (1996) argue that, if anything, U.S. investors first invested in Canada and only gradually shifted some of their investments to Europe, Japan and emerging economies, while maintaining the bias towards domestic equities. High correlations between the domestic and foreign stock market make the equity bias puzzle even stronger therefore since, if anything, U.S. investors should not have first invested in a country like Canada.

4.4 Deepening the home equity bias puzzle

The correlation between exchange rate changes and foreign stock returns tends to vary between -0.1 and 0.4 (Table 2, Panel C). In the benchmark model we used zero as the base case but it would be interesting to consider what happens when this correlation is increased. Figures 7 and 8 report the results for optimal international portfolio choice when this correlation is raised to 0.25, ceteris paribus. The home equity bias puzzle is substantially worsened since the domestic investor first invests in the foreign market and then allocates some funds to the domestic asset. Why does this happen? A positive correlation between foreign stock returns and the exchange rate implies that the domestic investor stands more to gain by investing abroad since the positive covariation between the exchange rate and the foreign stock return is an additional benefit when the expectation of $\widetilde{E}_{t+1}\widetilde{R}^{f}_{t+1}$ is computed (a booming foreign market offers the benefit of a depreciating dollar). To the extent, therefore, that this correlation is important, the home equity bias puzzle becomes even harder to explain. For the OECD countries in the sample, this correlation is particularly high for Canada (0.31), Spain (0.27), France (0.41), and Japan (0.29). To the extent, therefore, that U.S. investors do not invest more in (say) Japan, the home equity bias puzzle is deepened since the mere presence of this correlation should provide an even stronger incentive to diversify internationally.

4.5 Correlation between exchange rates and domestic (U.S.) stocks

The empirical range of the correlation between exchange rate changes and U.S. stock returns also varies between zero and 0.4 (Table 2, Panel B). Figures 9 and 10 compare the change in asset allocation when the correlation is raised from the benchmark value of 0.15 to the upper bound 0.4. The share of wealth allocated in domestic stocks now rises since foreign investments carry the additional risk of depreciation of the dollar when domestic stock markets will do well. Two points need to be noted. First, the portfolio remains internationally diversified so that varying this correlation will not resolve the home equity bias puzzle. Second, this correlation is the highest (0.4) for Canada, implying that according to this metric, US investors should not have first preferred Canada rather than another country when investing abroad. We conclude that this correlation can substantially alter the optimal international portfolio but is unlikely to provide an explanation for the observed bias in home equities.

4.6 How Important is Foreign Exchange Risk in the International Portfolio Choice Decision?

We have seen that even though the foreign asset is always held in positive amounts in the portfolio once saving takes place, there is a bias towards holding a larger proportion of wealth in the domestic asset. This arguably arises from the exchange rate risk that a foreign investment entails for a prudent investor. In order to more closely analyze the effect of foreign exchange rate risk on the optimal international portfolio choice decision, I recomputed the policy functions after reducing the standard deviation of exchange rate changes to 0.001 (from 0.09 in the benchmark model). The results are plotted in figures 11 and 12.

The optimal portfolio allocation is extremely sensitive to exchange rate volatility; the reduction in foreign exchange rate risk reduces the share of wealth allocated in the domestic market as the agent allocates more wealth abroad. In particular, when exchange rate risk is practically eliminated, approximately half of the wealth is allocated in the domestic market and half is allocated abroad[15], regardless of the coefficient of relative risk aversion.[16]

We conclude by pointing out that since lower foreign exchange rate risk implies an aggressive increase in foreign equities, a currency union that eliminates exchange rate risk should imply a higher rate of cross border investment within the union. The European Monetary Union should therefore provide the catalyst for a substantial increase in cross border investment within the members of the Union. Moreover, if international investors can (cheaply) hedge their foreign exchange risk, then the home equity puzzle becomes even more difficult to explain.

5 Can Small Costs Generate Home Bias in Equity Investments?

In the popular press, the idea that investors have better information about nearby firms than distant ones is taken for granted.[17] More recently, a number of academic papers have rigorously tested this hypothesis. Coval and Moskowitz (2001) find that the distance between fund managers and potential investments is a "key determinant of U.S. investment manager portfolio choice." Coval and Moskowitz (1999) also find that investors possess significant informational advantages in evaluating nearby investments and also find that active mutual fund managers overweight proximate firms in their portfolios and earn substantial abnormal returns in local holdings. If this argument holds for domestic investments, then it is natural to conjecture that geographical distance might be an important determinant of international portfolio choice. Indeed, Coval and Moskowitz (2001) extrapolate their findings to the international scale and find that "distance may account for roughly one third of the observed home country bias in U.S. portfolios estimated by French and Poterba (1991)".

In the next two subsections I assess the potential for small costs to generate a home equity bias. The first subsection assumes that domestic investors are better informed about domestic rather than foreign investment opportunities and therefore expect to earn a higher mean return on domestic investments; the question that arises then is what level of domestic to foreign equity premium differential is needed to generate the observed home equity bias.

The second subsection assumes that there is an explicit cost in undertaking foreign relative to domestic investment. In such an economic environment, we ask whether small cost differentials can generate the observed home equity bias (the costs can be explicit transaction costs or implicit in terms of the opportunity cost of time associated with finding a broker abroad, for instance).

5.1 How low must the foreign equity premium be to generate home equity bias?

In the benchmark model analyzed in previous sections, both the domestic and foreign equity premia were set equal to six percent. Interesting portfolio allocations result from changing the foreign equity premium downwards from six to two percent in the different economic environments under consideration. In the benchmark model with $\rho = 2$, a foreign equity premium of five percent generates complete portfolio specialization in domestic stocks (that is, a domestic to foreign mean return differential of a mere one percent per annum can generate complete home bias in equities). With $\rho = 5$, a foreign equity premium lower than 4.75 percent generates complete portfolio specialization in domestic equities; the mean differential between domestic and foreign equities has to be slightly higher than when $\rho = 2$ because the benefits from international diversification are higher for higher levels of prudence (or saving).

What is even more surprising is that such conclusions can be generated even for the case when positive correlation between domestic stock returns and permanent labor income shocks exist. In this case, given the magnitude of the home equity bias puzzle illustrated in section 4.2, the foreign equity premium must be perceived to be even lower than in the zero correlation case. For $\rho = 2$ the foreign equity premium must fall to four from five percent to generate complete portfolio specialization in domestic stocks while for $\rho = 5$ it must fall even lower to around three percent.

These results are quite surprising given the benefits that international diversification can offer and the consistent prediction in the previous section that the agent should hold an internationally diversified portfolio. What is the economic mechanism that can explain these surprising results? Buffer stock savers can smooth idiosyncratic earnings shocks with little wealth accumulation. Table 3 has shown that normalized consumption is half as volatile as normalized earnings (comparing standard deviations) and this is achieved by accumulating a total of 0.15 units of normalized wealth (15 percent of mean labor income) when $\rho = 2$ and 0.17 units of normalized wealth when $\rho = 5$. In turn, this wealth is broken down between 0.09 (0.10 for $\rho = 5$) units in domestic assets and 0.06 (0.07 for $\rho = 5$) units in foreign stocks, respectively. The low level of total savings and the bias towards domestic stocks that exchange rate risk generates, are two factors that reduce the attractiveness of foreign equities quite quickly. The even lower foreign equity premium needed to generate a domestic equity bias for higher degrees of prudence (ρ) is consistent with this explanation since the level of wealth invested in the foreign stock market is higher in this case and therefore the gain from international diversification is even stronger.

We conclude this section by pointing out that a domestic to foreign equity premium differential of the range of $2 - 3$ percent can generate the observed bias in domestic equities. How reasonable is such an assumption? This is an empirical question but the evidence adduced by Coval and Moskowitz is consistent with this observation; if investors believe that they have more accurate information about investments close to home, and therefore a higher domestic to foreign return on investment, home equity bias will arise. Equivalently, if familiarity raises domestic expected returns above foreign ones, even by a two to three percent per annum level, then it might breed domestic (rather than foreign) investment.

5.2 Can small information/transaction costs generate home equity bias?

We will now consider the potential for small information/trading costs associated with investing abroad to generate home equity bias, while keeping the same expected equity premia in the two different countries. The thought experiment is as follows. Suppose that access to foreign stockholding opportunities entails a small cost (it might be the cost of opening a foreign account, the opportunity cost of time monitoring a foreign investment, the higher cost of acquiring information about a foreign market, higher brokerage fees from investing abroad or simply inertia). We are interested in computing the threshold cost that will keep this investor in the domestic market, thereby generating a complete portfolio specialization in domestic stocks.

To compute this threshold entry cost, we solve for the associated value functions. Details of this computation are found in Appendix D. The value function of the international portfolio choice model exceeds that of the domestic portfolio choice model at any level of normalized cash on hand, since households are no worse off when they have the option to invest in foreign stocks. If we denote the value function associated with participating in the foreign stock market by V_f and the value function when using domestic capital markets by V_d, the normalized threshold entry cost as a function of normalized cash on hand is $k(x)$, such that

$$V_f(x - k(x)) = V_d(x) \tag{16}$$

Given the monotonicity in cash on hand of the value function, we can use a numerical interpolation procedure to invert the value functions and derive the entry cost as

$$k(x) = x - V_f^{-1}(V_d(x)) \tag{17}$$

Since $k(x)$ varies with the realized cash on hand, we can now make use of the time-invariant distribution of normalized cash on hand[18] to find the maximum level of x that the household will experience. We compute this from the invariant distributions as the level $\widehat{x}$, such that $\Pr(x \leq \widehat{x}) = 1$. The threshold entry cost is then computed as $k(\widehat{x})$.[19] Note that this procedure is necessary since the problem is "stationary": $\widehat{x}$ will be reached with probability one in this infinite horizons model; in order to be excluded from foreign investment, one needs to ensure that the domestic investor never reaches cash on hand levels above this cutoff point. Alternatively, one can think of heterogeneous cost levels that will vary by individual leading to segmented international markets between investors who participate in all financial markets and others who optimally choose not to incur the fixed cost and are satisfied with the domestic investment opportunities.

The invariant distributions associated with the international portfolio choice model are plotted for completeness in figure 13; they illustrate that for higher degrees of risk aversion/prudence, higher wealth accumulation takes place and the distribution of cash on hand is skewed to the right. The resulting certainty equivalents are also graphed in figure 14 and are shown to be increasing in the level of liquid wealth. At higher wealth levels the benefit from diversifying internationally is greater and therefore a higher cost is needed to generate foreign market non-participation. Moreover, higher levels of prudence require a higher threshold cost to deter foreign market non-participation since higher risk aversion implies a higher level of precautionary saving balances and therefore a higher benefit from diversifying internationally. Positive correlation between domestic stock market returns and permanent labor income shocks is also associated with higher levels of threshold costs needed to deter foreign market participation since, again, the benefits from diversifying internationally are greater than when this correlation is zero.

Table 4 reports the values of the threshold costs that can ensure non-participation in the international asset market for different specifications of the economic environment (as a percentage of mean labor income). The threshold entry costs are highest when the correlation between permanent labor income shocks and domestic stock returns is positive (panel II); this is consistent with the higher need to diversify internationally when the domestic stock market is not a good hedge against earnings fluctuations. The costs of 4.2 percent (for $\rho = 2$) and 10.0 percent (for $\rho = 5$) are substantial implying that in this economic environment, the home equity bias cannot be explained by small costs. On the other hand, panels I, II and IV show that very small information costs can generate home equity bias; these costs vary between 0.2 and 0.6 percent of mean labor income.

One may wonder why entry costs tend to be low, given that the household gains access to foreign stocks over an infinite horizon. Three factors are at work. First, access to stocks does not necessarily imply stockholding in every period. Liquidity constraints imply that households are likely to spend a substantial fraction of their time at levels of normalized cash on hand that do not justify any stockholding. Specifically, when $\rho = 2$ and stock returns are uncorrelated with labor income, the household does not save anything around 12 percent of the time. When the coefficient of relative risk aversion rises to 5, on the other hand, the liquidity constraint is binding around 10 percent of the time, enhancing the value of entering the foreign stock market and justifying the higher cost needed to generate foreign stock market non-participation (the cost rises from one to 2.6 percent of mean labor income). Second, the amount of total saving is low (see the results in table 1) implying that the benefits from international diversification are limited. Third, the exchange rate risk associated with foreign investing is non-negligible. Given the risk aversion of the agent, compounded by the liquidity constraint, the benefit of international diversification comes with a cost in the form of an additional layer of uncertainty. All three factors detract from the appeal of having access to foreign stocks and tend to lower the threshold entry costs.

The finding that relatively low entry costs can generate foreign stock market non-participation is consistent with the theoretical findings of Haliassos and Michaelides (2003) that low entry costs can generate stock market non-participation in the context of the domestic portfolio choice model. Given the recent empirical findings by Vissing-Jorgensen (2002) and Paiella (2000) that small entry costs can generate stock market non-participation domestically, we conjecture that an empirical study in an international context could yield similar support for international stock market non-participation. Moreover, it is important to note that foreign equity participation by U.S. investors has increased in the 1990s, but at around ten percent of equity holdings being invested abroad, it still remains at low levels (Tesar and Werner, 1998). The increase in foreign stock market participation by U.S. investors would be consistent with a gradual reduction in information costs about foreign investment opportunities in the 1990s either through the proliferation of mutual funds invested in foreign securities or simply through the greater ease of information acquisition that the Internet provides.

5.3 How credible are the empirical implications of the model?

The model generates home equity bias for small, fixed, international transaction costs because the household can smooth consumption fluctuations with a small amount of buffer stock saving that is invested in the stock market[20]. How does this finding relate to observed economic behavior? The Survey of Consumer Finances (SCF) contains detailed financial asset information for U.S. families and can be used to investigate the empirical relevance of this prediction. The SCF is a triennial survey sponsored by the Federal Reserve and surveys exist for 1989, 1992, 1995 and 1998. Table 5 reports summary statistics for some of the key variables used in the theoretical model for U.S. stockholders (who tend to be richer than non-stockholders). The four panels report statistics from each survey (all dollar amounts are in 1998 values) and the results are broken down by age group. It is important to realize that the model intends to capture the behavior of households in the first half of their working life cycle; households are thought to be buffer stock savers holding small amounts of liquid wealth for precautionary reasons until around age 45, whereas they start saving for retirement from then on (see Gourinchas and Parker (2002) and Cagetti (2001)). Details about the variables can be found in Appendix A.

To measure income, the survey requests information on families' total cash income, before taxes for the full calendar year preceding the interview. Table 5 shows that in all survey years, median income has a hump shape and peaks in the $45-54$ age group. The median value of directly held stocks tends to rise almost throughout the life-cycle, consistent with the idea that households tend to increase saving (and therefore the value of stocks held) as they approach retirement. What is perhaps remarkable is the low value of directly held stocks until age 44. For all surveys except 1998, the median value of stocks was less than around $5,000$ US$ for households with the age of the head less than 44. Given the increase in valuations in the 1990s, the $35-44$ age group in 1998 had holdings equal to $12,000$ US$. The value of directly-held mutual funds is also of interest and is reported in the third row of each panel. Reflecting the substantial proliferation of mutual funds in the U.S. in the 1990s, the median value of mutual funds has increased in importance in household portfolios over the decade. In 1989, for instance, the median value of mutual funds was approximately the same as the median value of stocks (averaging over all age groups). By 1992, however, mutual fund values were between 1.5 to three times the median value of stocks for the $35-74$ age groups with similar magnitudes existing in the 1995 and 1998 surveys.

Two statistics are relevant from the point of view of the theoretical model; the ratio of liquid wealth to income and the ratio of stocks to income. In the model, the first of these values was less than around 1.2 while the median of the ratio of stocks to income was around 0.15. Panels A-D illustrate that for directly held stocks these magnitudes are empirically relevant for households with the age of the head less than 44 while for households in higher age groups these magnitudes tend to be much lower than their empirical counterparts. When the amounts held in mutual funds are included, however, the conclusions are not as stark, except for the 1989 survey. Specifically, the median value of directly-held mutual funds has risen in the 1990s and is slightly more important in the portfolio than the value of directly held stocks. For the youngest households (less than 35 years old) the absolute value of directly held mutual funds does remain quite small however; it is 2,854$ in 1992, 5,842$ in 1995 and 7,000$ in 1998 (compare to 2,283$, 3187$ and 5,000$ in stocks, respectively). Two caveats must be borne in mind. First, the median values being reported are much higher than the values of stocks and mutual funds owned by the lower quintiles of these distributions. Second, the substantial increase in stock prices in the 1990s has increased the value of stock holdings in household portfolios but it is not clear whether the valuation change is permanent or transitory; to the extent that there is mean reversion in stock prices, the valuation of stocks and mutual funds in the portfolio might revert to the smaller levels observed in 1989.

What do we conclude from these statistics? For certain households early in the life-cycle the model seems to be quite relevant. These households tend to have a small precautionary buffer that they use to smooth consumption fluctuations. Given that the absolute amount of this buffer stock is small, the incentive to diversify internationally in the presence of either small transaction costs or lower expected returns associated with international investing can be weakened enough to generate a home bias in equity investments. The argument fails to hold after around age 40 as saving for retirement begins to take place; after that age stockholders tend to start accumulating substantial amounts of assets and the model stops capturing savings behavior adequately. Nevertheless, the model can contribute towards understanding foreign market non-participation for certain households in the population; these households tend to be the ones with low levels of stock market investment.

6 Concluding Remarks

This paper has extended the Heaton and Lucas (1997) approach to solving domestic portfolio choice models in an international context. We have found that the investor holds an internationally diversified portfolio, even when very small amounts of wealth are being invested. Positive correlation between domestic stock market returns and permanent labor income innovations worsens the home bias puzzle significantly since it predicts complete portfolio specialization in foreign stocks. Positive correlation between domestic and foreign stock markets reduces foreign stock market participation but the portfolio remains internationally balanced. Mitigating exchange rate risk also worsens the home equity bias puzzle.

Given these counterfactual predictions, the model was modified in two different directions that can both be motivated by the presence of differential costs about domestic versus foreign investment opportunities. Specifically, more accurate information about domestic investments that leads to either higher expected returns domestically, or to small foreign investment costs, generates a substantial home equity bias. This result arises because consumption fluctuations can be smoothed with a small amount of equity accumulation. The model therefore generates the prediction that, to the extent that equity wealth is held largely by small savers, a home equity bias can arise. On the other hand, it is often the case that certain stock-holders (usually beyond age 40) own a large component of total equity wealth; given that the diversification benefit is increasing in invested wealth, the home equity bias will be much harder to generate for such investors. The lack of international diversification for investors who hold large quantities of equity remains, therefore, an open question from the perspective of this model.

A Data

A.1 Time series Data

The sample extends between 1973 and 2001 at an annual frequency. The stock return data are constructed using the end of year Morgan Stanley International (MSCI) monthly indices that include dividends re-invested and subtract taxes. The exact codes names are:

Australia (MSCI.AU.MNI), Austria (MSCI.AT.MNI), Belgium (MSCI.BE.MNI), Canada (MSCI.CA.MNI), Denmark (MSCI.DK.MNI), France (MSCI.FR.MNI), Germany (MSCI.DE.MNI), Italy (MSCI.IT.MNI), Japan (MSCI.JP.MNI), The Netherlands (MSCI.NL.MNI), Norway (MSCI.NO.MNI), Spain (MSCI.ES.MNI), Sweden (MSCI.SE.MNI), Switzerland (MSCI.CH.MNI), Great Britain (MSCI.GB.MNI), United States (MSCI.US.MNI).

The end of year exchange rates and CPIs from the IFS had the following series codes: Australian CPI (19364...ZF...), Australian exchange rate (193..AG.ZF...), Austrian CPI (12264...ZF...), Austrian exchange rate (122..AE.ZF...), Belgian CPI (12464...ZF...), Belgian exchange rate (124..WE.ZF...), Canadian exchange rate (156..AE.ZF...), Canadian CPI (15664...ZF...), Danish exchange rate (128..AE.ZF...), Danish CPI (12864...ZF...), French exchange rate (132..AE.ZF...), French CPI(13264...ZF...), German exchange rate (134..AE.ZF...), German CPI(13464...ZF...), Italian exchange rate (136..AE.ZF...), Italian CPI(13664...ZF...), Japanese exchange rate (158..AE.ZF...), Japanese CPI (15864...ZF...), Dutch exchange rate (138..AE.ZF...), Dutch CPI (13864...ZF...), Norwegian exchange rate (142..AE.ZF...), Norwegian CPI (14264...ZF...), Spanish exchange rate (184..AE.ZF...), Spanish CPI (18464...ZF...), Swedish exchange rate (144..AE.ZF...), Swedish CPI (14464...ZF...), Swiss exchange rate (146..AE.ZF...), Swiss CPI (14664...ZF...), United Kingdom exchange rate (112..AG.ZF...), United Kingdom CPI (11264...ZF...), US CPI (11164...ZF...).

The British pound and the Australian dollar rates were inverted so that all exchange rates were denoted as national currency per U.S. dollar. For the relevant European currencies, post 1998 the lock-in rates against the euro and the euro/dollar rate were used to extend the local exchange rate series until 2001.

A.2 Cross Section Data (SCF)

The SCF is probably the most comprehensive source of data on U.S. households assets. The SCF uses a two-part sampling strategy to obtain a sufficiently large and unbiased sample of wealthier households (the rich sample is chosen randomly using tax reports). To enhance the reliability of the data, the SCF makes weighting adjustments for survey non-respondents, these weights were used in computing the median and mean values reported in the tables (see Kennickell and Starr-McCluer (1994) for details).

Liquid wealth (LW in table 5) is variable FIN in the publicly available SCF data set. For 1998 this is available at http://www.federalreserve.gov/pubs/oss/oss2/98/scf98home.html. This variable is defined as FIN=LIQ+CDS+NMMF+STOCKS+BOND+RETQLIQ+SAVBND + CASHLI+OTHMA+OTHFIN, where LIQ are all types of transaction accounts (checking, saving, money market and call accounts), CDS denote certificates of deposit, NMMF denote total directly-held mutual funds, excluding MMMFs (money market mutual funds), RETQLIQ denote total quasi-liquid financial assets (the sum of IRAs, thrift accounts, and future pensions), SAVBND are savings bonds, CASHLI is the cash value of whole life insurance, OTHMA denotes other managed assets (trusts, annuities and managed investment accounts in which the household has equity interest), and OTHFIN denotes other financial assets: includes loans from the household to someone else, future proceeds, royalties, futures, non-public stock, and deferred compensation).

S in table 5 denotes the value of directly held stocks (STOCKS in data set) whereas Y denotes total income (INCOME in data set) which includes both earnings and interest/dividend income.

B Numerical Dynamic Programming

Given the non-stationary process followed by labor income, we normalize asset holdings and cash on hand by the permanent component of earnings P_{it}, denoting the normalized variables by lower case letters (Carroll, 1992). Defining $Z_{t+1} = \frac{P_{t+1}}{P_t}$ and taking advantage of the homogeneity of degree $(-\rho)$ of marginal utility implied by CRRA preferences, the three Euler equations can be rewritten in the following way:

$$U'(x_t - s_t^d - s_t^f - b_t) = MAX\left[U'(x_t - s_t^d - s_t^f), \frac{1+r}{1+\delta}E_t U'(c_{t+1})Z_{t+1}^{-\rho}\right] \tag{18}$$

and

$$U'(x_t - s_t^d - s_t^f - b_t) = MAX\left[U'(x_t - b_t - s_t^f), \frac{1}{1+\delta}E_t\{\widetilde{R}_{t+1}^d U'(c_{t+1})Z_{t+1}^{-\rho}\}\right]. \tag{19}$$

and

$$U'(x_t - s_t^d - s_t^f - b_t) = MAX\left[U'(x_t - b_t - s_t^d), \frac{1}{1+\delta}E_t\{\widetilde{R}_{t+1}^f\widetilde{E}_{t+1}U'(c_{t+1})Z_{t+1}^{-\rho}\}\right] \quad (20)$$

The normalized state variable x (following Deaton, 1991) evolves according to

$$x_{t+1} = (s_t^d\widetilde{R}_{t+1}^d + s_t^f\widetilde{R}_{t+1}^f\widetilde{E}_{t+1} + b_tR_f)Z_{t+1}^{-1} + U_{t+1} \quad (21)$$

The identity $c_{t+1} = x_{t+1} - b_{t+1} - s_{t+1}^d - s_{t+1}^f$ where $\{b_{t+1}, s_{t+1}^d, s_{t+1}^f\}$ are all functions of x_{t+1} is used to substitute out c_{t+1} on the right hand sides of (18), (19) and (20).

In order for the algorithm to work, we must make sure that the three functional equations of interest define a contraction mapping. Three sufficient conditions for the individual Euler equations (18), (19) and (20) to define a contraction mapping for $\{b(x), s^d(x), s^f(x)\}$ respectively are the conditions in Theorem 1 of Deaton and Laroque (1992):

$$\frac{1+r}{1+\delta}E_tZ_{t+1}^{-\rho} < 1 \quad (22)$$

and

$$\frac{1}{1+\delta}E_t\{\widetilde{R}_{t+1}^dZ_{t+1}^{-\rho}\} < 1 \quad (23)$$

and

$$\frac{1}{1+\delta}E_t\{\widetilde{R}_{t+1}^f\widetilde{E}_{t+1}Z_{t+1}^{-\rho}\} < 1 \quad (24)$$

If these conditions hold simultaneously, there will exist a unique set of optimum policies satisfying the three Euler equations. We next simplify these conditions to gain an intuitive understanding of the problem. Given that $Z_{t+1} = GN_{t+1}$, with $\{N\}$ being log normally distributed, we have $E_t(GN_{t+1})^{-\rho} = \exp(-\rho\mu_g) * \exp(-\rho\mu_n + \frac{\rho^2\sigma_n^2}{2})$. Assuming that all three variables are uncorrelated with each other, we have

$$\begin{aligned} E_t\{\widetilde{R}_{t+1}^f\widetilde{E}_{t+1}Z_{t+1}^{-\rho}\} &= E_t\{\widetilde{R}_{t+1}^f\}E_t\{Z_{t+1}^{-\rho}\}E_t\{\widetilde{E}_{t+1}\} \\ &= (1+\mu_f) * \exp(-\rho\mu_g) * \exp(-\rho\mu_n + \frac{\rho^2\sigma_n^2}{2}) * 1 \end{aligned} \quad (25)$$

Taking logs of the two conditions and using the approximation $\log(1+x) \approx x$ for small x, (22) becomes

$$\frac{r-\delta}{\rho} + \frac{\rho}{2}\sigma_n^2 < \mu_g + \mu_n \tag{26}$$

which is the condition derived by Deaton (1991) with $\mu_n = 0$. (23) and (24) are identical because the conditional next period expectation of the exchange rate is one and the domestic and foreign equity premia are equal. The conditions therefore become

$$\frac{MAX[\mu^f, \mu^d] - \delta}{\rho} + \frac{\rho}{2}\sigma_n^2 < \mu_g + \mu_n \tag{27}$$

Note that the three conditions collapse into one when the stock market investment opportunities have the same return characteristics as the risk free rate.

With a positive equity premium ($\mu^f > r$), satisfaction of (27) guarantees (26). Impatience must now be even higher than in the saving model to prevent the accumulation of infinite stocks, since the condition involving $\mu^f - \delta$ must be satisfied. Two other distinct cases can also guarantee the existence of a solution. First, a high expected earnings growth profile (as measured by μ_g) guarantees that the individual will not want to accumulate an infinite amount of stocks or bonds but would rather borrow now, expecting earnings to increase in the future. Second, if the rate of time preference exceeds the expected stock return, more risk averse (higher ρ) individuals will not satisfy the convergence conditions.

The single state variable (cash on hand, x_t) is discretized into 50 equidistant grid points between (.6 and 3). The quadrature methods proposed by Tauchen and Hussey (1991) are used to compute expectations numerically[21] (I use a 7-point quadrature throughout). Given that the three conditions that guarantee that the above system defines a contraction mapping are satisfied, we can solve simultaneously for $\{s^d(x), s^f(x), b(x)\}$. Starting with any initial guess (say $s^d(x) = .1 * x$, $s^f(x) = .1 * x$, $b(x) = .1 * x$), we use the right hand side of the first Euler equation ((18)) to get an update for b and continue doing so until b converges to its time invariant solution b_1^* (see Deaton (1991)). We then use the second Euler equation with b_1^* taken as given, to find the solution for the time invariant optimal s^d, call it s_1^{d*}. We then substitute these two functions in the third Euler equation and iterate on s^f until we find the time invariant solution for this function, call it s_1^{f*}. We know have three updated functions $\{b_1^*, s_1^{d*}, s_1^{f*}\}$; the process can be repeated until these functions converge to their time invariant solutions.

B.0.1 Contemporaneous Correlation

To compute the joint distribution of M correlated random variables, we use the Cholesky decomposition of the M by M variance-covariance matrix to rotate the quadrature points, keeping the weights (probabilities) the same. A clear exposition of this technique that need not be repeated here can be found in Burnside (1999, p. 104).

C Computing the Time- Invariant Distribution

Normalized cash on hand follows a renewal process[22] and therefore has an associated invariant distribution. To find the time invariant distribution of normalized cash on hand, we first compute the optimal policy rules; bond ($b(x)$), domestic stock ($s^d(x)$) and foreign stock ($s^f(x)$) policy functions. Note that the normalized cash on hand evolution equation is

$$\begin{aligned} x_{t+1} &= [b(x_t)R_f + s^d(x_t)\widetilde{R}^d_{t+1} + s^f(x_t)\widetilde{R}^f_{t+1}\widetilde{E}_{t+1}]\frac{P_t}{P_{t+1}} + U_{t+1} \\ &= w(x_t|\widetilde{R}^d_{t+1}, \widetilde{R}^f_{t+1}, \frac{P_t}{P_{t+1}}, \widetilde{E}_{t+1}) + U_{t+1} \end{aligned} \tag{28}$$

where $w(x)$ is defined by the last equality and is conditional on $\{\widetilde{R}^d_{t+1}, \widetilde{R}^f_{t+1}, \frac{P_t}{P_{t+1}}, \widetilde{E}_{t+1}\}$. Denote the transition matrix of moving from x_j to x_k,[23] as T_{kj}. Let Δ denote the distance between the equally spaced discrete points of cash on hand on the grid. The risky domestic asset return $\widetilde{R}^d$, the risky foreign asset return $\widetilde{R}^f$, the exchange rate next period $\widetilde{E}$ and the permanent shock $\frac{P_t}{P_{t+1}}$ are all discretized using 10 grid points respectively: $R^d = \{R_l\}_{l=1}^{l=10}$, $R^f = \{R_m\}_{m=1}^{m=10}$, $\widetilde{E} = \{E_n\}_{n=1}^{n=10}$, $\frac{P_t}{P_{t+1}} = \{GN_o\}_{o=1}^{o=10}$. $T_{kj} = \Pr(x_{t+1=k}|x_{t=j})$ is found using

$$\sum_{l=1}^{l=10}\sum_{m=1}^{m=10}\sum_{n=1}^{n=10}\sum_{o=1}^{o=10} \Pr(x_{t+1}|x_t, \theta) * \Pr(\widetilde{R}^d_{t+1} = R_l) * \Pr(\widetilde{R}^f_{t+1} = R_m) \tag{29}$$

$$* \Pr(\widetilde{E}_{t+1} = E_n) * \Pr(\frac{P_t}{P_{t+1}} = N_o) \quad (30)$$

where $\theta' = [\widetilde{R}^d_{t+1} = R_l,\ \widetilde{R}^f_{t+1} = R_m,\ \widetilde{E}_{t+1} = E_n,\ \frac{P_t}{P_{t+1}} = N_o]$ and the assumption that all four random variables are independent was used. Making use the approximation that for small values of σ_u^2, $U \sim N(\exp(\mu_u + .5 * \sigma_u^2), (\exp(2 * \mu_u + (\sigma_u^2)) * (\exp(\sigma_u^2) - 1)))$, and denoting the mean of U by $\overline{U}$ and its standard deviation by σ, the transition probability conditional on $\{R_l, R_m, E_n, N_o\}$ then equals

$$\begin{aligned} T_{kjlmno} &= \Phi(\frac{x_k + \frac{\Delta}{2} - w(x_t|\theta') - \overline{U}}{\sigma} \geqslant x_{t+1} \geqslant \frac{x_k - \frac{\Delta}{2} - w(x_t|\theta') - \overline{U}}{\sigma} \\ |x_t &= x_j, \theta') \end{aligned}$$

The unconditional probability from x_j to x_k is then given by

$$T_{kj} = \sum_{l=1}^{l=10} \sum_{m=1}^{m=10} \sum_{n=1}^{n=10} \sum_{o=1}^{o=10} T_{kjlmno} \Pr(R_l) \Pr(R_m) \Pr(E_n) \Pr(N_o) \quad (31)$$

The time invariant distribution π is then calculated as the normalized eigenvector of T corresponding to the unit eigenvalue by solving the linear equations

$$\begin{pmatrix} T - I & e \\ e' & 0 \end{pmatrix} \begin{pmatrix} \pi \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} \quad (32)$$

where e is a (50 by 1) vector of ones .

Once the limiting distribution of cash on hand is derived, average cash on hand can be computed using $\sum_j \pi_j * x_j$. Similar formulae can be used to compute the mean, median and standard deviations of the variables of interest, as reported in the tables. Correlation between the random variables can be accommodated by calculating the joint probabilities of the variables in (31).

D Value Function Computation

An induction argument is sufficient to show that the value function inherits the properties of the utility function; in particular, the value function is homogeneous of degree $(1 - \rho)$

when the utility function in of the CRRA form. As a result, the equation that determines the value function

$$V(X_t, P_t) = MAX_{B_t, S_t^d, S_t^f} U(C_t) + \beta E_t V(X_{t+1}, P_{t+1}) \tag{33}$$

can be rewritten as

$$V(x_t) = MAX_{b(x_t), s^d(x_t), s^f(x_t)} U(c_t) + \beta E_t[\{\frac{P_{t+1}}{P_t}\}^{1-\rho} V(x_{t+1})] \tag{34}$$

Starting from any initial guess of the value function (say $V(x) = \frac{x^{1-\rho}}{1-\rho}$) and substituting this along with the optimal consumption, bond and stock policy functions on the right hand side of (34), we obtain an update of $V(x)$; this procedure can be repeated until the value function converges at all grid points.

References

[1] Abowd, John and Card, David, "On the Covariance Structure of Earnings and Hours Changes" *Econometrica*, 1989, 57, 411-45.

[2] Ahearne, Alan, William L. Griever and Francis E. Warnock. 2000. "Information Costs and Home Bias: An Analysis of U.S. Holdings of Foreign Equities." Federal Reserve Board, International Finance Discussion Paper Numbe 691.

[3] Baxter, Marianne and Urban J. Jermann. 1997. "The International Diversification Puzzle is Worse Than You Think." *American Economic Review*, 87:1, pp. 170-180.

[4] Block, Sandra. February 28 1997. "Finding Returns By Investing Close to Home." *USA Today*, 8B.

[5] Bohn Henning and Linda Tesar. 1996. "U.S.Equity Investment in Foreign Markets: Portfolio Rebalancing or Return Chasing?" *American Economic Review,* Vol. 86, No. 2, Papers and Proceedings of the Hundredth and Eighth Annual Meeting of the American Economic Association San Francisco, CA, January 5-7, 1996, pp. 77-81.

[6] Bottazzi, Laura, Paolo Pesenti and Eric van Wincoop. 1996. "Wages, Profits and the International Portfolio Puzzle." *European Economic Review*, 40:2, pp. 219-254.

[7] Brennan, Michael and Henry Cao. 1997. "International Portfolio Investment Flows." *Journal of Finance*, 52:5, 1851-80.

[8] Burnside, Craig. 1999. "Dicrete state-space methods for the study of dynamic economies." in *Computational Methods for the Study of Dynamic Economies*, edited by Ramon Marimon and Andrew Scott, Oxford University Press.

[9] Cagetti, Marco. 2001. "Wealth Accumulation over the life cycle and Precautionary Savings" UVA working paper.

[10] Campbell, John, Joao Cocco, Francisco Gomes and Pascal Maenhout. 2001. "Investing Retirement Wealth: A Life-Cycle Model." In "Risk Aspects of Social Security Reform." *University of Chicago Press*.

[11] Carroll, Christopher and Lawrence Summers. 1991. "Consumption Growth Parallels Income Growth: Some New Evidence." In B. Douglas Bernheim and John B. Shoven (eds) *National Saving and Economic Performance*, Chicago, Chicago University Press for NBER, 305-43.

[12] Carroll, Christopher D., 1992. "The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence." *Brookings Papers on Economic Activity* no. 2: 61-156.

[13] Carroll, Christopher D., "Buffer Stock Saving and the Life Cycle / Permanent Income Hypothesis." 1997. *Quarterly Journal of Economics*, CXII, 1, 3-55.

[14] Carroll, Christopher D. 1999. "Why do the Rich Save so Much?" In Joel Slemrod (ed). *Does Atlas Shrug?* Office of Tax Policy Research, University of Michigan.

[15] Cocco F. Joao, Fransisco J. Gomes and Pascal Maenhout. 1997. "Consumption and Portfolio Choice over the Life Cycle". Harvard University Working Paper.

[16] Constantinides,-George-M.; Donaldson,-John-B.; Mehra,-Rajnish. 2002. "Junior Can't Borrow: A New Perspective on the Equity Premium Puzzle." *Quarterly Journal of Economics*, 117(1), pages 269-96.

[17] Cooper, Ian A and Evi Kaplanis. 1986. "Costs of Cross Border Investment and International Equity Market Equilibrium." In *Recent Advances in Corporate Finance*. Jeremy Edwards, ed. Cambridge: Cambridge University Press.

[18] Coval, Joshua and Tobias Moskowitz. 2001. "The Geography of Investment: Informed Trading and Asset Prices." *Journal-of-Political-Economy*; 109(4), pages 811-41.

[19] ———— 1999. "Home Bias at Home: Local Equity Preference in Domestic Portfolios." *Journal of Finance*, December, 54(6), pp. 2045-2073.

[20] Davis, Steven J. and Paul Willen. 2001. "Occupation-level Income Shocks and Asset Returns: Their Covariance and Implications for Portfolio Choice." *Working Paper*, University of Chicago.

[21] Deaton Angus, 1991: 'Saving and Liquidity Constraints', *Econometrica*, Vol. 59, No.5, (September, 1991), 1221-1248.

[22] ————- and Laroque G., 1992, 'On the Behavior of Commodity Prices' *Review of Economic Studies*, 59, 1-23.

[23] Feldstein Martin and Charles Horioka. "Domestic Savings and International Capital Flows," *Economic Journal*, June 1980, 90 (358), pp 314-329

[24] French, Kenneth R. and James M. Poterba. 1991. "International Diversification and International Equity Markets." *American Economic Review*, 81:2, pp.222-26.

[25] Gehrig, Thomas P. 1993. "An Information Based Explanation of the Domestic Bias in International Equity Investment." *Scandinavian Journal of Economics*, 95:1, pp. 97-109.

[26] Gourinchas Pierre-Olivier and Jonathan Parker. 2002. "Consumption over the Life-Cycle." *Econometrica*, Vol 70, 1, 47-89.

[27] Haliassos, Michael and Alexander Michaelides. 2003. "Portfolio Choice and Liquidity Constraints." *International Economic Review,* Vol. 44, No.1, pp. 1-36.

[28] Hau, Harald. 2001. "Location Matters: An Examination of Trading Profits." *Journal-of-Finance*; 56(5), October 2001, pages 1959-83.

[29] Heaton John, and Deborah Lucas. 1997. "Market Frictions, Savings Behavior, and Portfolio Choice." *Macroeconomic Dynamics* 1: 76-101.

[30] —– 2000a. "Asset Pricing and Portfolio Choice: The Importance of Entrepreneurial Risk." *Journal of Finance*, 55: no 3.

[31] —- 2000b. "Portfolio Choice in the Presence of Background Risk." *The Economic Journal* 110: 1-26.

[32] Jermann, Urban. 1999. "Social Security And Institutions for Intergenerational, Intragenerational and International Risk-Sharing: A Comment." *Carnegie-Rochester Conference Series on Public Policy*, 50, pp. 205-212.

[33] Kennickell, Arthur and Martha Starr-McCluer. 1994. "Changes in Family Finances from 1989 to 1992: Evidence from the Survey of Consumer Finances." *Federal Reserve Bulletin* 80, 861-882.

[34] Levy H., Sarnat, M., 1970. International Diversification of Investment Portfolios. *American Economic Review*, 60, 668-675.

[35] Lewis, Karen. 1999. "Trying to Explain Home Bias in Equities and Consumption." *Journal of Economic Literature*, Vol. XXXVII pp. 571-608.

[36] Ludvigson Sydney and Alexander Michaelides. 2001. "Does Buffer Stock Saving Explain the Smoothness and Excess Sensitivity of Consumption?" *American Economic Review,* 91(3), pages 631-47.

[37] MaCurdy, T. E. 1981. "The use of time series processes to model the error structure of earnings in longitudinal data analysis." *Journal of Econometrics.* 18: 83-114.

[38] Obstfeld, Maurice and Kenneth Rogoff. 2000. "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" Forthcoming in the *NBER Macroeconomics Annual*.

[39] Paiella, Monica. 2000. "Transaction Costs and Limited Stock Market Participation to Reconcile Asset Prices and Consumption Choices", mimeo.

[40] Pischke Jörn-Steffen, 1995, "Individual Income, Incomplete Information and Aggregate Consumption" *Econometrica*, Vol.63, No.4, 805-840.

[41] Portes, Richard and Helene Ray, 1999. "The Determinants of Cross-Border Equity Flows: The Geography of Information." NBER Working Paper 7336.

[42] Solnik, Bruno. 1974. "An Equilibrium Model of the International Capital Market." *Journal of Economic Theory.* 8:4, pp. 500-524.

[43] Storesletten, Kjetil, Telmer Chris and Yaron Amir. "Persistent Idiosyncratic Shocks and Incomplete Markets." Working paper, Carnegie Mellon University, 2001.

[44] Tauchen, G. and R. Hussey. 1991. "Quadrature-Based Methods for Obtaining Approximate Solutions to Nonlinear Asset Pricing Models." *Econometrica*, 59, 371-396.

[45] Tesar, Linda and Ingrid Werner. 1995. "Home Bias and High Turnover." *Journal of International Money and Finance*, 14:4, pp. 467-92.

[46] ——- 1998. "The Internationalization of Securities Markets since the 1987 Crash." In *Brookings-Wharton papers on Financial Services.* R Litan and A Santomero (eds). Washington: The Brookings Institution.

[47] Viceira, Luis. 2001. "Optimal Portfolio Choice for Long-Horizon Investors with Nontradable Labor Income." *Journal of Finance*, 55, 1163-98.

[48] Vissing-Jorgensen, Annette. 2002. "Towards an Explanation of Household Portfolio Choice Heterogeneity: Nonfinancial Income and Participation Cost Structures." Working paper.

Notes

[1]Solnik (1974) derives an international Capital Asset Pricing Model that predicts that the share of wealth in the domestic market should be a constant multiple of the share of wealth invested in the foreign market.

[2]Cooper and Kaplanis (1986) argue that home bias seems to characterize smaller countries as well.

[3]Carroll (1992) generates no borrowing behavior endogenously by assuming that the transitory labor income shock can fall to zero in any given period with a small probability (0.5 percent). Deaton (1991), on the other hand, explicitly imposes a no borrowing liquidity constraint.

[4]Viceira (2001) considers the effects of labor income risk on optimal domestic portfolio choice in a model without liquidity constraints.

[5]Heaton and Lucas (1997, 2000b) and Haliassos and Michaelides (2003) have studied the portfolio choice implications of the model for a single domestic risky asset. Heaton and Lucas (1997) find that such a model predicts complete portfolio specialization in stocks, and that this result is robust to habit persistence, transactions costs, risk aversion, and to an equity premium as low as two percent. Nevertheless, Heaton and Lucas (2000b) find that positive correlation between stock returns and shocks to labor income (or income from business ownership, Heaton and Lucas (2000a)) tends to discourage households from putting all of their wealth in stocks. Haliassos and Michaelides (2003) corroborate these findings for a different labor income process but show that small stock market entry costs are sufficient to generate stock market non-participation because buffer stock savers can smooth idiosyncratic labor income shocks with a small buffer stock of assets. Low wealth accumulation implies that stock market entry has limited benefits and therefore a small cost can deter households from entering the stock market. They conclude that to the extent that the median household behaves like a buffer stock saver (see Carroll (1997)), median stock holding in a population could be zero in the presence of small, stock market entry costs.

[6]This is the generalization of the Heaton and Lucas (1997) domestic portfolio model result in an international setting.

[7]Obstfeld and Rogoff (2000) argue that small transportation costs in the goods market can explain home equity bias; the analysis here differs by considering the effects of small costs in assets markets.

[8]The lognormality of U_{it} and the assumption about the mean of its logarithm imply that $EU_{it} = \exp(-.5 * \sigma_u^2 + .5 * \sigma_u^2) = 1$ and similarly for EN_{it}.

[9]Although these studies generally suggest that individual earnings changes follow an MA(2), the MA(1) is found to be a close approximation.

[10]Many studies using this microeconomic process use variances that are higher than the ones used here (see Gourinchas and Parker (2002) or Storesletten et. al. (2001)). We use lower variances, similar in magnitude to Deaton (1991) and Carroll (1997), who argue that the measurement error found in microeconomic surveys is large enough to warrant deflating the estimates from micro data.

[11]These results are omittted for space considerations but are available upon request.

[12]These results are omittted for space considerations but are available upon request.

[13] I am not aware of any study that has computed the correlation between individual earnings innovations and exchange rates or foreign stock returns.

[14] The consumption policy function retains its concave shape in all the experiments and this figure is therefore omitted in all the experiments that follow.

[15] There is still a slight bias towards domestic equities in the graphs as the exchange rate risk is not completely eliminated due to numerical convergence problems arising from the fact that the domestic and foreign asset become indistinguishable assets when exchange rate risk is completely absent, rendering the Euler equations for domestic and foreign asset choice identical.

[16] Note that this is consistent with the Solnik (1974) model where in the presence of two foreign markets with the same equity premia and variances of returns, half of total wealth is allocated domestically and half is allocated abroad.

[17] In "Finding Returns by Investing Close to Home" Sandra Block writes that a number of fund managers believe that they can obtain abnormal returns by investing in "their own back yard" with the belief that geographic proximity offers them a competitive advantage. She quotes Conrad Herrmann, manager of the Franklin California Growth Fund, as stating: "We have a unique advantage over someone investing from over 3000 miles away. We read the local newspapers, socialize with people that work for these companies, and we can get a sense for how the region is doing." (USA Today, February 28, 1997).

[18] See Appendix C for the computation of the time invariant distribution.

[19] We use the invariant distribution associated with the domestic portfolio choice model to compute $\widehat{x}$ since we are assuming that the household is contemplating entry in the foreign stock market for the first time.

[20] It should be noted that the domestic portfolio choice model generates a complete portfolio specialization in stocks prediction. On the other hand, this prediction is also an artifact coming from having a simplistic investment environment without a private business or other alternative investment opportunities. The basic conclusions from this analysis should still go through with a model including alternative financial assets as long as the total level of savings is low.

[21] I would like to thank George Tauchen for providing me with the original codes from Tauchen and Hussey (1991).

[22] The proof for a mathematically equivalent model of commodity prices with non-negative inventories is given by Deaton and Laroque (1992, theorem 2).

[23] The normalized grid is discretized between $(x\min, x\max)$ where $x\min$ denotes the minimum point on the equally spaced grid and $x\max$ the maximum point.

Benchmark Model; ρ=2 or 5

Fig.1 : Normalized Consumption

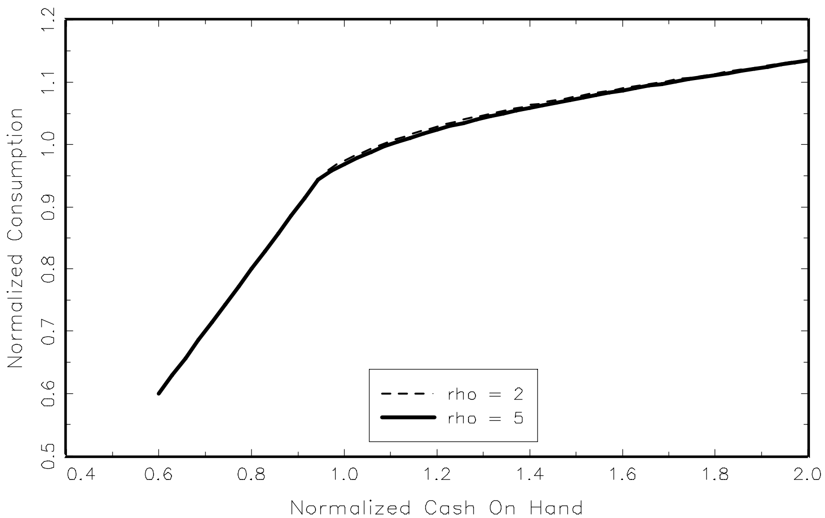


Fig.2 : Share of Wealth in Domestic Stocks

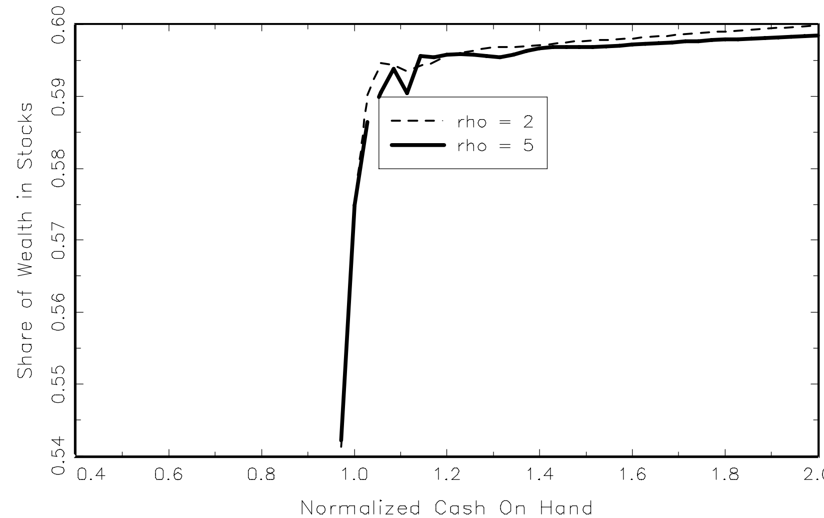


Fig.3 : Share of Wealth in Foreign Stocks

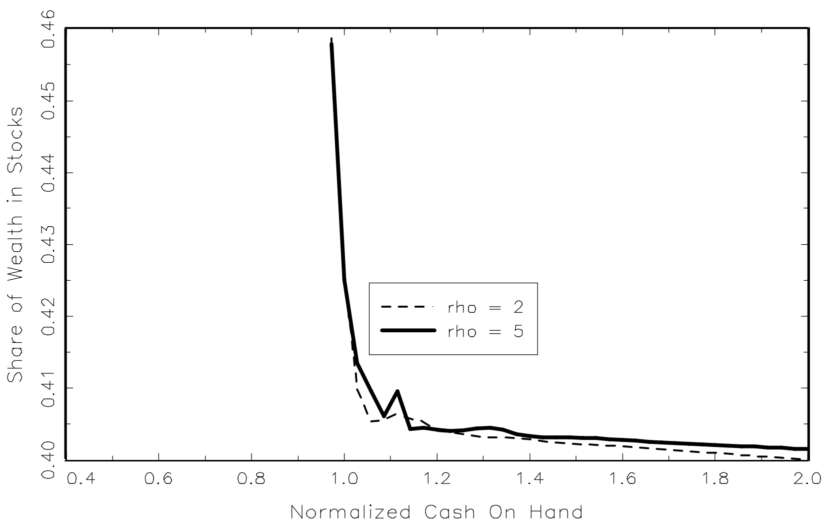
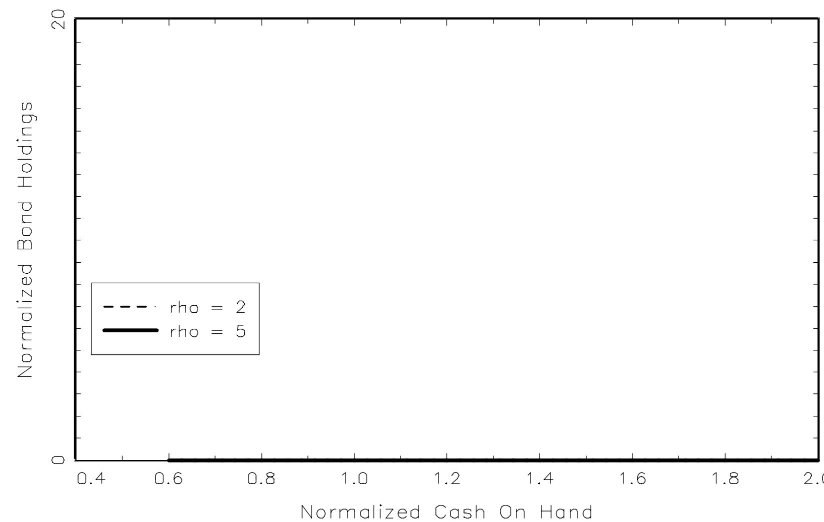


Fig.4 : Normalized Bond Holdings



Varying Correlations

Fig.5 : Share of Wealth in Domestic Stocks

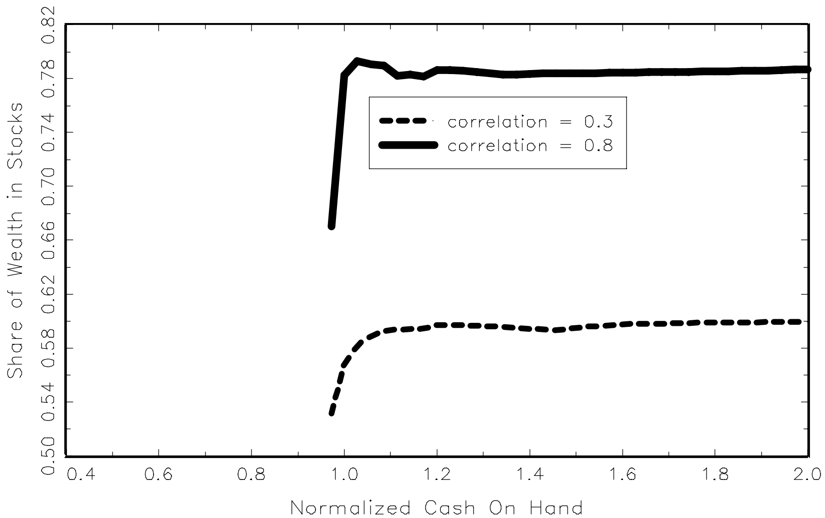


Fig.6 : Share of Wealth in Foreign Stocks

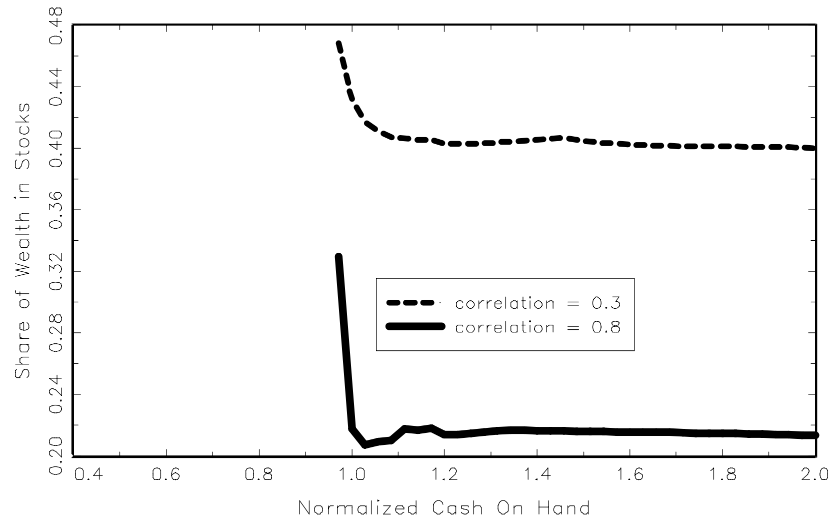


Fig.7 : Share of Wealth in Domestic Stocks

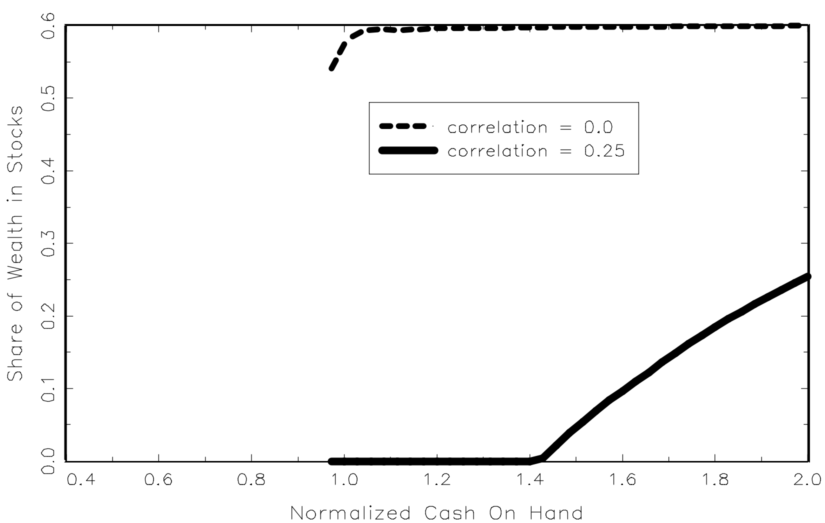
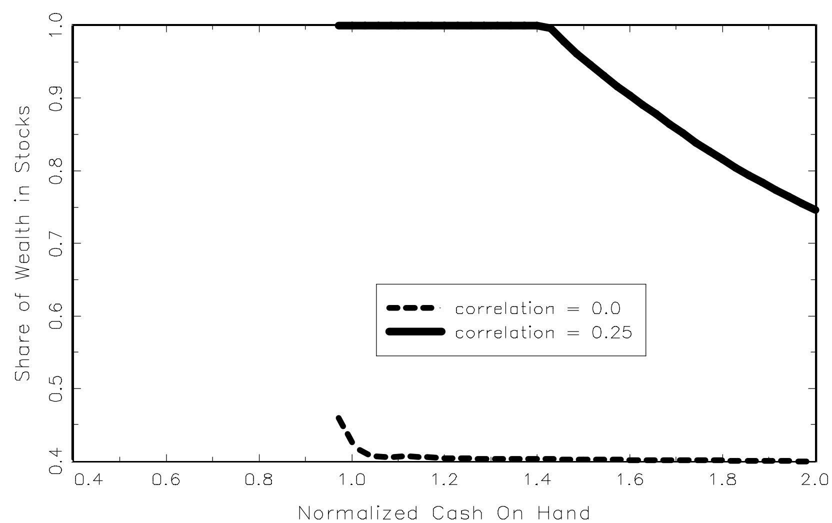


Fig.8 : Share of Wealth in Foreign Stocks



Varying Correlations and Exchange Rate Volatility

Fig.9 : Share of Wealth in Domestic Stocks

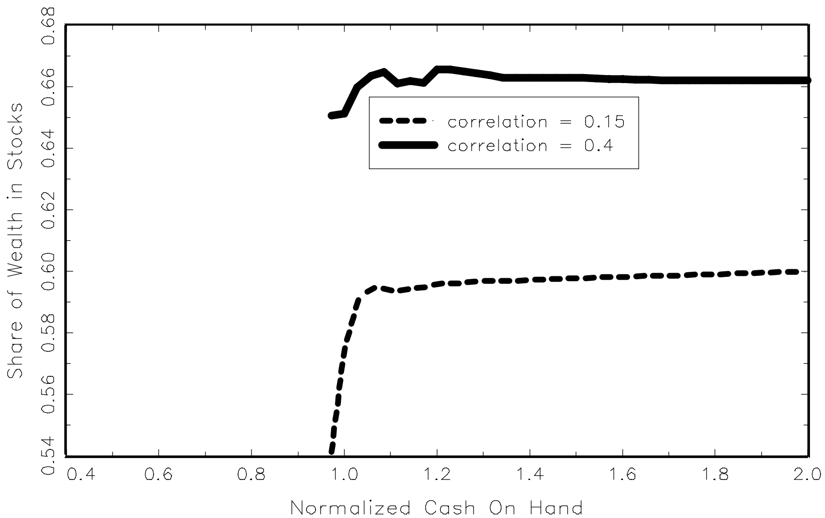


Fig.10 : Share of Wealth in Foreign Stocks

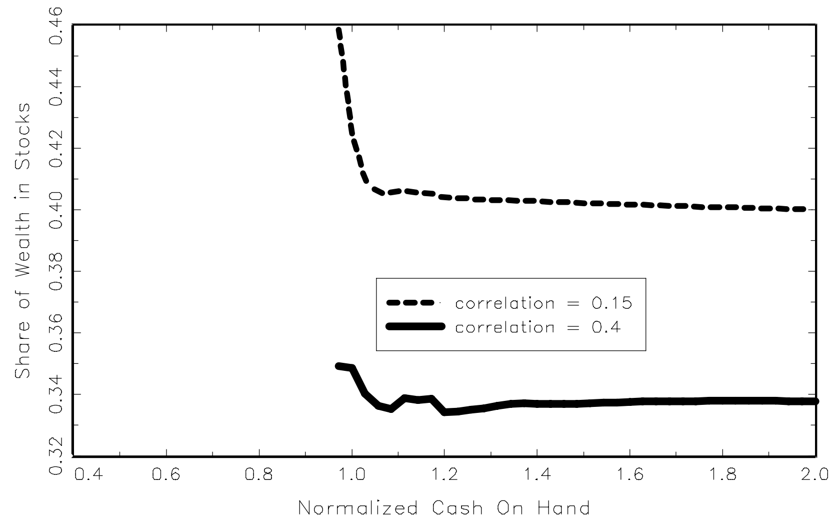


Fig.11 : Share of Wealth in Domestic Stocks

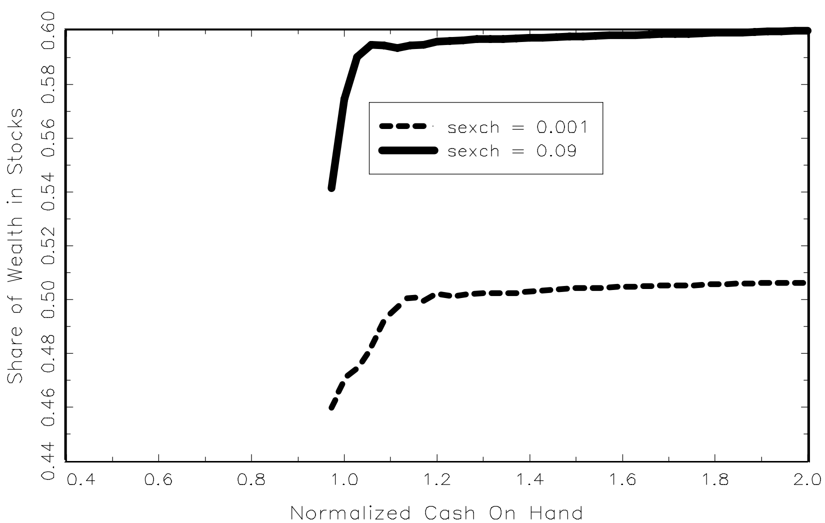


Fig.12 : Share of Wealth in Foreign Stocks

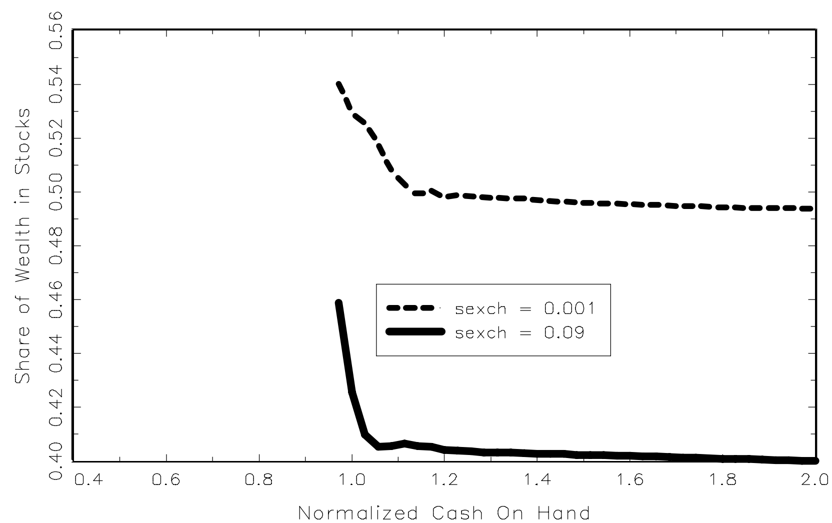


Fig.13 : Invariant Distributions: International Model

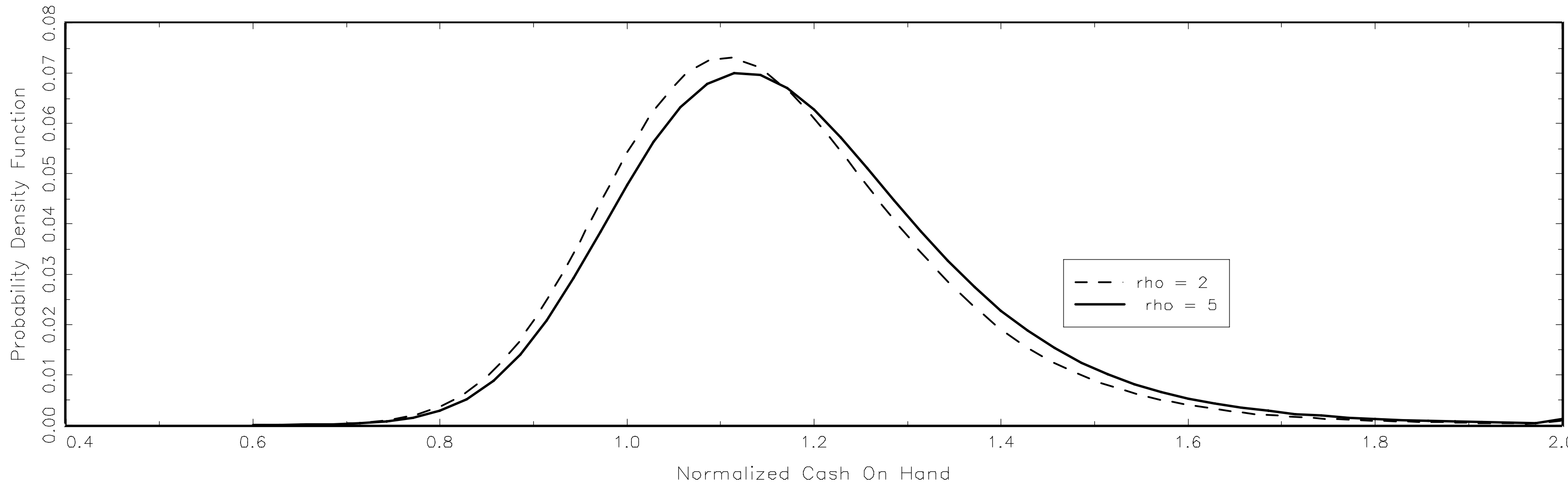


Fig.14 : Threshold Foreign Market Entry Costs

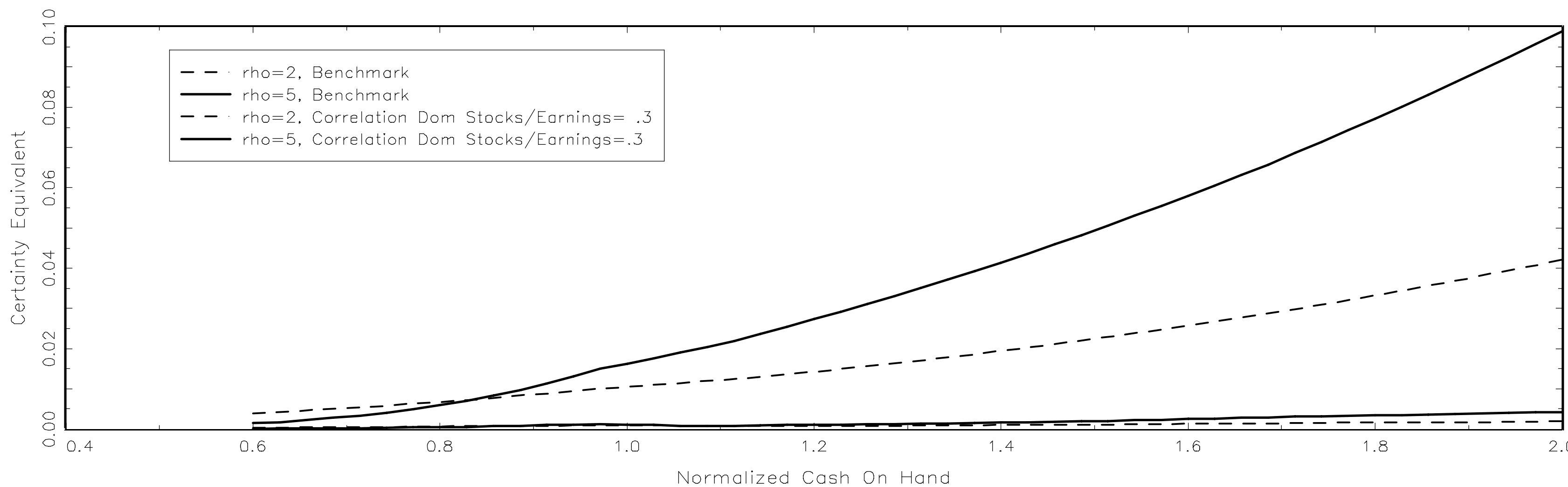


Table 1: Descriptive Statistics on 28 Annual Observations of Net Real Stock Returns and Real Exchange Rate Changes

Panel A: Descriptive Statistics for Annual Stock Returns

	S_AT_NR_	S_AU_NR_	S_BE_NR_	S_CA_NR_	S_CH_NR_	S_DE_NR_	S_DK_NR_	S_ES_NR_	S_FR_NR_	S_GB_NR_	S_IT_NR_I	S_JP_NR_	S_NL_NR_	S_NO_NR_	S_SE_NR_	S_US_NR_
Mean	5.3862	6.9578	9.0275	7.5806	7.9542	9.3801	6.6744	5.1602	9.6852	7.8855	7.4120	4.7422	12.0412	6.4335	16.8492	7.7724
Median	-4.3041	5.2740	5.0743	2.2043	5.7307	3.8885	1.7426	-2.7082	11.3322	6.7611	3.4398	5.5805	8.4975	6.1514	8.6063	6.5073
Maximum	113.5515	60.7871	72.0292	77.2153	49.8484	49.9330	49.0077	89.8277	58.0508	43.5309	106.2080	57.5702	68.9863	111.0049	144.9283	53.7910
Minimum	-27.1062	-43.4018	-34.8959	-50.8270	-34.0357	-23.5051	-28.5650	-44.3961	-45.5451	-55.3701	-48.2211	-34.3352	-34.1011	-36.7271	-38.7743	-27.5119
Std. Dev.	31.9112	21.9260	22.9915	25.8508	19.5164	21.5124	22.3240	31.9466	24.6467	19.1732	39.0362	23.0014	20.9563	33.1985	39.1889	18.5458
Skewness	2.0655	-0.0286	0.6889	0.5523	0.1760	0.4260	0.3810	0.7973	-0.3208	-0.8710	0.9235	0.2569	0.6014	1.1524	1.4058	0.2669
Kurtosis	6.8897	4.1146	3.6784	4.0749	2.5459	2.0246	2.0161	3.3699	2.8242	5.9026	3.6031	2.5201	4.0683	4.7132	5.3568	2.8298
Jarque-Bera	37.5605	1.4533	2.7517	2.7717	0.3850	1.9570	1.8069	3.1260	0.5164	13.3698	4.4045	0.5766	3.0192	9.6219	15.7028	0.3662
Probability	0.0000	0.4835	0.2526	0.2501	0.8249	0.3759	0.4052	0.2095	0.7724	0.0013	0.1106	0.7495	0.2210	0.0081	0.0004	0.8327
Sharpe Ratio	0.1061	0.2261	0.3057	0.2159	0.3051	0.3431	0.2094	0.0989	0.3118	0.3070	0.1386	0.1192	0.4791	0.1335	0.3789	0.3113

Panel B: Descriptive Statistics for Annual Exchange Rate Changes

	E_ATRET_	E_AU2RET	E_BERET_	E_CARET_	E_CHRET_	E_DERET_	E_DKRET_	E_ESRET_	E_FRRET_	E_GB2RET	E_ITRET_I	E_JPRET_	E_NLRET_	E_NORET_	E_SERET_R
Mean	-2.504484	-10.01017	-4.585079	-6.648555	-0.266153	-1.992942	-6.489601	-12.71217	-7.044742	-9.084646	-13.07142	0.280327	-2.833619	-7.434089	-8.930613
Median	-6.134982	-9.268462	-7.992435	-6.130684	-3.22662	-6.003915	-10.34757	-14.58733	-9.179929	-7.953551	-11.84962	-3.822896	-7.177653	-8.2236	-10.76169
Maximum	36.1553	7.911354	34.21849	5.746463	40.70088	37.74434	29.6325	15.84703	29.02922	13.91254	22.49992	51.02911	37.64943	14.95561	18.41701
Minimum	-32.80963	-29.14177	-35.7302	-17.94228	-26.96833	-32.6367	-39.08249	-41.07208	-41.73476	-35.15546	-47.47149	-30.57428	-34.22822	-33.09167	-33.47509
Std. Dev.	13.87236	10.05145	15.00486	6.000318	15.03098	14.03712	14.34614	15.51291	15.4076	12.92026	15.65095	16.91596	14.40505	10.93946	13.35932
Skewness	0.609629	-0.046004	0.499682	-0.343027	0.917592	0.67179	0.541091	0.099325	0.203767	-0.240461	0.064002	0.817077	0.683885	0.074788	0.132103
Kurtosis	3.805493	2.271874	3.242905	2.434082	3.681093	3.937058	3.552994	2.259399	3.115962	2.383315	3.118403	4.174671	3.985003	2.901613	2.442309
Jarque-Bera	2.491308	0.628406	1.234022	0.922755	4.470416	3.130499	1.723071	0.685943	0.209453	0.713516	0.035472	4.725362	3.31453	0.037395	0.444294
Probability	0.287753	0.730371	0.539555	0.630415	0.10697	0.209036	0.422513	0.709659	0.900571	0.699942	0.982421	0.094167	0.19066	0.981476	0.800798

Notes to Table 1

1) AT=Austria, AU=Australia, BE=Belgium, CA=Canada, CH=Switzerland, DE=Germany, DK=Denmark, ES=Spain, FR=France, GB=Great Britain, IT=Italy, JP=Japan, NL=Netherlands, NO=Norway, SE=Sweden, US=United States

2) All exchange rates are denoted as US dollar per foreign currency.

3) NR denotes the net (after tax) stock return on the country's MSCI index, as calculated by MSCI International. Dividends are re-invested in the index.

4) Inflation rates are constructed from each country's CPI from the IFS database.

4) Exchange rates are end of period (December) from the IFS database.

5) Real stock returns were constructed by subtracting the inflation rate from the nominal annual stock return.

6) Real exchange rate changes were constructed by subtracting the inflation rate from the nominal annual exchange rate return.

Table 2

Contemporaneous Correlation Between Real Annual, U.S. Stock Returns, Real Foreign Stock Returns (in local currency) and Real, Exchange Rate Changes

Panel A: Correlation between U.S. Stock Returns and Foreign (in local currency) Stock Returns

	S_AT_NR_	S_AU_NR_	S_BE_NR_	S_CA_NR_	S_CH_NR_	S_DE_NR_	S_DK_NR_	S_ES_NR_	S_FR_NR_	S_GB_NR_	S_IT_NR_	S_JP_NR_	S_NL_NR_	S_NO_NR_	S_SE_NR_
S_US_NR_	0.3412	0.5313	0.6158	0.6632	0.7434	0.7250	0.7448	0.4883	0.5254	0.8183	0.5411	0.3738	0.8332	0.3564	0.6564

Panel B: Correlation Between U.S. Stock Returns and Exchange Rate Changes

	E_ATRET_	E_AURET_	E_BERET_	E_CARET_	E_CHRET_	E_DERET_	E_DKRET_	E_ESRET_	E_FRRET_	E_GBRET_	E_ITRET_	E_JPRET_	E_NLRET_	E_NORET_	E_SERET_
S_US_NR_	0.149635	-0.04355	0.197237	0.4024	0.111792	0.150349	0.285102	0.153444	0.271242	0.244611	0.306201	0.253102	0.165174	0.06539	0.210587

Panel C: Correlation Between Exchange Rate Changes and Foreign Stock Returns

	S_AT_NR_	S_AU_NR_	S_BE_NR_	S_CA_NR_	S_CH_NR_	S_DE_NR_	S_DK_NR_	S_ES_NR_	S_FR_NR_	S_GB_NR_	S_IT_NR_	S_JP_NR_	S_NL_NR_	S_NO_NR_	S_SE_NR_
E_ATRET_	**0.061337**	0.268468	0.380811	0.10853	0.044033	0.092781	0.08887	0.018392	0.325817	0.251358	-0.02163	-0.02238	-0.09871	0.146761	-0.01747
E_AURET_	-0.26179	**0.138013**	-0.01904	-0.04847	-0.06531	-0.24055	-0.19826	0.281592	-0.00218	-0.13663	0.006901	0.152457	-0.16103	0.02619	-0.04173
E_BERET_	0.119427	0.345431	**0.347637**	0.165841	0.130009	0.118347	0.133057	0.084159	0.336618	0.271882	0.057918	0.001667	-0.06844	0.17975	-0.05682
E_CARET_	0.149772	0.33633	0.222259	**0.305363**	0.209457	0.130621	0.184271	0.318506	0.1621	0.138265	-0.01522	0.097599	0.284553	0.215237	0.230812
E_CHRET_	0.00871	0.233127	0.318687	0.096007	**0.04732**	0.137146	0.120475	-0.04535	0.345694	0.254557	0.016236	0.045718	-0.09143	0.048052	0.051836
E_DERET_	0.061726	0.266678	0.39132	0.104302	0.050912	**0.098524**	0.09248	0.012108	0.343596	0.278939	-0.0195	0.004887	-0.0838	0.148473	-0.02292
E_DKRET_	0.16051	0.288165	0.408203	0.129979	0.189102	0.194846	**0.232035**	0.135667	0.378068	0.322287	0.038237	-0.02488	0.006474	0.145914	-0.0007
E_ESRET_	0.186442	0.169802	0.304537	0.062438	0.085281	0.08777	0.134677	**0.267165**	0.307194	0.064284	0.039408	-0.11677	-0.11424	0.272506	-0.11612
E_FRRET_	0.149949	0.335697	0.381662	0.147056	0.210462	0.212248	0.252027	0.126333	**0.407644**	0.299961	0.049518	-0.01199	-0.00447	0.12584	-0.02646
E_GBRET_	0.158515	0.349486	0.466537	0.240635	0.281552	0.177157	0.217024	0.384303	0.486965	**0.227171**	0.199715	-0.00125	0.100575	0.340711	0.039066
E_ITRET_	0.176573	0.28986	0.483685	0.159753	0.273329	0.254087	0.295608	0.294834	0.491285	0.288764	**0.096803**	0.074766	0.085453	0.214665	0.045704
E_JPRET_	-0.14546	0.327951	0.348782	0.21278	0.158172	0.052693	0.070283	0.246444	0.356822	0.410793	0.300622	**0.290184**	0.084343	-0.00237	0.314455
E_NLRET_	0.085242	0.259271	0.413493	0.108044	0.071068	0.098181	0.099886	0.057071	0.352914	0.275671	0.002517	0.018081	**-0.07393**	0.168986	-0.00134
E_NORET_	0.033702	0.176073	0.209019	0.007884	0.00237	-0.00024	0.03327	-0.0262	0.218067	0.064547	-0.15686	-0.22413	-0.20716	**0.121779**	-0.23349
E_SERET_	0.050928	0.254547	0.307389	0.13576	0.144684	0.173159	0.192705	0.205947	0.347812	0.159211	0.039058	0.024513	-0.02701	0.125802	**-0.09081**

1) AT=Austria, AU=Australia, BE=Belgium, CA=Canada, CH=Switzerland, DE=Germany, DK=Denmark, ES=Spain, FR=France, GB=Great Britain, IT=Italy, JP=Japan, NL=Netherlands, NO=Norway, SE=Sweden, US=United States
2) All exchange rates are denoted US dollar per foreign currency.
3) NR denotes the net (after tax) stock return on the country's MSCI index, as calculated by MSCI International. Dividends are re-invested in the index.
4) Inflation rates are constructed from each country's CPI from the IFS database.
4) Exchange rates are end of period (December) from the IFS database.
5) Real stock returns were constructed by subtracting the inflation rate from the nominal annual stock return.
6) Real exchange rate changes were constructed by subtracting the inflation rate from the nominal annual exchange rate return.

Table 3: Time Series Moments from varying coefficient of relative risk aversion

	$\rho = 2$	$\rho = 5$
Mean Normalized Bond Holdings	0.00	0.00
Mean Normalized Domestic Stock Holdings	0.09	0.10
Mean Normalized Foreign Stock Holdings	0.06	0.07
Mean Normalized Consumption	1.01	1.01
Mean Share of Wealth Invested Domestically	0.57	0.53
Mean Share of Wealth Invested Abroad	0.33	0.37
σ(Normalized Bond Holdings)	0.00	0.00
σ(Normalized Domestic Stock Holdings)	0.08	0.08
σ(Normalized Foreign Stock Holdings)	0.05	0.06
σ(Normalized Consumption)	0.05	0.05
σ(Share of Wealth Invested Domestically)	0.18	0.16
σ(Share of Wealth Invested Abroad)	0.12	0.11
Median Normalized Bond Holdings	0.00	0.00
Median Normalized Domestic Stock Holdings	0.06	0.08
Median Normalized Foreign Stock Holdings	0.04	0.05
Median Normalized Consumption	1.01	1.01
Median Share of Wealth Invested Domestically	0.59	0.60
Median Share of Wealth Invested Abroad	0.41	0.40
σ(Normalized Earnings)	0.10	0.10

Notes to Table 3: Normalized variables are normalized with respect to the permanent component of labor income (P_{it} in the text). The reported numbers are generated using the time invariant distributions associated with each model, as described in the text. Other parameters are: $\delta = .05$, mean equity premium is 6 percent in both the domestic and foreign stock market, standard deviation of excess returns is 18 percent in both markets, the standard deviation of the exchange rate is 9 percent, $\sigma_u = .1, \sigma_n = .08$. The correlation between domestic and foreign stock markets equals 0.5, the domestic stock and exchange rate correlation is 0.15 and the foreign stock-exchange rate correlation is zero. When no saving takes place, the share of wealth in domestic stocks is set to zero.

Table 4: Fixed Costs Generating Home Equity Bias

	I. Equity Premium = 6%, C1=0,C2=0	II. Equity Premium = 6%, C1=0.3,C2=0
$\rho = 2$	1.0	6.4
$\rho = 5$	2.6	15.4
	III. Equity Premium = 6%, C1=0,C2=0.3	**IV. Equity Premium = 6%, C1=0,C2=0, No FX risk**
$\rho = 2$	0.6	1.5
$\rho = 5$	1.7	3.6

Notes to Table 4: The table reports the fixed costs necessary to generate foreign stock market non-participation as a percentage of mean labor income (at an annual horizon). C1 is the correlation between the permanent labor income shocks and the stock market return innovations. C2 is the correlation between the domestic and the foreign stock market innovations. No FX risk refers to the case where there is no foreign exchange rate risk. ρ is the CRRA coefficient. The discount rate equals five percent, the mean earnings growth rate equals 3 percent, the standard deviation of permanent shocks (σ_n) equals .08 and the standard deviation of transitory shocks (σ_u) equals .1. The standard deviation of foreign and domestic stock market returns is set at 18 percent, the equity premium is set to six percent in both domestic and foreign markets and the standard deviation of exchange rate changes is set to 9 percent.

Table 5: Survey of Consumer Finances Statistics
Direct Stockholding in levels and as a proportion of income for U.S. stockholders

Panel A: SCF 1989

	Age of Head (in Years)					
	Less then 35	**35-44**	**45-54**	**55-64**	**65-74**	**75+**
Median Income	26,570	46,498	49,155	33,213	21,256	17,271
Median value of stocks	3,820	5,093	6,367	25,466	31,833	31,833
Median value of mutual fund	1,273	5,093	15,280	31,833	22,919	38,199
Median LW/Y (in percent)	44	68	96	208	424	490
Median S/Y (in percent)	6	6	8	29	85	76
Median MF/Y (in percent)	3	6	19	37	37	83

Panel B: SCF 1992

	Age of Head (in Years)					
	Less then 35	**35-44**	**45-54**	**55-64**	**65-74**	**75+**
Median Income	28,115	41,002	48,031	33,973	19,915	15,229
Median value of stocks	2,283	4,567	11,417	14,842	17,126	28,543
Median value of mutual fund	2,854	20,436	17,126	28,543	34,251	23,976
Median LW/Y (in percent)	50	84	176	314	429	464
Median S/Y (in percent)	6	8	16	32	49	55
Median MF/Y (in percent)	9	23	25	44	74	65

Panel C: SCF 1995

	Age of Head (in Years)					
	Less then 35	**35-44**	**45-54**	**55-64**	**65-74**	**75+**
Median Income	27,261	40,346	42,526	35,984	20,718	17,447
Median value of stocks	3,187	4,780	10,622	20,182	21,244	19,120
Median value of mutual fund	5,842	10,622	22,306	59,483	58,124	53,429
Median LW/Y (in percent)	65	96	168	213	389	370
Median S/Y (in percent)	9	6	12	28	43	60
Median MF/Y (in percent)	11	17	27	77	119	117

Panel D: SCF 1998

	Age of Head (in Years)					
	Less then 35	**35-44**	**45-54**	**55-64**	**65-74**	**75+**
Median Income	27,365	42,567	50,675	38,513	24,324	16,216
Median value of stocks	5,000	12,000	24,000	22,000	50,000	50,000
Median value of mutual fund	7,000	14,000	30,000	58,000	60,000	59,000
Median LW/Y (in percent)	69	134	228	293	576	426
Median S/Y (in percent)	10	16	26	35	81	126
Median MF/Y (in percent)	16	19	39	106	152	146

Notes:
1) All dollar amounts are in 1998 dollars.
2) LW/Y denotes liquid wealth normalized by income for stockholders
3) S/Y denotes the value of stocks normalized by income (only for stockholders)
4) MF/Y denotes the value of directly-held mutual funds, excluding money market mutual funds.
5) Appendix A contains further details on the SCF and the variable construction.