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Equity Home Bias in the Czech Republic

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Abstract:
Investors reveal a tendency to prefer domestic over foreign equities despite the financial losses. From institutional perspective the factors that cause home biasness are the barriers to entry the foreign markets, transaction costs, illiquidity, asymmetric information and information costs, corporate governance and inflation and exchange rate risks. Behavioral finance argues that irrationality of investors cause the home biasness. Investors tend to be under the influence of psychological biases: optimism, overconfidence, social identity, narrow framing and loss aversion. In this paper we introduce a model of optimal portfolio of Czech investors with three utility functions: Markowitz, exponential and CRRA. The prediction of the model without short selling suggests that Czech investors should have more than 60 % (between 72 - 83 % for feasible levels of risk aversion) in domestic equities. The OECD data claims that they hold around 87 % in domestic equities.

Keywords: Equity home bias, optimal investment portfolio, behavioral finance

JEL: G11

I. Introduction

Equity home bias is a situation on a market when investors hold an unreasonably high share of their portfolios in domestic equities. This is in a sharp contrast with the traditional finance theory which suggests that the investors should fully exploit the opportunities that arise from the potential diversification. The international capital asset pricing model (ICAPM) based on Sharpe (1964) and Lintner (1965) predicts that an investor should hold equities from a country as per that country's share of world market capitalisation (Mishra, 2008). The less the integrated international markets are the higher the benefits from international diversification could be. The studies by Harvey (1991) and Chan et al. (1992) indicate a lack of integration between the US and major Asian markets. The US and European equity markets seem to be better integrated as shows the evidence of Kasa (1992) and Arshanapalli and Doukas (1993). The findings of De Fusco et al. (1996) and Gilmore and McManus (2001) indicate that the equity market in the US is not integrated with the emerging markets in the geographical regions of the Pacific basin, Latin America, the Mediterranean and the Central Europe. These studies provide evidence that the correlation coefficients between the indices in different countries in the world are still quite low. In Section 5 we will show the recent correlation coefficients between the 10 national stock indices. The message from the low international integration is that the investors should diversify their portfolios into equities in different countries to earn benefits from risk reduction.

The question of high domestic equities concentration bothered the economist at least since Levy and Sarnat (1970) were one of the first to discover the equity home bias phenomenon on US equities. Since 1970 there has been vast number of studies that confirmed the existence home bias not only in US, but also many other countries in the world. Tesar and Werner (1995) presented international investment positions of USA and Canada in the period 1975-1990, pointing out the home biasness of investors in these two countries. Cooper and Kaplanis (1994) showed the extent of equity portfolios concentration with domestic equities among 8 world major economies. According to this study, in 1987 the most home biased investors were in Sweden (100 % share of domestic equities), the best situation was in France ("only" 64,4 % share of domestic equities). Further evidence of home bias was provided by Adler and Dumas (1983), Lewis (1994), Lewis (1999) and Zalewska (2005), for example. The interesting contributions are the papers by Oehler et al. (2008) and Barker D. and T.

Loughran (2007). The first paper recognizes an strong "Europe bias" among German mutual funds. The second paper introduces the "geographical bias". The study provides evidence that the closer the companies are to each other the more are their stock returns correlated.

The recent papers do not focus mainly on providing only other proofs of the phenomenon, but they try to view the puzzle from different perspectives and value the possible impacts of different factors. From the simplest perspective we can divide these factors into two groups: institutional and behavioral, that will be discussed in more details in the following sections. Institutional reasons of the existence of home bias are stemming from the violation of the main assumption of traditional finance: the "perfect" markets. There should be no barriers to entry, no transaction or information costs and markets should react in almost no time. On the other hand, the behavioral factors view the puzzle from the perspective of violation of the second key assumption: rational investors. Investors should evaluate all possible investment opportunities and react upon their best judgment.

In the paper we will examine whether there is equity home bias in the Czech Republic. We will compare the actual evidence with the theoretical composition of a investment portfolio model. Before we introduce the model of optimal portfolio allocation, we will provide the reader with a short summary of the methodological issues connected with measurements of home bias. Then, we will follow with the description of the model: assumptions, data and results. And finally, we will compare the theoretical portfolio compositions with the reality based on the OECD (2006) evidence.

The paper proceeds as follows. In Sections II. and III., we review the institutional and behavioral factors that should explain the existence of the equity home bias. Section IV. investigates the methodology of the home bias studies and we describe the model of optimal portfolio with Markowitz utility function. In Section V we evaluate the home biasness of Czech investors based on our results. We also provide with a sensitivity analysis with different utility functions. In Section VI. we reach some conclusions.

II. Institutional explanations

The home bias can be explained by violations of the main assumption of international financial: high liquid markets without barriers to entry, high transaction or information costs,

asymmetric information problems and the possibilities of moral hazard connected to the corporate governance of the firms. The arguments against these assumptions may help us understand the reasons of the equity home bias.

Firstly, there still exist some barriers to enter the foreign financial markets. One of the barriers are the restriction on foreign exchange transaction. There is a sufficient amount of evidence that proves that this type of barrier has fallen over time. French and Poterba (1991) and Cooper and Kaplanis (1994) argue that the explicit barriers are no longer large enough to explain the observed portfolio allocations of investors. However, there is a paper by Zalewska (2005) that explains the existence of home bias by the existence of restrictions in the investment policies of pension funds. According to her study, German, Italian and Canadian funds can not invest more than 20 % of their assets abroad. In the Netherlands foreign assets can be up to 70 % of their portfolios. The UK and US regulators are more liberal and do not set a rule to the size of international investments. Emerging markets restrictions are generally stronger; the Polish pension fund can have only up to 5 % foreign assets, Peru 8 % and Argentina 10 %. Brazil and Chile are standing on opposite sides, Brazilian pension funds have to lock all their assets at home, while the Chilean allow up to 30 % of the money to allocate in foreign securities. Despite the existence of the restrictions of pension funds, home bias cannot be explained only by those, because also other investors reveal the preference for domestic stocks.

Secondly, researchers have tried to explain the home bias by the transaction costs: high direct trading costs, as fees and commissions to the brokers and low liquidity. Tesar and Werner (1995) and Kang and Stulz (1997) that the stocks that are traded by foreign investors are traded frequently, implying that the variable costs should not be prohibitively high. The frequency of trading is connected closely to liquidity issue that is discussed in next section. There is however a different study that criticized the conclusions of the Tesar and Werner´s (1995) evidence of very high turnover rates on foreign equity portfolios. Warnock (2002) claimed that this study had underestimated the cross-border equity positions. The new study's findings are that the foreign turnover rates calculated using information from comprehensive benchmark surveys on cross-border holdings are much lower than previously reported and comparable to domestic turnover rates. However, this study concludes that the basic intuition from the Tesar–Werner study, that transaction costs do not help explain the observed home bias, was confirmed using data on transaction costs in 41 markets (Warnock 2002).

Thirdly, to learn and evaluate information is not free. On the contrary, information processing is highly priced in the financial world. Foreign investors generally lack the common local knowledge, have less information about the functioning of the financial market and the future perspectives of the firms listed on the equity market. They are therefore in a less feasible position than domestic investors. They can learn about the companies, but they have to pay additional "learning" costs. The indirect proof of the information problems are the existence of information providing and credit rating companies. If all investors were able to learn about all information without any costs there would be such companies as Bloomberg, Moody's and Standard and Poor's. The impact of the information costs may be severe, but we did not find any study that would explain home bias only by the existence of information costs.

Fourthly, the home bias studies explain that the asymmetric information problems are higher for investors across borders. Foreign investors are generally in higher risk of not knowing the correct situation of the firms. Coval and Moskowitz (2002) show that US investment managers exhibit a strong preference for locally headquartered firms, particularly small, highly levered firms that produce non-traded goods. These results suggest that asymmetric information between local and non-local investors may drive the preference for geographically proximate investments. The relation between the investment proximity, firm size and leverage may shed light on several well-documented asset pricing anomalies. Investors seem to value local firms differently from the further firms, because they are including the asymmetric information risks into their price evaluation. Foreign firms are therefore riskier. Asymmetric information has been provided as an explanation of home biasness also in the paper of Matsen (2002). He examined the allocation decision of an investor who owns two projects, a domestic and a foreign one. In his model, a manager governs the expected return from each project, and the investor has less information on the actions of the foreign manager. His profits would be different if he received full information. With asymmetric information, he generally achieved a better risk-return characteristic of his net terminal wealth with an allocation different from full diversification, because a "biased" allocation can be beneficial to the managers' efforts and risk properties of the optimal contracts (Matsen 2002). The paper however concludes that numerical simulations illustrate that, in general, the portfolio bias is small. According to the study, the asymmetric

information does not look like as a prime reason for the observed home-bias in portfolio allocation.

Finally, there is evidence on how the corporate governance and internal regulation of investment managers can creates compulsory home biased preference. If the rights of investors are poorly protected then those who are in control of firms have the ability to expropriate assets, firms may find it too expensive to raise funds unless those in control can commit to limit the expropriation. When those in control of a firm have a large stake in the firm's cash flows, expropriation is expensive for them as it involves them paying a large fraction of these deadweight costs. Consequently, having a controlling shareholder with a large cash flow stake is one solution whereby firms can become public and raise public equity (Dahlquist et al., 2002). There is evidence that the investor protection is vital for sound equity investment environment. According to an entrepreneurship model of Shleifer and Wolfenson (2002) the probability of getting caught is higher in countries with better shareholder protection. In their model, better investor protection leads to greater recourse of external financing by firms. Furthermore, the largest companies are controlled by the large shareholders and foreign investors are therefore unable to gain a controlling amount of equities. Pinkowitz et al. (2001) constructed an estimate of the world portfolio of shares available to investors who are not controlling shareholders. According to their study, the available world portfolio differs sharply from the world market portfolio. The foreign investors are in a disadvantage, because they can hold only a small fraction of a company, while the major part remains in the hands of majority investors. Foreign investors can gain almost no control power of the firm and their valuation of the investment decreases, which can distract them from the investment. The corporate governance studies provide us with a possible solution how to eliminate the home bias. To decrease the home biasness of the investors it is important to improve the investors' rights across countries, where the firms are mostly controlled by large shareholders.

Barriers to entry, transaction and information costs, asymmetric information and corporate governance can help to understand the source of investment home biasness from the institutional perspective. However, the evidence shows that none of these factors can fully explain the extent of home biasness alone. We have already mentioned that the barriers to entry and transaction costs improved significantly in last decades. The reduction of institutional problems should correspond to decrease in home bias tendencies, which has been

confirmed by the study of Amadi (2004). He demonstrates that there has been a distinct reduction in equity home bias in recent years. In his paper he examines if any of the theoretical explanations or recent developments such as free trade and globalization, the advent the internet, and the rise of emerging markets and mutual fund investment have affected the increase in the international diversification. The empirical analysis demonstrates that the rise of the internet and mutual fund investments have indeed affected the changes in foreign diversification (Amadi, 2004). The reason for the increase in diversification is the decrease in the asymmetric information and increase in the transparency.

III. Behavioral explanations

In the recent years the behavioral finance has been evolving rapidly and it can help us to understand the sources of home biasness from a different perspective. The traditional assumption of rational investors seems to be too strong. Shleifer (2000) argues that not only the investors are behaving irrationally, but there is also herd irrationality. Groups of investors do not evaluate their investments properly and even if they do, they do not act upon their evaluations. He argues that the herd irrationality cannot be offset by rational investors if there are no truly rational investors on the market. Behavioral finance tries to explain the actual behavior of investors with the advice of experimental psychology. Barberis and Thaler (2002) have taken into account the psychological biases to explain the biases on the markets. Some of these psychological biases can be reasons for the home biasness of the investors.

Firstly, we will discuss the psychological bias of optimism. People tend to display unrealistically optimist views of their abilities and prospects and they tend to be too overconfident in their own judgments. The psychologist surveys show that over 90 % of people think that they are above average in some ability (Barberis and Thaler, 2002). The optimist domestic investor would buy much more domestic equities than it should be rational. The results of optimism towards the performance of domestic firms were documented by Fellner and Maciejovski (2003). Their results show that there is a general optimistic perception of the domestic industry. Companies at home are expected to be performing much better by domestic than by foreign investors. The other study looks at the role of optimism from a different perspective. Graham et al. (2006) investigate the optimism and its effect on the trading frequencies. They provide theoretical link between the optimistic feelings of investors and the trading strategies. Optimistic investors believe that they have about average

skills and knowledge about the stock market. This belief makes them feel more competent to trade in stocks. In the paper they found evidence that investors who feel to be more competent trade more often and have more internationally diversified portfolios.

Secondly, the source of home biasness can be found in the psychological biases of narrow framing and loss aversion. Kahneman and Tversky (1982) demonstrated that people do not evaluate their utility from the total outcome, but instead they are usually evaluating different risk separately. Narrow framing means that the investor would derive the utility of the specific investment separately. The possible losses and gains of the investment are evaluated independently to the impact on total wealth of the investor. The prospect theory claims that people define their utilities separately over their gains and losses rather than over their final wealth. It means that the total utility of 100 CZK loss followed by the 100 CZK gain is no longer zero. People tend to be more risk averse over their losses, therefore their utility would be below zero. In standard prospect theory the people preferences exhibit the risk aversion for gains, risk loving for losses and loss aversion[1]. The loss aversion can distract investments into risky assets with higher volatility. Volatile stocks can bring higher losses, which are more painful than the possible gains. Magi (2007) provided an explanation of aggregate portfolio behavior in the framework that took into account the narrow framing bias described in the previous section. In the paper, the utility of wealth of the representative investors was not derived only from the total consumption level, but also from the wealth fluctuations caused by the financial assets. In his paper he made an assumption that the investor behaved loss aversely and framed the investments into foreign stocks separately. This study concludes that if we take into account the loss aversion and narrow framing than the model of international portfolio choice provide a plausible explanation of the equity home bias puzzle.

Thirdly, the other behavioral explanation was provided by Fellner and Maciejovski (2003). In their paper they further investigated home biasness from the perspective of the social identity of investors. They conducted an experiment in which they contrasted institutional with behavioral explanations of the home bias. They compared the asymmetric information with the social identity. The results of the experiment show that social forces lead to a domestically biased portfolio. Social identity of being a citizen of a country drives investors to invest into

[1] These preferences create a special convex-concave (convex for losses, concave for gains) shape of utility fiction that can be found in Kahneman and Tversky (1979).

the domestic equities. They argue that social identity explains the observed home bias equally well as the asymmetric information.

The irrationality of investors is a plausible explanation of the equity home bias. Behavioral finance with the help of cognitive psychology provides a theoretical framework, as well as substantial evidence, that explain the home biasness of investors. Optimism, loss aversion, narrow framing and social identity are the potential behavioral features that can explain the home bias puzzle. There is however a vast space for further research in this area. The studies that try to explain the home biasness can answer more questions about the actual belief formation and preferences of the real world investors.

IV. Methodology

IV.1. Model selection

In the literature the recognition of equity home bias has been generally taken as a task to evaluate the optimal investment portfolio and compare it with the actual evidence. The early models were applied from portfolio selection framework of Markowitz (1952). The IAPM based on Sharpe (1964) and Lintner (1965) makes a very strong conclusion that all investors should in equilibrium hold equities in same proportions: weighted by the market capitalizations. The home bias puzzle was discovered in the papers of international diversification of investment portfolios (Levy and Sarnat, 1970). Adler and Dumas (1983) proposed an international asset pricing model (CAPM), which resulted in a vector of optimal weights of an investor with a given utility function. This asset pricing approach is based on a mean-variance optimalization. The researchers that try to prove the existence of home bias use concave utility functions and search for their maximum. The development in this approach introduced Magi (2007) who extends this model with a special utility function over the gains/losses from foreign investments. This utility is in accordance with the Kahneman and Tversky (1979) convex-concave utility function which is steeper for losses. The alternative is to take the optimal weights given as a proportion of individual equity market capitalization from total world equity market capitalization as was proposed in IAPM by Sharpe (1964) and Lintner (1965). It is clear that based on their model we would conclude that the Czech equity market is strongly home biased because the optimal weights of domestic equity holdings for Czech investors should be far below 1 percentage. Therefore, we prefer the mean-variance optimization framework.

In our optimal portfolio model we use different utility functions to answer the question whether the Czech investors are biased towards the domestic equities. We will develop a model of investment portfolio which is very similar to the model used in Lewis (1999). She tested a bias implied by a standard CAPM model for two assets, domestic and foreign equities. She derived a model from the basic mean-variance approach modified for inclusion of foreign securities. In our model we will use a more general version of the model for N indices and Markowitz utility function. This is a concave utility function which approximates the preferences of the investors who are risk averse. He higher the curvature of the utility function, the higher the risk averseness. In the case of Markowitz utility function, the level of risk averseness is described by the coefficient lambda. The utility function will be described in the following section. The alternatives to this utility functions are the exponential utility functions that exhibit the constant absolute risk aversion or the logarithmic utility function that exhibit the constant relative risk aversion. In modern portfolio theory the risk aversion is measured as a reward (expected returns) for the risk (standard deviation) which is in correspondence with our utility function. In following sections we will also introduce models with different utility functions.

IV. 2. Assumptions of the model

The main assumptions of the model are that there are no transaction costs and no barriers to enter on a market. We assume the weak form market efficiency. Furthermore, we assume that the returns are normally distributed with the mean and variance which are constant in time, i.e. same as historical mean and variance during 1998-2008. Therefore, in the model we get N=10 weak form efficient markets with country specific drifts. Investors are assumed to be rational and cannot influence the price. They have free access to all relevant information and evaluate only the relevant information. New events are expected to be random with a zero mean on price change, therefore they form their expectation only based on historical prices and historical variances. Finally, we also assume that all investors are maximizing their utilities. All investors have the same utility function. In the model we assume a risk averse investor with a concave utility function that is increasing in expected profits and decreasing in expected risk. For the sake of simplicity we assume that there is not a risk free investment opportunity other than no investment. This assumption implies that investors will invest into

stock all their wealth unless they get less money than their initial wealth at the end of the investment period. We also assume that the investors do not take into account the inflation.

IV. 3. Model of optimal equity portfolio with Markowitz utility function

In this section we will introduce a model derived from CAPM model (Lewis, 1999) to determine how much foreign equities should have an average Czech investor in his equity portfolio. We will evaluate the more realistic case of risk averse investor who tries to maximize his risk adjusted wealth. He is trading off between risk and returns. In our model are his preferences described by a Markowitz utility function:

$$U = E_t W_{t+1} - \lambda \cdot \text{var}(W_{t+1}) \tag{1}$$

where λ is in this model a proxy of risk aversion. His utility is linearly increasing in the expected wealth: $\frac{\partial U}{\partial E_t W_{t+1}} = 1$ and decreasing in variance of his future wealth: $\frac{\partial U}{\partial \text{var}(W_{t+1})} = -\lambda$.

The higher is his risk aversion measured by λ, the lower will be his utility from a given level of variance.

How big should the coefficient of risk aversion be? Suppose that investor invested all of his funds to one single stock index. The following table shows us his utility if the stock prices followed the expected growth patterns for different levels of λ for monthly data.

Table 2: 100% investment into single stock index (monthly horizon)

	R CR	*R US*	*R EU*	R JA	R RS	R CH	R IN	R BZ	R SA	R NZ
AVERAGE	*0,0109*	*-0,0039*	*-0,0022*	*-0,0046*	*0,0153*	*0,0012*	*0,0008*	*0,0077*	*0,0029*	*-0,0021*
VAR	*0,0048*	*0,0030*	*0,0034*	*0,0043*	*0,0223*	*0,0352*	*0,0928*	*0,0158*	*0,0069*	*0,0035*
Wealth (t=0)	1	1	1	1	1	1	1	1	1	1
Wealth (t=1)	1,0109	0,9961	0,9978	0,9954	1,0153	1,0012	1,0008	1,0077	1,0029	0,9979
Utility (1/3)	**1,0093**	0,9950	0,9966	0,9940	**1,0078**	0,9895	0,9699	**1,0024**	**1,0006**	0,9968
Utility (1/2)	**1,0086**	0,9945	0,9961	0,9933	**1,0041**	0,9836	0,9544	0,9998	0,9995	0,9962
Utility (1)	**1,0062**	0,9930	0,9943	0,9911	0,9930	0,9660	0,9080	0,9919	0,9961	0,9944
Utility (2)	**1,0014**	0,9900	0,9909	0,9868	0,9707	0,9308	0,8152	0,9762	0,9892	0,9909

Table 2 shows us a case of investments in completely isolated markets, where the investors can invest only into their domestic stock index. We can see that for a single 100 % investment into one stock index even the risk aversion $\lambda = 1$ is quite high. For $\lambda \geq 1$ the only profitable investment opportunity would be the Czech stock index. In this case the only investment that would make sense (on the assumption of non-negative risk-free rate) would be the investment to Czech stock index. All other possibilities mean the decrease of utility at the end of next period. It is interesting to realize that investment which was the most beneficial for risk-neutral investor (100% into Russian index) would mean decrease of utility of risk averse investor with Markowitz utility function with $\lambda = 1$. The limiting risk aversion for which would an investor invest into any (in this case Czech) stock index (on the assumption of only 100% investments) is $\lambda = 2{,}7$. Investors who are more risk averse would not invest at all.

We will proceed with the description of the model. In our case, the investor can choose from n stock indices. We assume that investor invests all his wealth into stocks so he gets the maximum utility of the expected wealth at the end of the next period. Let us denote the vector of expected returns as a (n x 1) vector r, the transposed vector of returns looks like: $r' = (r_1, r_2, ..., r_n)$[2]. Our investor can sell stock indices even without owning them and buy them with profit at the end of next period. Therefore he can gain even from the downfall of the stock prices.

Let us denote Ω for the (n x n) variance-covariance matrix, ω for a (n x 1) vector of desirable weights of the stock indices in portfolio: $\omega' = (\omega_1, \omega_2, ..., \omega_n)$ and I for a (n x 1) vector: $I' = (1, 1, ..., 1)$. Investor is constrained with an equation: $\omega_1 + \omega_2 + ... + \omega_n = 1$. If we rewrite this condition in matrix algebra we get an optimalization constraint: $\omega' \cdot I = 1$. In this model we will allow for costless short selling so the weights can be also negative.
In this notation the investor utility function of the portfolio at the end of next period:

$$U = W_t(1 + \omega' \cdot r) - \lambda \cdot W_t^2 \cdot \omega' \cdot \Omega \cdot \omega \qquad (2)$$

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[2] In a model I assume only 1 period investment, therefore I will use henceforth the notation of r instead of $E_t r_{t+1}$. In our case: $r_1 = r_{CR}$, $r_2 = r_{US}$, $r_3 = r_{EU}$, $r_4 = r_{JA}$, $r_5 = r_{RS}$, $r_6 = r_{CH}$, $r_7 = r_{IN}$, $r_8 = r_{BZ}$, $r_9 = r_{SA}$, $r_{10} = r_{NZ}$.

we can simplify the equation by the assumption: $W_t = 1$. To solve the maximization problem we need a Lagrangean function:

$$L = (1 + \omega' \cdot r) - \lambda \cdot \omega' \cdot \Omega \cdot \omega - \varphi \cdot (\omega' \cdot I - 1) \tag{3}$$

where $\varphi \in R$ is the Lagrange multiplier. The first order condition with respect to ω is[3]:

$$\frac{\partial L}{\partial \omega} = r - 2 \cdot \lambda \cdot \Omega \cdot \omega - \varphi \cdot I = 0 \tag{4}$$

solving for ω, $\lambda \neq 0$:

$$\omega = \frac{\Omega^{-1}(r - \varphi \cdot I)}{2 \cdot \lambda} \tag{5}$$

where Ω^{-1} is inverse to Ω. We can rewrite the equation (5):

$$\omega = \frac{1}{2 \cdot \lambda} \cdot \Omega^{-1} \cdot r - \frac{\varphi}{2 \cdot \lambda} \cdot \Omega^{-1} \cdot I \tag{6}$$

which transposed gives:

$$\omega' = \frac{1}{2 \cdot \lambda} \cdot r' \cdot \Omega^{-1'} - \frac{\varphi}{2 \cdot \lambda} \cdot I' \cdot \Omega^{-1'} \tag{7}$$

and multiplied by I:

$$\omega' I = \frac{1}{2 \cdot \lambda} \cdot r' \cdot \Omega^{-1'} \cdot I - \frac{\varphi}{2 \cdot \lambda} \cdot I' \cdot \Omega^{-1'} \cdot I = 1 \tag{8}$$

which is the investor's constraint condition. Realizing that $I' \cdot \Omega^{-1'} \cdot I$ is only a number and therefore $I' \cdot \Omega^{-1'} \cdot I = (I' \cdot \Omega^{-1'} \cdot I)' = I' \cdot \Omega^{-1} \cdot I \neq 0$. Also we should note that the variance-covariance matrix Ω and therefore also Ω^{-1} is symmetric which means the transposed matrix is identical to original matrix: $\Omega = \Omega'$ and $\Omega^{-1'} = \Omega^{-1}$. We can now rewrite for φ:

$$\varphi = \frac{r' \cdot \Omega^{-1} I - 2 \cdot \lambda}{I' \cdot \Omega^{-1} \cdot I} \tag{9}$$

plugging this equation for φ into (6) we finally get:

$$\omega = \frac{\Omega^{-1} \cdot r}{2 \cdot \lambda} - \frac{\frac{1}{2 \cdot \lambda} r' \cdot \Omega^{-1} \cdot I - 1}{I' \cdot \Omega^{-1} \cdot I} \cdot \Omega^{-1} \cdot I \tag{10}$$

This is our final equation. We will solve the optimal portfolio weights for the monthly and quarterly for 5 levels of risk aversion: $\lambda = 3, 2, 1, 1/2 \text{ and } 1/3$. The results of the tested model are presented in the following section.

[3] This statement is expressed in matrix form, there are in fact n F. O. C.´s.

IV. 3. Model of optimal equity portfolio with exponential utility function

We will introduce an alternative utility function to show if the results of the previous optimization problem are robust. This model have similar assumptions including the assumption of normally distributed returns which is vital for the numerical method of solving this model. We are again maximizing utility given the optimization constraint that the sum of the weight should be 1.. In this case we use the CARA (Constant Absolute Risk Aversion Function). We will focus only on the case of not allowed short selling. Therefore we have to solve the model numerically with a restriction that the individual portfolio weights of a single stock can not be negative. Our model can be rewritten as follows:

$$\max_{\omega} U, so\ that: \omega' \cdot I = 1 \tag{11}$$

The CARA utility function:

$$U = -E\exp(-W_t \alpha \omega'(1+r)) \tag{12}$$

where α is the coefficient of absolute risk aversion. For simplicity, we again assume that $W_t = 1$. The assumption of the normally distributed returns leads to a log normal distribution and we search for the expected value:

$$E(LN(\bar{r}, \overline{\Omega})) = \exp(r, \frac{\overline{\Omega}}{2}), \bar{r} = -\alpha\omega' r, \overline{\Omega} = \alpha^2 \omega' \Omega \omega \tag{13}$$

Finally, we can rewrite our utility maximizing problem as :

$$\max_{\omega} U = -\exp(-\alpha\omega' E(r) - \frac{\alpha^2 \omega' \Omega \omega}{2}) \tag{14}$$

IV.4. Model of optimal equity portfolio with CRRA utility function

To improve our sensitivity analysis we add the Constant Relative Risk Aversion utility function. In this case, the maximization problem is :

$$\max_{\omega} U = E\frac{(\omega'(1+r)W_t)^{1-\gamma}}{1-\gamma} = \frac{W_t^{1-\gamma}}{1-\gamma} E\frac{(\omega'(1+r)^{1-\gamma}}{1-\gamma} \text{ so that: } \omega' \cdot I = 1 \tag{15}$$

where γ is the coefficient of relative risk aversion. We assume non-negative portfolio weights because the short sell is not allowed. To calculate the portfolio weights we use a numerical approximation of the integral of expected value of the utility function:

$$E(U(x) = \int_{-\infty}^{\infty} U(x) f(x) dx = \frac{W_t^{1-\gamma}}{1-\gamma} \int_{-\infty}^{\infty} \frac{(1+\omega' r)^{1-\gamma}}{1-\gamma} f(x; \omega' r, \omega' \Omega \omega) dr \quad (16)$$

where $f(x; \mu, \Sigma)$ is density of normal distribution with parameters μ a Σ. This utility maximization problem with the CRRA utility is irrelevant on absolute wealth. Portfolio weights will be same with investments 1 CZK or 1 mil CZK.

V. Optimal portfolio in the Czech Republic

V. 1. Data description

To test the home bias puzzle in Czech Republic we need to simulate a world equity portfolio. In the model we use 10 years of monthly data starting in May 1998 and finishing in May 2008[4]. For Czech investors the world equity market comprises of 9 foreign and one domestic stock index[5]. Foreign equity indices were converted into CZK and the monthly continuous compounding returns are calculated by the formula: $r_t = \ln(\frac{P_t}{P_{t-1}})$ [6].

V. 2. International portfolio diversification in the Czech Republic

Based on our data we will try to examine the degree of the integration of Czech equity market. As discussed above the degree of integration has been judged by the correlations between financial markets. The higher is the correlation, the higher is the integration. We use the monthly data of N=10 stock indices described above and calculate the historical correlation coefficients between the indices. Correlation coefficients between Czech and

[4] The monthly data were taken as the closing prices at the end of month, starting at the end of May 1998 and finishing at the end of May 2008. For the indices of New Zealand and South Africa the monthly data were taken as the opening prices at the beginnings of following months. I assume that the one day difference should have only a neglectable impact on the investment decision.

[5] Domestic index: PX. Foreign equities: United States: SP 500 (US), European Union: Dow Jones EUROSTOX 50 (EU) – consists of 12 EU countries excluding Czech Republic , Japan: Nikkei (JA), Russia: RTS $ (RS), China: Schangai composite (CH), India: Bombay Sensex (IN), Brazil: Brazil Bovespa $ (BZ), New Zealand: DJTM NEW ZEALAND $ (NZ), South Africa: DJTM SOUTH AFRICA $ (SA). Sources: PSE, Data Stream

[6] Monthly closing prices of CZK/USD, CZK/EUR and CZK/JPY exchange rates were taken from ČNB ARAD. I calculated the cross exchange rate for CZK/YUYN, CZK/BRL and CZK/INR. We used the monthly opening prices of YUAN/USD, INR/USD and BRL/USD taken from Data Stream. Again we assume that the one day difference should have only a neglectable impact on the investment decision.

foreign index are computed by a formula: $\rho_{CR,Foreign} = \frac{Cov(r_{CR}, r_{Foreign})}{\sigma_{CR} \cdot \sigma_{Foreign}}$, where σ_X a historical standard deviation of return series and $Cov(X,Y)$ is the covariance between two data sets of stock returns.

Table 1: Monthly correlation coefficients

ρ	CR	US	EU	JA	RS	CH	IN	BZ	SA	NZ
CR	1,00									
US	0,26	1,00								
EU	0,37	0,73	1,00							
JA	0,25	0,62	0,51	1,00						
RS	0,44	0,45	0,49	0,45	1,00					
CH	0,32	0,26	0,32	0,30	0,63	1,00				
IN	0,26	0,06	0,18	0,10	0,25	0,81	1,00			
BZ	0,42	0,51	0,62	0,37	0,58	0,44	0,21	1,00		
SA	0,31	0,41	0,46	0,42	0,45	0,38	0,24	0,46	1,00	
NZ	0,20	0,52	0,52	0,48	0,39	0,32	0,17	0,35	0,52	1,00

As we can see from the **Table 1** above, the lowest monthly correlation was between Czech stock market and the markets in New Zealand and Japan. The price increase on Czech market was accompanied only by up to 25% surge in a price movement in these two countries. On the other hand, the highest monthly correlation was between Czech and Russian stock market. But even between these two countries did not reached a 50 % level. Interesting observation is that all coefficients are positive. Positive correlation signifies the partial comovement of the stock prices between Czech and other world markets. Highest monthly correlation reveal the markets of China and India (0,81) and of the US and EU (0,73). On the contrary, the lowest correlated pairs are the markets of India and New Zealand (0,17) and of the Czech Republic and New Zealand (0,2). These low correlation coefficients signal good opportunities for diversification.

Based on these data we can conclude that Czech equity market is better integrated with the developed than with the emerging markets, because of the higher correlation coefficients.

With the markets of the US, Japan, EU and South Africa, there are higher profit possibilities from diversification if we invest on a monthly basis. The important conclusion is that Czech stock market is not perfectly world integrated. Therefore, there should be very good incentives for Czech investors to invest abroad.

V. 3. Results of the model with Markowitz utility

In this section we will discuss the model of the optimal portfolio model for different levels of risk aversion and different time horizons. Let us first look on the result of the optimal portfolio model for an investor who invests with an investment horizon of one month and is allowed to short sell.

Table 3 : Optimal monthly portfolio weights (Markowitz utility, with short selling)

Investor's risk aversion:	**3**	**2**	**1**	**1/2**	**1/3**
Czech Republic	0,72	0,92	1,52	2,72	3,92
United States	0,12	0,04	-0,23	-0,75	-1,27
European Union	-0,11	-0,26	-0,69	-1,56	-2,44
Japan	-0,11	-0,22	-0,54	-1,18	-1,83
Russia	0,13	0,26	0,63	1,39	2,14
China	-0,18	-0,29	-0,61	-1,26	-1,92
India	0,04	0,07	0,17	0,36	0,55
Brazil	-0,01	0,03	0,15	0,39	0,63
South Africa	0,11	0,15	0,26	0,47	0,69
New Zealand	0,28	0,29	0,34	0,43	0,52
Utility gain	**-0,001**	**0,004**	**0,014**	**0,031**	**0,047**

As we can see from the **Table 3** the leader is the Czech stock index. Optimal decision is to "borrow" money and invest into it more than initial wealth for all cases of tested risk aversion except the case $\lambda = 3$. For investors with such risk aversion the optimal outcome would be no investment. Under our assumptions, no investment yields zero return. Utility of zero risk-free return is zero which is higher than the returns from the portfolio. As we can see from the **Table 3** the investors should invest mainly into Czech stock index. The investment strategy should focus also on the acquiring the shares of New Zealand, South Africa, India, Brazil,

Russia and US. On the other hand, the investor should short sell EU, Japanese and Chinese indices. We can see that with decreasing risk aversion the amount of investments increases in both directions. The less risk averse the more the investor buys "good" stocks and the more he sells "bad" stocks. Also we can see that higher risk aversion implies lower gains in utility. In this sense, the risk aversion is a negative trait of investors that damages their utility.

In the real world the short selling is very costly and in most of the cases it is virtually impossible to short sell an ordinary stock index. On the contrary, it is usually possible to take a short position in the derivative instruments like futures and options that consist of these stock indices. However, the trading on derivative markets has a barrier for ordinary investors. It is costly and the trades occur in high figures. Furthermore, the derivative instruments increase the risks and multiply the expected returns which is suitable for big financial institutions, but not for individual investors. Therefore, in the following table we will show what the optimal portfolio of an investor without the short selling possibility would be.

Table 4: Optimal monthly portfolio weights (Markowitz utility, no short selling)

Investor's risk aversion:	3	2	1	1/2	1/3
Czech Republic	0,71	0,84	0,86	0,75	0,63
United States	0,01	0,00	0,00	0,00	0,00
Japan	0,00	0,00	0,00	0,00	0,00
Russia	0,00	0,05	0,14	0,25	0,37
South Africa	0,07	0,08	0,00	0,00	0,00
New Zealand	0,21	0,03	0,00	0,00	0,00
Utility	**-0,002**	**0,002**	**0,007**	**0,009**	**0,010**

For the model without short selling we had to use a numerical method to find solutions. It is a standard convex problem on polyhedral feasibility set, which assures that the numerical method has a unique solution[7]. Also in this case of world without the possibility to sell equities short, only investors with $\lambda \leq 2$ would gain from investments. For the coefficient of risk aversion $\lambda = 1/2$, the Czech investor would choose about 75 % of Czech equities and 25 % Russian equities. For $\lambda = 1$, the Czech investor would choose about 86 % of Czech equities and 14 % Russian equities. As we can conclude from the **Tables 3 and 4** the happiest

[7]As it is explained in textbook of Chong and Zak (2001).

investor would be the investor with the lowest risk aversion that is able to sell the stock indices short. Investor with $\lambda = 1/3$ would gain 4,7 % increase in his utility if he is allowed to short sell free of costs, but gains only 1 % if he is not.

Let us draw an overall conclusion from the results of the model. A risk averse Czech investor with the Markowitz utility function with reasonable levels of risk aversion would invest more than 60 % of his money into Czech equities. Do not forget that for the sake of simplicity of the model I did not take into account other investment opportunities. In our model the only alternative to investment into stock indices is no investment at all. This is a weak point of our model, but can be also interpreted behaviorally. This model would imply that the investors choose a part of their wealth that is meant only for investments into equities. This fact is not so unrealistic if we realize that the most of the financial institutions have some limits on equity investments. Also financial advisers usually recommend that only certain percentage of the investor's wealth should be invested into stocks. The managers of pension funds have also limits of the funds they are allowed to invest into equities (Zalewska, 2005).

We should not forget about the exchange rate risk and risk of inflation. Exchange rate risk in our model became a part of the index risk, because the foreign indices were recalculated in USD terms. The returns of Czech stock index were without the exchange rate risk component. Therefore I implicitly assumed that the Czech investors hold their wealth in Czech crowns, i.e. without any exchange rate risk for Czech index. Foreign investors holding foreign currency would have to exchange money and therefore the Czech equities would be riskier for them than for domestic investors.

V.4. Results of the model with exponential utility

As was mentioned above we will hereafter focus only on the solutions with restricted short selling. We use the estimations of the coefficient of risk aversion from the paper of (Bliss and Panigirtzoglou, 2004): $\alpha = 0{,}91$.[8] As you can find in **Table 5** Czech investors should hold 72 % of Czech and 28 % Russian equities in their portfolios.

[8] This is an option-implied coefficient for 4 weeks (1 month) period on 95 % level of significance.

Table 5: Optimal monthly portfolio weights (exponential utility, no short selling)

Risk aversion:	***0,91***
Czech Republic	0,72
Russia	0,28

V.5. Results of the model with CRRA utility

We use the estimations of the coefficient of risk aversion from the paper of (Bliss and Panigirtzoglou, 2004): $\gamma = 4{,}05$.[9] **Table 6** reveals that the optimal weights for Czech investors should be: 83 % for Czech, 5 % for Russian, 8 % for South African and 4 % for New Zealand´s equities. These results of the model with CRRA are perhaps the most reliable, because the CRRA model is independent on absolute value of wealth, e.g. it does not make a difference if the investor invest 1 CZK our 1 million CZK. The optimal weights remain the same for small and also big investors.

Table 6: Optimal monthly portfolio weights (CRRA utility, no short selling)

Risk aversion:	***4,05***
Czech Republic	0,83
Russia	0,05
South Africa	0,08
New Zealand	0,04

V. 6. Czech equity portfolio: OECD statistics

The most valuable evidence of the portfolio allocation of Czech investors can be obtained from the OECD data. **Table 7** provides the evidence of the stock of assets and liabilities for different sectors at the end of 2006. The domestic equities held by Czech investors are on the asset side of the balance sheet, foreign equities can be found on the side of liabilities of rest of world. If Czech investor buys foreign equities it becomes a liability of rest of world.

[9] This is an option-implied coefficient for 4 weeks (1 month) period on 95 % level of significance.

Table 7: Financial balance sheets of Czech Republic

A: Assets

mil CZK	Financial	Non financial	Government	Households[10]	Total economy	Rest of World
Shares and other equity	144 488	488 704	771 833	306 810	1 711 835	1 595 246
Mutual funds	27 854	18 088		225 350	271 292	
Shares and mutual funds	172 342	506 792	771 833	532 160	**1 983 127**	1 595 246

B: Liabilities

mil CZK	Financial	Non financial	Government	Households	Total economy	Rest of World
Shares and other equity	223 471	2 907 440			3 130 911	176 170
Mutual funds	156 392				156 392	114 900
Shares and mutual funds	379 863	2 907 440	0	0	3 287 303	**291 070**

Source: OECD 2006

At the end of 2006 Czech investors owned 1 711 billion CZK in shares and other equities, of which 45 % owned the government, 29 % non financial, 18 % households and 8 % financial institutions. Almost the same amount of Czech equities was owned by the rest of world. Foreign investors owned more equities (1 595 billion CZK) in Czech Republic than Czech investors owned foreign equities (291 billion CZK).

To answer the question whether there is home bias we have to compute the ratio of domestic equities in the equity portfolio of Czech investors. If we include the mutual funds[11] into equity, the ratio of domestic/total equities in Czech portfolio was 87,2 %[12]. This high figure can be little bit biased, because it includes the government, which is not a typical investor. However, if the government is excluded, the ratio is still quite high: 83, 3 %.

If we compare these figures with the results of our model without short selling possibility that are shown in **Tables 4 – 6,** we can conclude that the model is not in favor of the equity home bias hypothesis in the Czech Republic. Results of utility maximization problem with three different utility functions indicate that the optimal weight for Czech equities should be above 60 % and for reasonable levels of risk aversions between 72-83%.

10 Including nonprofit institutions serving households

11 Assuming that mutual funds are perfect substitutes to foreign shares.

12 Ratio=Total economy assets/ (Total economy assets + Rest of World Liabilities)

VI. Conclusion

People prefer to buy stocks of their own country despite the loss they suffer. This is evident based on the findings of the research in international portfolio studies. In this paper we have tried not only to provide evidence of the "home bias" phenomenon, but also to provide theoretical explanations of its sources. The market imperfections as the barriers to entry, transaction and information costs are one of the institutional reasons for the creation of home biased portfolio. However, the institutional features can explain only partly the home biasness, there is not a model that evaluates the impact of these factors together. It is difficult to quantify the impact of factors such as asymmetric information and corporate governance have on the investment decisions. The international evidence shows the imperfection of traditional finance models that assume no barriers to entry to equity markets, zero transaction and information costs and dispersed ownership of companies that works without any agency problems.

Behavioral finance can help us to understand how the investors are making their investment decision. Evidence from cognitive psychology suggests that the assumption of rationality in traditional financial sense is too strong and unrealistic. It is actually quite irrational to assume rationality. People reveal many psychological biases. Some of these biases can provide us with explanations of the propensity of investors to prefer domestic equities. Investors tend to be too optimistic about the future perspectives of a domestic firm. Narrow framing and loss aversion can also lead to home biasness. However insightful the behavioral theories are, the exact impact of the irrationality is difficult to assess. Second conclusion is therefore quite similar to the first one. Behavioral finance that assumes specific form of irrationality can partly explain the home bias puzzle.

However, based on our model and actual evidence from Czech Republic we could not prove the home biasness of Czech investors. This conclusion is a result of the comparison of the evidence of international portfolio allocation and the model of optimal portfolio allocation. Czech investors hold 87 % domestic equities out of total equity holdings. This figure includes the ownership of Czech government. The model without short selling for three different utility functions suggests that there should be more than 60 % of domestic equities in the portfolio (and 72-83 % for the feasible levels of risk aversion).

The weakness of this conclusion can be found in the assumptions of the model and a data selection. The model of optimal portfolio allocation assumes perfect markets and rational investors. The student´s questionnaire indicates that even trained students of economics do not make their decisions in the same way as the model would predict. The model also assumes that there are no transaction costs, including the costs with currency costs. The model does not take into account other investment opportunities. Furthermore, the period 1998 – 2008 was very successful for the Czech stock market. Therefore, this paper may be revisited after several years to show if the Czech equities are so desirable for the investors in longer run.

There is a big potential in future research in the field of behavioral finance. Models able to simulate truthfully the decisions of irrational investors could explain the home bias. In my opinion, the home bias is result of both factors: the imperfection of markets and investors. It would be interesting, but very demanding, to combine the institutional with behavioral factors. The factors behind the home biasness can help us in understanding of the financial world in reality. Financial models have made predictions based on unrealistic assumptions and therefore many puzzles have arisen.

List of abbreviations and symbols:

BRL	Brazilian real
BZ	Brazil Bovespa index
CH	Shanghai composite index
CR	PX stock index
CZK	Czech crown
EU	DJ Eurostox 50
IN	Bombay Sensex
INR	Indian rupee
JA	Nikkei
JPY	Japanese yen
NZ	DJTM New Zealand - Price index in $
RS	RTS – Russian price index in $
SA	DJTM South Africa - Price index in $
US	Standard and Poor's 500
YUAN	Chinese Yuan

r	Average returns of stock indices
ω	Portfolio weights
Ω	Variance-covariance matrix
λ	Coefficient of risk aversion
W_t	Investor's wealth at time t
U	Utility function of investors
L	Langrange function
φ	Langrange multiplier

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