INTERNATIONAL ASSET PRICING MODELS AND CURRENCY RISK: EVIDENCE FROM FINLAND 1970-2004

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Abstract

This paper investigates whether global, local and currency risks are priced in the Finnish stock market using conditional international asset pricing models. We take the view of U.S. investors. The estimation is conducted using the multivariate GARCH framework of De Santis and Gérard (1998) using a sample period from 1970 to 2004. In a time-varying specification for the prices of world and currency risk, we find both of them time-varying, even though only the world risk is statistically significant. After joining the EMU, the price of currency risk decreased. The local price of risk is also found to be priced on the Finnish stock market, but not on the US equity market. While world market risk accounts for most of the US equity market risk premium, it accounts only for 60 per cent of the corresponding Finnish premium, which is driven mostly by the local market risk, and to some degree by the currency risk component. The local price of risk is also found time-varying. The results differ partly from De Santis and Gérard (1998).

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EFM-classification: 310, 630

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1 INTRODUCTION

International aspects of asset pricing have recently received increasing attention. Many papers explore the degree to which national capital markets are integrated with world capital markets. For example, Dumas and Solnik (1995) show that there is little evidence that global equity and foreign exchange markets deviate from full integration. On the other hand, Bekaert and Harvey (1995) find that many emerging stock markets exhibit time-varying integration with world stock markets. Furthermore, Bekaert and Harvey report some evidence opposing the popular notion that global capital market integration has increased over time.

Prior studies on international asset pricing models use data mainly from large markets closely integrated with global financial markets.[2] However, many small developed countries have only recently experienced full liberalization of their capital markets and many emerging countries are still in the midst of the liberalization process. For example, all restrictions on foreign investments into Finland were abolished as late as in 1993. As a result, researchers have suggested models of partial segmentation could be more appropriate for these markets (see, e.g., Errunza and Losq, 1985). These models suggest that both local and world factors should influence equilibrium asset returns. In their study, Nummelin and Vaihekoski (2002) indeed find that both the local and global sources of risks are priced in the Finnish market. Furthermore, Vaihekoski and Nummelin (2001) find that the degree of equity market integration for Finland has increased over time from 1987 to 1996 indicating that a partial segmented model could be more appropriate in pricing Finnish stocks.

Besides, the segmentation issue, the currency risk can play a very important role especially in many small and/or emerging markets, since their exchange rate mechanism often differs, e.g., from that of the USA. The pricing of currency risk in the stock market is though still a somewhat controversial issue. Using an unconditional approach, Jorion (1991) reports that the currency risk is not priced in the US market. However, several researchers have later found currency risk to be highly time-varying. For example, De Santis and Gérard (1998) conclude that the time variation in the risk premium could explain why the unconditional models are unable to detect highly time-varying currency risk.

Taking the results together, the evidence suggests, that the relation between expected returns and measures of global market risks is unstable over time, and that exposures to global risks could be increasingly important in determining expected returns in most national stock markets, even though the local risk could still be priced in the market. Furthermore, one should include also time-varying currency risk into the pricing model.

In this paper, we use the framework of De Santis and Gerard (1998) to study the pricing of global and local market risks, and currency risk on the relatively small Finnish stock market.[3] We utilize a rather long sample period, from 1970 to 2004. This sample period

[2] See, e.g., Cho, Eun, and Senbet (1986), Korajczyk and Viallet (1989), Cumby and Glen (1990), Harvey and Zhou (1993), Dumas (1994), Bekaert and Harvey (1995, 1997), Harvey (1995a,b), and Dumas and Solnik (1995). A review of the issues involved can be found, e.g., from Adler and Dumas (1983). A more recent review can be found, e.g., in Stulz (1995).

[3] For example, at the end of September 1997, the Finnish stock market was the fifth smallest market included in the MSCI world stock market index right after Norway and before Denmark. Finland represented less than one percent of the total market capitalization of the MSCI world index with its market capitalization value of USD 87 billion. Although the Finnish stock market is small, it has

and the Finnish stock market are an interesting test laboratory for international asset pricing models, justified by the fact that the Finnish stock market has developed during this period from a relatively closed market to open and integrated market, especially after the final abolishment of all restrictions on foreign ownership in 1993. On the other hand, Finland is interesting from currency risk's point of view, since the Finnish currency has undergone several currency regimes (multiple cases of devaluations and revaluations, periods of fixed and floating exchange rates, and joining the EMU in 1999). On the other hand, many Finnish companies and especially Nokia have drawn foreign investors' attention and increasing ownership recently.

Overall, we believe these institutional features and this particular sample period make the Finnish stock market an interesting one for tests of conditional international asset pricing models. Our primary goal is to explore whether the global market risk is priced in the Finnish stock market and what is its role in the pricing. Second, we ask whether currency risk is priced in the stock market. Third, we study whether the partially segmented model is more appropriate for a small country. Finally, we study whether the global market and currency risks are time-varying and to what degree these sources of risks account for the risk premium. The results can shed light on the role of the currency risk and local risk on the pricing of stocks in countries that are currently emerging from segmentation and which are also restricting the free valuation of their currencies (e.g., China and Eastern European new EU members).

The remainder of the paper is as follows. Section 2 presents the research methodology. Section 3 gives a short introduction to the history of Finnish currency policy and presents the data in this study. Section 4 shows the empirical results. Section 5 concludes.

2 RESEARCH METHODOLOGY

2.1 Theoretical background

We begin our examination with the conditional international capital asset pricing model consistent with fully integrated capital markets. If world markets are fully integrated, then the expected return on all assets should be the same after adjusting for exposure to global sources of risk. Hence, in a single-factor-setting, the single relevant source of global risk is a benchmark portfolio comprised of *the world equity market portfolio*.

If there are no restrictions on capital movements so that domestic investors are free to diversify internationally and foreign investors are allowed to invest in local markets, markets are said to be legally integrated. By financial market integration we understand that assets in all markets are exposed to the same set of risk factors with the risk premia on each factor being the same in all markets. In this case, e.g., Adler and Dumas (1983) have shown that the global value-weighted market portfolio is the relevant risk factor to consider. Assuming that investors do not hedge against exchange risks and a riskfree

traditionally been included among the developed stock markets (for criterion between developed and emerging stock markets see, e.g., MSCI, 1998).

asset exists, the conditional version of the world CAPM implies the following restriction for the nominal[4] excess returns

(1) $$E[r_{it}|\Omega_{t-1}] = \beta_{it}(\Omega_{t-1})\ E[r_{mt}|\Omega_{t-1}],$$

where and $E[r_{it}|\Omega_{t-1}]$ and $E[r_{mt}|\Omega_{t-1}]$ are expected returns on asset *i* and the global market portfolio conditional on investors' information set Ω_{t-1} available at time t–1. Both returns are in excess of the local riskless rate of return r_{ft-1} for the period of time from t–1 to t. The global market portfolio comprises all securities in the world in proportion to their capitalization relative to world wealth (see Stulz, 1995). All returns are measured in one numeraire currency.

Since the conditional beta is defined as $Cov(r_{it}, r_{mt}|\Omega_{t-1}]Var(r_{mt}|\Omega_{t-1})^{-1}$, we can rewrite equation (1) as the ratio $E[r_{mt}|\Omega_{t-1}]Var(r_{mt}|\Omega_{t-1})^{-1}$. It can be considered as the conditional price of global market risk λ_{mt}.[5] It measures the compensation the representative investor must receive for a unit increase in the variance of the market return (see Merton, 1980). Now the model gives the following restriction for the expected excess returns for assets:

(2) $$E[r_{it}|\Omega_{t-1}] =\lambda_{mt}Cov(r_{it},r_{mt}|\Omega_{t-1}).$$

Since the market portfolio is also a tradable asset, the model gives the following restriction for the global market portfolio's expected excess returns

(3) $$E[r_{mt}|\Omega_{t-1}] =\lambda_{mt}Var(r_{mt}|\Omega_{t-1}).$$

As the returns are measured in a numeraire currency, the model also implies that expected returns do not have to be the same for investors coming from different currency areas even though they do not price the currency risk. On the contrary, the price of global market risk is the same for all investors irrespective of their country of residence.[6]

However, if some assets deviate from pricing under full integration, their risk-adjusted return will differ from the global CAPM. If this is the case, the market price of global risk should be the same for all assets everywhere, after adjusting for the costs arising from the barrier constraints. Following Errunza and Losq (1985), the pricing equation may include also the local market portfolio as a source of local market risk. The pricing equation can be written as follows:

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4 Originally, the restriction implied by the ICAPM holds for the real excess returns, but since we are testing the model within one country, the real returns can be replaced with nominal returns (see Stulz, 1995).

5 The price of risk is sometimes also called as reward-to-risk, compensation for covariance risk, or aggregate relative risk aversion measure.

6 The price of global market risk is the average of the risk aversion coefficients for each national group, weighted by their corresponding relative share of global wealth. Note that, in theory, these weights do not have to be the same if measured in different currencies, but lack of arbitrage between currencies is sufficient to give the same λ_{mt}.

(4) $$E[r_{it}|\Omega_{t-1}] = \lambda^{w}_{mt}Cov(r_{it}, r^{w}_{mt}|\Omega_{t-1}) + \lambda^{l}_{ml}Var(r_{it}|\Omega_{t-1}),$$

where λ^{w}_{mt} and λ^{l}_{mt} are the conditional prices of world and local market risk.

However, any investment in a foreign asset is always a combination of an investment in the performance of the asset and in the movement of the foreign currency relative to the domestic currency. Adler and Dumas (1983) show that if the purchasing power parity (PPP) does not hold, then investors view real returns differently and they want to hedge against exchange rate risks.[7] Specifically, the risk induced by the PPP deviations is measured as the exposure to both the inflation risk and the currency risk associated with currencies. Assuming that the domestic inflation is non-stochastic over short-period of times, the PPP risk contains only the relative change in the exchange rate between the numeraire currency and the currency of *C*+1 countries (see, e.g., De Santis and Gérard, 1998). In this case the conditional asset pricing model for partially segmented markets implies the following restriction for the expected return of asset *i* in the numeraire currency

(5) $$E_{t-1}[r_{it}] = \lambda^{w}_{mt}Cov_{t-1}(r_{it}, r^{w}_{mt}) + \sum_{c=1}^{C}\lambda_{ct}Cov_{t-1}(r_{it}, f_{ct}) + \lambda^{l}_{mt}Var_{t-1}(r^{l}_{mt}),$$

where λ_{ct} is the conditional price of exchange rate risk for currency *c*. $Var_{t-1}(.)$ and $Cov_{t-1}(.)$ are short-hand notations for conditional variance and covariance operators, all conditional on information Ω_{t-1}.

Now, the risk premium for the local market risk premium can be written as follows

(6) $$E_{t-1}[r^{l}_{mt}] = \lambda^{w}_{mt}Cov_{t-1}(r^{l}_{mt}, r^{w}_{mt}) + \lambda^{l}_{mt}Var_{t-1}(r^{l}_{mt}) + \sum_{c=1}^{C}\lambda_{ct}Cov_{t-1}(r^{l}_{mt}, f_{ct}),$$

Finally, the currency risk premiums can be written as follows

(7) $$E_{t-1}[f_{jt}] = \lambda_{mt}Cov_{t-1}(f_{jt}, r_{mt}) + \sum_{c=1}^{C}\lambda_{ct}Cov_{t-1}(f_{jt}, f_{ct}),$$

Unfortunately, the model above is intractable in practice if *C* is large. Thus, one can either focus on a subset of currencies or use a more parsimonious measure for the currency risk. Ferson and Harvey (1993) and Harvey (1995) show how one can use a single aggregate exchange risk factor to proxy for the deviations from the PPP to the model. In this case, the model (5) boils down into a three-factor model.

2.2 Empirical formulation

If we want to study the implications of the conditional asset pricing models in a conditional framework, we need to decide how we model investors' conditional

[7] Moreover, currency risk may enter indirectly into asset pricing, if companies are exposed to unhedged currency risk for example through foreign trade and/or foreign debt. Empirical evidence has found conflicting support for the pricing of the foreign exchange rate risk (see, e.g., Jorion 1990, 1991; Roll, 1992; De Santis and Gérard, 1997, 1998; Doukas, Hall, and Lang, 1999).

expectations. Here we utilize the framework of De Santis and Gérard (1998).[8] They use a multivariate GARCH-in-Mean approach to model the conditional expectations, covariances, and variances. Their approach avoids nicely setting up separate model for the expected returns. Instead they can use the theoretical model for them.

Our starting point is a US investor investing both in the domestic stock market, and one additional, smaller country, in this case Finland. We therefore estimate the model using three test assets: world equity market, the U.S. and Finnish market equity market indices. The U.S. market is included to compare the results with De Santis and Gérard (1997, 1998). The empirical model for the excess returns in USD is the following:

(8) $$r_{mt}^{w} = \lambda_{mt-1}^{w} h_{t}^{w} + e_{mt}^{w},$$

(9) $$r_{mt}^{US} = \lambda_{mt-1}^{w} h_{t}^{US,w} + \lambda_{mt-1}^{US} h_{t}^{US} + e_{mt}^{US},$$

(10) $$r_{mt}^{FIN} = \lambda_{mt-1}^{w} h_{t}^{FIN,w} + \lambda_{mt-1}^{FIN} h_{t}^{FIN} + e_{mt}^{FIN},$$

$$\boldsymbol{\varepsilon}_t \sim \text{IID}(\mathbf{0}, \boldsymbol{H}_T).$$

where lambdas are the conditional prices of risk and ε_t is a 3×1 vector of stacked innovations, i.e., $\boldsymbol{\varepsilon}_t = [e_{mt}^{w}\ e_{mt}^{US}\ e_{mt}^{FIN}]'$. $\boldsymbol{H}_T$ is the variance-covariance matrix. Equations (8), (9) and (10) are the empirical counterparts to equations (3) and (4). In this formulation we have omitted the currency component of equation (5).

There are several alternatives to specify the three-variate covariance process of $\boldsymbol{\varepsilon}_t$. Financial returns often exhibit features like clustering, time-variation and non-normality. Variance-covariance specifications in the family of (Generalized) Autoregressive Conditional Heteroskedasticity (henceforth GARCH) capture these features.[9] The drawback of the first multivariate extension by Bollerslev et al. (1988) is the large number of parameters to estimate, the difficulties to obtain a stationary covariance process and the problems to get a positive-definite (co)variance matrix. Many of these problems are circumvented by the BEKK (Baba, Engle, Kraft and Kroner) parameterization proposed by Engle and Kroner (1995):

(11) $$\mathbf{H}_{t+1} = \mathbf{C}'\mathbf{C} + \mathbf{A}'\varepsilon_t\varepsilon'_t\mathbf{A} + \mathbf{B}'\mathbf{H}_t\mathbf{B},$$

where, e.g., for the bivariate case, the matrices can be written as follows

(12) $$\mathbf{C} = \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix},\ \mathbf{A} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}, \text{and } \mathbf{B} = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}.$$

While specification (11) allows for rich dynamics and a positive-definite covariance matrix, the number of parameters still grows fairly large in higher-dimensional systems. Therefore, parameter restrictions are often imposed, for example diagonality or symmetricity restrictions. In order to simplify the estimation process, we adopt the

8 The estimation is conducted using a Gauss program originally written by Bruno Gerard. Modifications to the original program are made by the authors.

9 For good surveys, see for example Bollerslev et al. (1992, 1994), and Hentschel (1995).

covariance stationary specification of Ding and Engle (1994), and utilized for example by De Santis and Gérard (1997, 1998):

$$(13) \qquad H_t = H_0 \times (ii' - \boldsymbol{aa}' - \boldsymbol{bb}') + \boldsymbol{aa}' \times \varepsilon_{t-1}\varepsilon'_{t-1} + \boldsymbol{bb}' \times H_{t-1},$$

where $\boldsymbol{a}$ and $\boldsymbol{b}$ contain the diagonal elements of $\boldsymbol{A}$ and $\boldsymbol{B}$, respectively, and $\boldsymbol{H}_0$ the unconditional variance-covariance matrix.

The parameters are estimated by maximum likelihood. Assuming conditional normality, and defining the residuals from equations (8), (9) and (10) as $\boldsymbol{\varepsilon}_t = [e^w_{mt}\ e^{US}_{mt}\ e^{FIN}_{mt}]'$, and $\boldsymbol{H}_t$ as specified in equation (11) yields the following time t log likelihood function (omitting the constant):

$$(14) \qquad \ln L_t = -\frac{1}{2}\ln|\mathbf{H}_t| - \frac{1}{2}e_t'\mathbf{H}_t^{-1}\mathbf{e}_t .$$

Although asset returns are often non-normal, we choose the normal distribution. However, we use the quasi-maximum likelihood (QML) approach of Engle and Wooldridge (1992) to calculate the standard errors. Given that the conditional mean and conditional variance are correctly specified, QML yields consistent and asymptotically normally distributed parameter estimates. Further, robust Wald statistics can straightforwardly be computed. We use the Berndt–Hall–Hall–Hausman (BHHH, 1974) algorithm for the optimization.

We also have to select a model for the conditional price of risk coefficients. Following earlier research, one alternative to model the global market price of risk is the following linear function of the global variables:

$$(15) \qquad \lambda_{wt} = Z^w_{t-1}\kappa_w ,$$

where Z^w_{t-1} is an (1×L) data vector for the global instrument variables at t-1, κ_w is a vector of linear regression coefficients, and L is the number of global instrument variables, including the constant. If we wish to restrict the price of market risk to be positive, we can use the following formulation:

$$(16) \qquad \lambda_{wt} = \exp(Z^w_{t-1}\kappa_w) .$$

More specifically, we have to decide on the variables to be used to model the time-variation in the price of risk. The price of risk measures should be the same for all countries regardless of the currency used as numeraire currency (c.f., e.g., De Santis and Gérard, 1998). Similarly, we have to decide what variables are used to model the time-variation in the local price of risk. The main question is whether we use only global information or do we also allow for local influence when investors are forming their expectations. Researchers seem to disagree to some degree in this issue. Ferson and Harvey (1993) claim that perfect integration implies that local information does not play any role when investors form their expected global risk premiums.[10] Ferson and Harvey (1994), on the other hand, point out that expected risk premium may depend on the collection of the country specific attributes, even in integrated markets. Here we also choose to include local information variables in the model. Now the local market premium can be written as follows:

$$\lambda_{mt}^{l} = Z_{t-1}^{wl} \kappa_{l}, \tag{17}$$

where $Z_{t-1}^{w,l}$ is an $(1 \times L_l)$ data vector of combined global and local instrument variables, κ_l is a vector of linear regression coefficients. Instrumental variables do not need to be the same for all individual markets, but typically they are equalized to keep the system estimable. In the cases where currency is a risk factor, its premium can be written as

$$\lambda_{ct} = Z_{t-1}^{wl} \kappa_{c}. \tag{18}$$

Overall, there is still no consensus on what metric to use in selecting between the variables and models. Simply maximizing the explanative power of the model and variables raises the question of data mining. In addition, that approach is bound to be theoretically questionable and econometrically difficult to implement. The question of selecting the right information variables is even more problematic. In general, the question of relevant information variables should be addressed by economic reasoning. In practice, one hopes to select theoretically justified variables that are also able to capture part of the predictability in the prices of risk.

3 DATA

Our estimation period covers 418 months of data from March 1970 to December 2004. The beginning of the sample was selected due to the availability of total return equity market data from Finland. The sample period differs from De Santis and Gérard (1998) as it begins four years earlier and ends seven years later. For the years that overlap (1973–1997) we utilize the same data as they do, with the exception of the Eurodollar interest rate and the U.S. term premium information variable.[11]

We take the view of an US investor. Thus, all returns are measured in the US dollars. As a proxy for the U.S. investors' risk-free return measured in USD for month *t*, we use a one-month holding period return on the one-month Eurodollar interbank money market rate on the last trading day of month *t*–1.[12] We use continuously compounded asset

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[10] See also Bekaert and Harvey (1995), who state that markets are completely integrated if assets with the same risk have identical expected returns irrespective of the market or even irrespective of local information.

[11] We use the Eurodollar series of De Santis and Gérard (1998) for 1970–1997, after which we use the one-month Eurodollar London 11am bid rate obtained from Datastream. For the term premium we use the 10-year treasury constant maturity rate and the 3-month Treasury bill secondary market rate for the whole period, both taken from Federal Reserve Economic Data, FRED II. The difference is small. Both series exhibit high correlation with De Santis and Gérard's during overlapping periods.

[12] Eurodollar market was born in the 1950s. However, the market started to grow strongly in the 1970s when the East-European countries transferred their savings from the USA to Europe. After the oil-crisis, the Arabic countries also contributed to the growth.

returns throughout, since these returns more accurately describe price changes during volatile periods.[13] All returns in estimations are in percentage – not decimal – form.

3.1 Case: Finland

3.1.1 Foreign Exchange Policy

The Finnish currency, Markka (FIM), has experienced many changes during its history. Panel A in Table 1 lists all the major changes since 1949. FIM was established first in 1860 under the autonomy from Russia. During late 19th and early 20th century FIM was now and then tied to gold. After joining the International Monetary Fund, and the World Bank in 1948, FIM was tied via the US dollar to gold. After the collapse of the Bretton Woods system in 1970, Finland joins the Smithsonian agreement with a fluctuation width of ± 2.25 per cent for FIM. From 1973–1977 FIM was unofficially pegged against an exchange rate index, and later 1978–1991 officially.

During the 1970s and 1980s FIM experienced several devaluations (and also a few revaluations) to defend the competitive position of the Finnish industry. Especially in the early 1990s the currency experienced many speculative attacks where the Bank of Finland defended the currency against a devaluation using high short-term interest rates. There was devaluation in late 1991, and the peg to the European Currency Unit made in June 1991 was canceled in September 1992, when the FIM was forced to let freely floating.

Table 1. Regimes and major changes to the value of Finnish currency (Finnish Markka)

Panel A lists Finnish currency regimes from 1949 to 2004. Panel B shows major changes to the value of Finnish currency from 1971 to present day.

Period	Description
Panel A	
1949-1970/8	Bretton Woods: Finnish Markka (FIM) pegged against USD.
1971-1973	Smithsonian Agreement of
1973/6-1977/11	Markka fixed against trade-weighted currency index with fluctuation range, unofficial
1977/11-1991/6	Markka fixed against trade-weighted currency index with fluctuation range, official
7.6.1991	FIM linked to ECU (European Currency Unit) with fixed rate
8.9.1992	FIM let floating
14.10.1996	FIM joins the ERM with fixed central rate 5.80661/5.85424
1.1.1999	FIM joins the EMU; Euro replaces FIM on the financial markets
1.1.2002	Euro notes are taken into use and Euro fully replaces FIM.
Panel B	
1971-1974	Gradual devaluation of 7.1%
5.4.1977	Devaluation 5.7 %
1.9.1977	Devaluation 2.9 %
17.2.1978	Devaluation 7.4 %
5.8.1979	Revaluation 1.5% within fluctuation range

[13] The one-month Eurodollar rate is changed to continuously compounded using the following equation: $ln(1 + r \times \text{(number of days between month-end observations)}/360)$.

21.9.1979	Revaluation 2.0% within fluctuation range widened
25.3.1980	Revaluation 2.0% within fluctuation range
6.10.1982	Adjustment (=devaluation) of 3.8 % within fluctuation range
11.10.1982	Devaluation 5.7% fluctuation range reduced (or not)
27.3.1984	Adjustment (=revaluation) of 1.0% within fluctuation range
1986	Adjustment of 1.6% within fluctuation range
1989	Fluctuation range widened
17.3.1989	Revaluation 3.8 %; fluctuation range changed
15.11.1991	FIM devaluated 12.3%

Source: Bank of Finland.

Shortly afterwards Finland joined the EU and the European Monetary System, and the Markka started to appreciate and the exchange rate volatility reduced considerably, especially between currencies joined in the exchange rate mechanism of the EMS. Later, in October 1996, the currency joined the Exchange Rate Mechanism (ERM) but the mechanism still allowed for fluctuation. Beginning in 1999, FIM has been tied to Euro within the European Monetary System with a fixed exchange rate, and exchange rate fluctuations against other Euro currencies became impossible. At the same time, the Finnish stock exchange started use Euro as the pricing currency. Companies also started to use Euro as the currency of choice within the Euro area. Later in 2002, the Euro replaced Markka as all pricing and transactions were changed to euro.

The economic and political integration process within the EU and its monetary system (EMS) has made Finland more closely tied to the European and global economy. This process has not been without problems, though. Finnish government has traditionally resorted to devaluation of the Finnish currency as a tool to maintain the competitiveness of Finnish industries. Panel B in Table 1 lists all major changes to the value of FIM. Even though most of the devaluations (and revaluations) were made against a basket of currencies, they affected the value of FIM also in USD terms. Figure 1 shows the development of the USD/FIM exchange rate during the sample period. As we can see, the exchange rate has been highly time-varying.

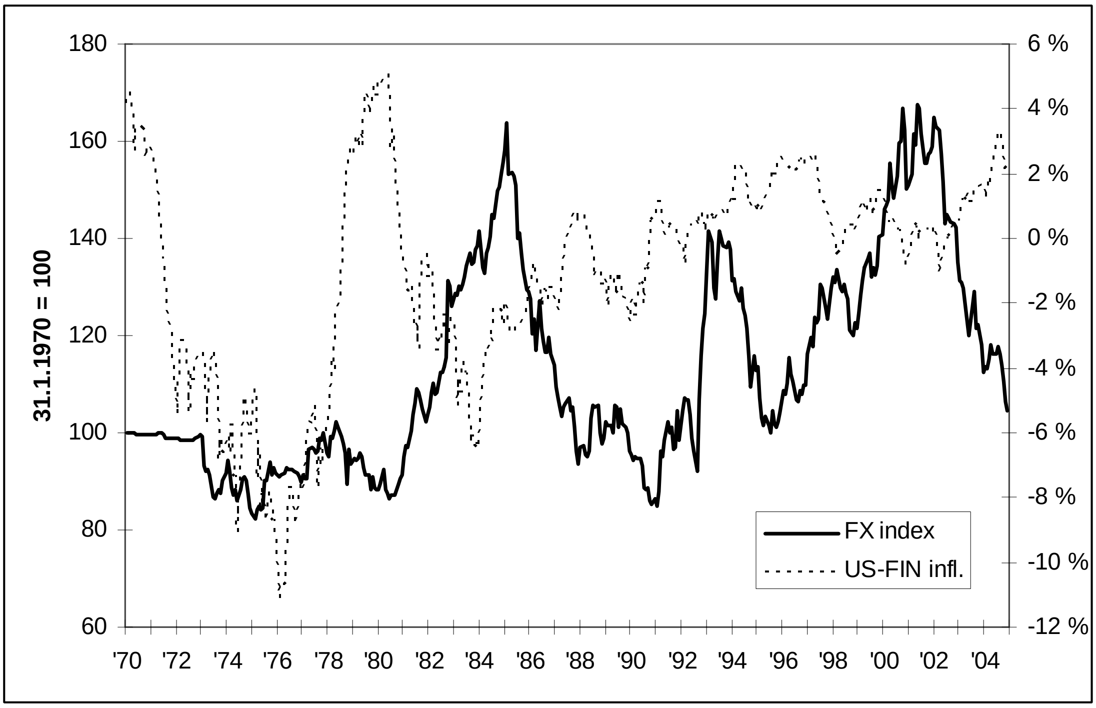

Figure 1. Value of Finnish Markka in terms of USD from 1970 to 2004 (left y-axis) and the difference in the US and Finnish inflation (right y-axis). From 1999 forward, the currency index is calculated from the euro-USD exchange rate. Inflation difference is lagged by two months.

3.1.2 Foreign Ownership Restrictions

Foreign investors became interested to invest in Finnish stocks as early as in the 1970s. However, this was rather small-scale operations until early 1980s. As the investments rose, the government wanted to restrict the foreign ownership. As a result, foreign ownership was restricted to unrestricted shares from 1984 forward. These shares could not account for more that 20 percent of the equity capital (40 percent from 1989 forward). Unrestricted shares were listed separately (for more information, see, Hietala, 1989). In the beginning of 1993, all restrictions on foreign ownership were abolished and all shares became "unrestricted".

However, setting restrictions on foreign ownership does not necessarily mean that the global risk factors are not priced in the market. The Finnish economy has traditionally been very dependent on foreign trade. Imports and exports accounted, e.g., in 1997 for approximately 30 and 40 percent of the total value of the Finnish GDP, respectively. This makes the whole economy exposed to global risks. In addition, listed companies in many cases represent companies which even more rely on international trade and thus their cash flows are to a large degree dependent on the international development. Finally, markets can be integrated simply because Finnish investors were allowed to invest more freely abroad in the late 1980s.

3.2 Variables

3.2.1 Risk factors and test assets

We employ two types of risk factors in our international asset pricing model to represent economic risks. Our first risk factor is the global market portfolio. Global market portfolio returns are proxied by the total return on the Morgan Stanley Capital International (MSCI) world equity market index with reinvested gross dividends. We take the perspective of a U.S. investor and express all returns in USD.

Our second source of risk is related to exchange rate changes. If the currency risk is relevant for the pricing of Finnish stocks, the exchange risk premium should be found significant in the estimation. Moreover, it is expected to be highly time-varying in the sample period due to many regimes. We use continuously compounded change in the U.S. dollar (USD) as a measure of the currency risk.

Initially, we test the model using two test assets on top of the global market, namely the U.S. and Finnish market portfolios. We do this in order to compare results with the portfolio results and with the earlier studies e.g. by De Santis and Gérard (1998). Note, however, that the currency deposits employed in their study are not included in our test assets.

The U.S. stock market returns are calculated from the MSCI US total return index The Finnish stock market returns are calculated using the value-weighted HEX yield index. The HEX index is calculated by the stock exchange and it covers all stocks quoted on the Main List of the Exchange from 1991 forward.[14] Prior to 1991, we use the WI-index which is calculated by the Swedish School of Economics and Business Administration.[15]

Table 2 shows the summary statistics of all the return series. Mean and standard deviation are scaled by 12 and the square root of 12 to show them in annual terms. All returns are continuously compounded, and calculated in USD. The mean USD return for the world equity factor is 10.164% annually. The mean return from the local USA market is 10.417%. The difference between the world and the USA might be surprisingly low, but we have to keep in mind that the US accounts for the largest part of the world index (correlation is 0.861). Finland seems to have been a good investment for the US investors as the annualized mean return has been clearly higher, 14.755 percent. The change in the value of Finnish currency in USD terms is close to zero on average (-0.123 percent). Risk-free rate is surprisingly high 7.449 per cent on average during the sample period.

The world portfolio has the lowest standard deviation as suggested by its low return. On the other hand, Finland has by far the highest standard deviation. All return series show evidence of non-normality since we can clearly reject the normal distribution hypothesis for return distribution using the Bera-Jarque test statistic.

Finland is the only equity market showing evidence of first-order autocorrelation (the coefficient is 0.180). The autocorrelation also shows surprisingly high persistence (or predictability) of the returns on the basis of past market returns as shown by the

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[14] There exists also an MSCI index for Finland, however not for the whole period. Therefore we chose to use the domestic indices instead. They are frequently used in earlier studies.

[15] For more details on the WI-index see Berglund, Wahlroos and Grandell (1983).

significant $Q(12)$ test statistic. This could be driven by infrequent trading or inefficiciency in the market. Finding high autocorrelation is not caused by the early part of the sample, as Nummelin and Vaihekoski (2002) also find similar results over the period from 1987-1998.

3.2.2 Information variables

We use global and local predetermined forecasting variables to track predictable time-variation in asset returns, risk exposures, and the common rewards to risks. The instrument set is chosen to match that of De Santis and Gérard (1998). Originally, the instruments are chosen on the basis of parsimony, previous empirical studies (e.g., Ferson and Harvey, 1993), and theoretical content (e.g., Adler and Dumas, 1983). De Santis and Gérard (1998) made some minor transformations to the variables to reduce the multicollinearity and to guarantee stationarity.

The global information set contains: (1) a constant, (2) world index dividend yield in excess of one-month Eurodollar rate (XDYD), (3) the change in the U.S. term premium (ΔUSTP), (4) the change in the one-month Eurodollar rate (ΔEuro$), and (5) the U.S. default premium (USDP). XDYD is calculated using the MSCI world total return and price indices. One-month Eurodollar rate is the same as for the risk-free asset. USTP is the yield difference of the 10 year constant maturity bond and 3 month Treasury bill expressed in annual percentage terms. ΔUSTP is simply the first difference of the series. Both series are taken from Federal Research Economic database. The U.S. default premium is the difference in Moody's Baa minus Aaa bond yields.

When modeling the price of the currency risk, the global instrument set is augmented with two local information variables. The local information set contains the difference in the U.S. and Finnish annual inflation rate (dINF). Inflation rates are taken from the Federal Research Economic database (USA) and ETLA's database (Finland). It is aimed to capture pressure on the value of the Finnish currency, i.e., indicating potential devaluations and/or depreciation/appreciation of the currency (see Figure 1 earlier). We also add a separate indicator variable into the information set. This variable, DEMU, gets a value one after Finland joined the EMU, i.e., from January 1999 onwards. Finally, we use two variables to model the price of local risk. The first one is a liberalization dummy, DLIB, which gets a value of one after 1993 when all restrictions on foreign ownership in the Finnish stock market were removed. The second is dINF. We measure all instrumental variables by inserting a one-period lag in the investors' information set (inflation with two lags in order to allow for the publication lag).

Table 3 shows descriptive statistics of the information variables. The forecasting variables are not mutually correlated. The highest pair-wise correlation is between XDYD and ΔUSTP (0.601), but most of the correlations are below 0.3. This suggests that none of the variables is likely to be redundant. Again, most of the forecasting variables do not appear to be normally distributed and there is evidence of serial correlation. However, Dickey-Fuller tests (not reported) reject non-stationarity, which suggest that the instruments are feasible.

4 EMPIRICAL RESULTS

4.1 Unconditional World CAPM

We begin by testing the World CAPM and the partially segmented APM with the simplest specification, i.e., unconditional means and conditional variance process. This corresponds to equation (2) for the fully integrated CAPM, and equation (4) for the partially segmented specification. Panel A of Table 4 shows the parameter estimates.

For full integration, we find the global price of risk to be positive as suggested by the theory (0.017 with a *p*-value of 0.146). This result corresponds to De Santis and Gérard (1998) who found the unconditional market price of risk to be 0.0278. Similar to their results, the price of world risk parameter is not found significant. We also re-estimate the same model with asset specific intercepts. These intercepts are aimed at capturing the average mispricing. None of them is found significantly different from zero, indicated by the.insignificant robust Wald $\chi^2(3)$ statistic (2.14 with *p*-value 0.544).

In the partial segmentation specification (equation 4) the price of world risk parameter is still estimated as 0.017 (*p*-value 0.167). The market specific risk coefficient is 0.003 (*p*-value 0.517) for the USA, and 0.008 (*p*-value 0.140) for Finland. Thus, market specific risk does not seem to be priced on either one of the markets using unconditional approach. Similarly, the Wald joint $\chi^2(2)$ test statistic for the local prices of risk (2.79 not reported) is not significant at the five per cent level (*p*-value 0.248). Again, we re-run the test with asset specific alphas, but they are found jointly insignificantly different from zero (Wald statistic 0.43, *p*-value 0.935).

Panel B of Table 4 shows some diagnostic test statistics for the standardized residuals, defined as $z_t = \varepsilon_t/\sigma_t$. Theoretically they should be mean zero with unit variance. There seems to be some evidence of misspecification for the Finnish equation in the full integration case (standardized residual 0.062). Interestingly, this problem disappears in the partial segmentation model. This is another indication that the model is better specified if market specific risk is included. The rest of the diagnostics are similar for both specifications. The coefficients of skewness and excess kurtosis are significant for the US, and the world equation. The Bera-Jarque statistic rejects the normality of the residuals for all markets. However, it is least significant for Finland. The use of the quasi-maximum likelihood technique is therefore justified. The Ljung–Box (1974) $Q(12)$ statistic, testing for autocorrelation up to order 12, is significant only for Finland. Since the Q statistics are lower for squared residuals, the variance specification is better fitted to the data than the mean specification. Given the results in Table 4, it seems evident that a partially segmented asset pricing specification is better suited at least for Finland.

4.2 Conditional World CAPM

Next, we allow the price of world risk to be time-varying. All information variables are demeaned in the estimation. The results are reported in Table 5. The parameter estimates are very similar between the full integration and the partial segmentation specifications. Asset specific intercepts – if included (not reported) – are jointly insignificantly different from zero (Wald statistic 1.78, *p*-value 0.620). The constant parameter for the world price of risk is equal to 0.008, but it is still insignificant (*p*-value 0.541). Since the information variables have been demeaned, the constant can be interpreted as the average unconditional value for the price of world covariance risk.

Two of the information variables are found significant predictors for the price of world risk, namely the excess dividend yield and the default premium. The Wald $\chi^2(4)$ clearly rejects the null of joint insignificance. Thus, the evidence suggests – similar to De Santis and Gérard (1998) – that the price of world covariance risk is time-varying.

The coefficient for market specific risk is for USA 0.002 (p-value 0.594) and for Finland 0.009 (p-value 0.107). Again, there is no significant evidence that the local risk is priced. The joint Wald $\chi^2(2)$ for the zero local market price of risk is 3.03 with p-value of 0.220. Thus we cannot find clear evidence in favor of the hypothesis that the local risks are needed to price returns in the US and Finnish markets. The variance parameters are of the same magnitude as those in Table 4, and usually highly significant.

The misspecification statistics in Panel B of Table 5 are very much in line with the corresponding statistics reported Table 4. Especially it should be noted that the standardized residual for Finland indicates much less specification errors if market specific is explicitly modeled.

4.3 Time-varying Price of Market and Currency Risk

As stated before, the currency movements have played an important role in the Finnish economy, and for the companies as well as for the investors. This suggests *a priori* that the foreign exchange risk may be priced in the Finnish stock market. Indeed, Roll (1992) found time-series support for the unconditional bilateral USD/FIM currency risk in the Finnish stock market.

Therefore, we also include the currency component to the specification. The price of world risk is time-varying as in the previous section. The currency component is also allowed to be time-varying following De Santis and Gérard (1998). The information set includes the same global variables as for the price of world risk, augmented with two additional local variables for the currency risk.

Table 6 shows the results, again for the fully integrated and partially segmented models. Similar to Tables 4 and 5, the results show that the constants for the price of world risk (0.020 and 0.019 for the integrated and segmented cases) are not significant. However, the excess dividend yield and the change in the US default premium are still significant information variables for the price of world risk. Again the null of constant price of world risk is rejected (see Panel B).

The constant terms for the price of currency risk (-0.090 and -0.090) are highly significant in both models. Again the constant can be interpreted as the unconditional average due to demeaned instruments. The robust Wald statistic shown in Panel B supports the idea that the currency risk is also time-varying even though the p-values are marginally insignificant (0.051 and 0.071). We also reject the hypothesis of insignificant influence from the local variables. Thus they seem to be needed in modeling the variation of the price of currency risk even though they are individually not found significant. Interestingly, it has a positive sign indicating that the price of currency risk has become smaller (closer to zero) after the EMU.

The local market price of risk for Finland is found out to be 0.012 using the APM for the partially segmented market. Contrary to earlier models, the local risk is now found highly significant source of risk for Finland. Interestingly, the same parameter for the USA is only -0.004 and insignificant indicating that the local risk is not needed to price the US stocks. The magnitude and significance of the variance parameters (a_i, b_i, not reported) are very much in line with the values in tables 4 and 5. Also the misspecification diagnostics in Panel B are in line with the corresponding diagnostics in tables 4 and 5.

4.4 Time-varying Prices of Risk in Three-Factor Model

Our final model is a full-blown model with time-varying prices of global, local, and currency risks. The information set is similar to earlier specifications but the price of local variance risk is modeled linear on DLIB (i.e., dummy for post-1993) and dINF. Table 7 shows the results for the partially segmented model. The results show that the constant for the price of world risk (0.017) is still not significant, but we cannot reject the hypothesis that is significantly different from zero (see Panel B) or that the world risk is time-varying (see Panel B).

The constant term for the price of currency risk (-0.090) is highly significant. Again the constant can be interpreted as the unconditional average due to demeaned instruments. Surprisingly, almost none of the instrument variables are significant. Also the null that the currency risk is also time-varying is rejected using the robust Wald statistic shown in Panel B – albeit marginally (*p*-value is 0.060). This is in sharp contrast with the result of De Santis and Gérard (1998).

The unconditional mean for the local market price of risk for Finland is found out to be 0.025 and statistically highly significant. We also find the local price to be time-varying (see Panel B). The inflation difference is found to be a significant predictor for the local price of risk. On the other hand, the indicator variable for the abolishment of the foreign ownership restrictions is insignificant, yet not far from being significant (*p*-value 0.084). Its value suggests that the price of local variance risk has lowered and became almost zero after 1993. The reason for not finding this variable significant could be due its either-or nature. A foreign ownership variable used, e.g., in Nummelin and Vaihekoski (2002) could be more appropriate variable to describe the integration process.

The magnitude and significance of the variance parameters (a_i, b_i, not reported) are very much in line with the values in Table 6. The misspecification diagnostics in Panel B are in line with the corresponding diagnostics in previous tables.

4.5 Prices of Risk and Risk Decomposition

The prices of world, local, and currency risk were found time-varying. Using the parameter results in Table 7 and the instrument variables, we can calculate the time series for the prices of risk and for the decomposed risk premia. Table 8 shows descriptive statistics for the three time-varying prices of risk as defined in equations (15), (17) and (18). The average price of world risk is 0.017, and in line with the estimates in previous tables. The price of local risk for Finland averages to 0.016, while the currency risk parameter is negative, -0.085. The standard deviation is highest for the currency parameter, and lowest for the price of local risk. This can be seen also in Figure 2, showing the development of the conditional price of risk parameter series. It can clearly be seen that the risks are time-varying.[16] Note also, how the local price of risk changes

[16] Note, however, that these series have been created with all information variables, not just those that were found significant. Thus, part of the variation can be said to be pure noise.

after year 1993 when foreigners were allowed to freely invest in Finnish securities. Since there are no parameter restrictions, the world risk is occasionally also negative. All series are negatively correlated with each other.

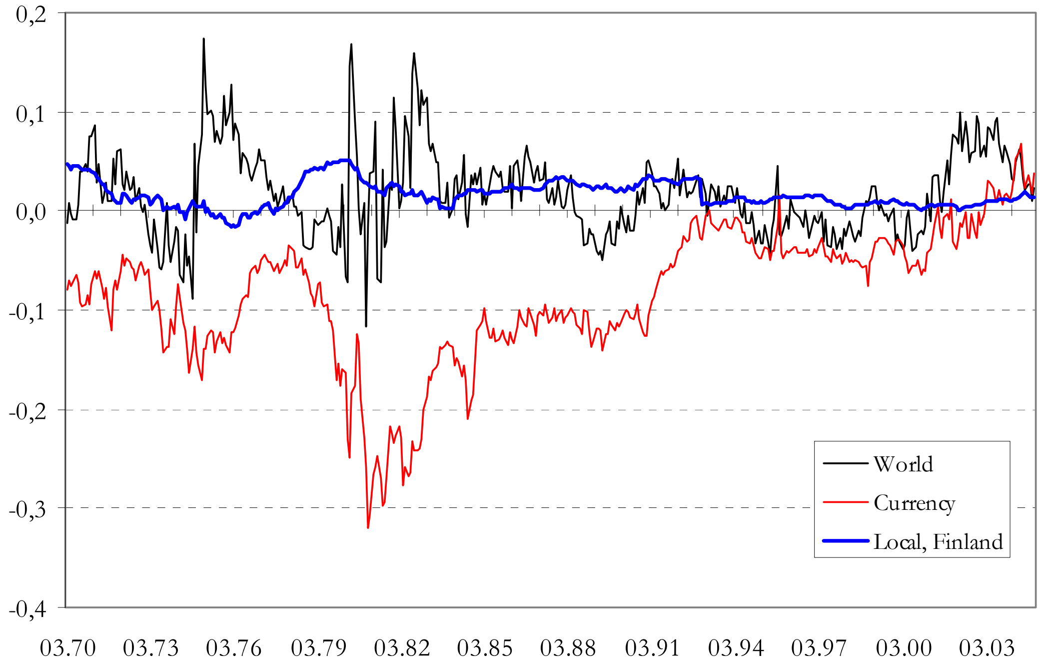

Figure 2. Time-varying prices of world and local equity market risk and currency risk.

We also decompose the total risk premium implied by the asset pricing model. Using the parameter estimates from Table 7, we can calculate the expected risk premium for all assets. This risk premium can then be further decomposed into three parts, namely the world risk, currency risk, and market specific risk. Descriptive statistics for the USA and Finland are shown in Table 8.

The average monthly US total risk premium is 0.305 per cent per month (annualized 3.7 per cent). While the annualized standard deviation for the US original data was 15.5, it is much lower for the estimated series, 2.7 per cent (0.789 per cent per month). The average Finnish risk premium is 0.429 per cent per month (annualized 5.1 per cent) with a standard deviation of 1.105 per cent (annualized 3.8 per cent).

Finally, Figures 3 and 4 show the decomposition for the US and Finnish markets, respectively. It can clearly be seen that the series are time-varying. The Finish risk premium clearly decreased at the liberalization in 1993. Surprisingly, it has increased again in the end of the period.

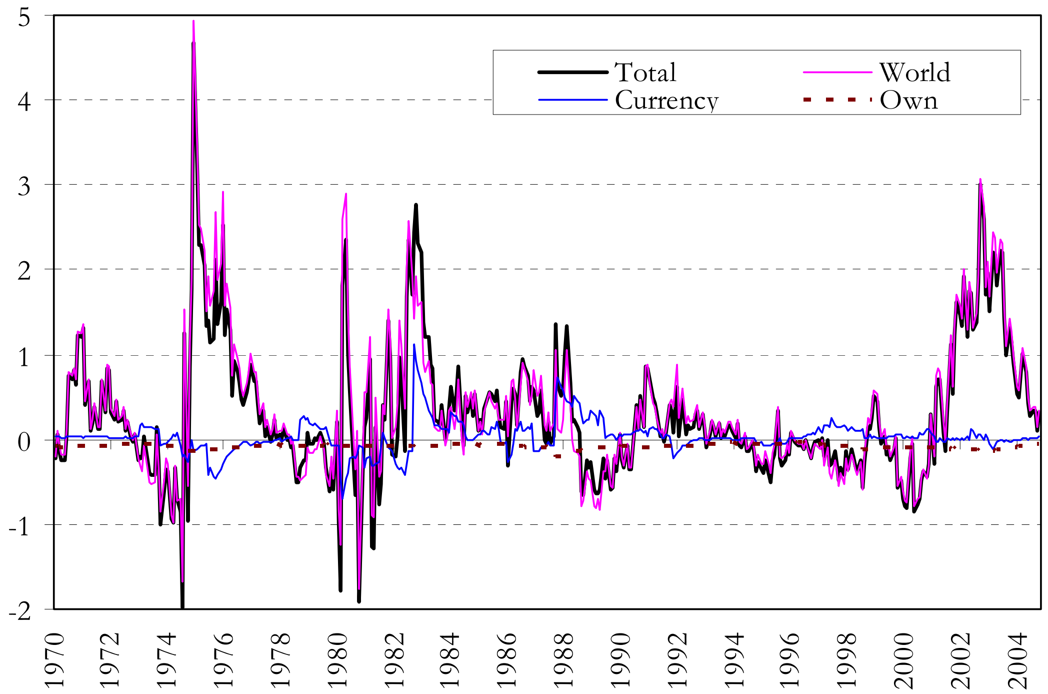

Figure 3. Risk premia decomposition for the US stock market (based on Table 7).

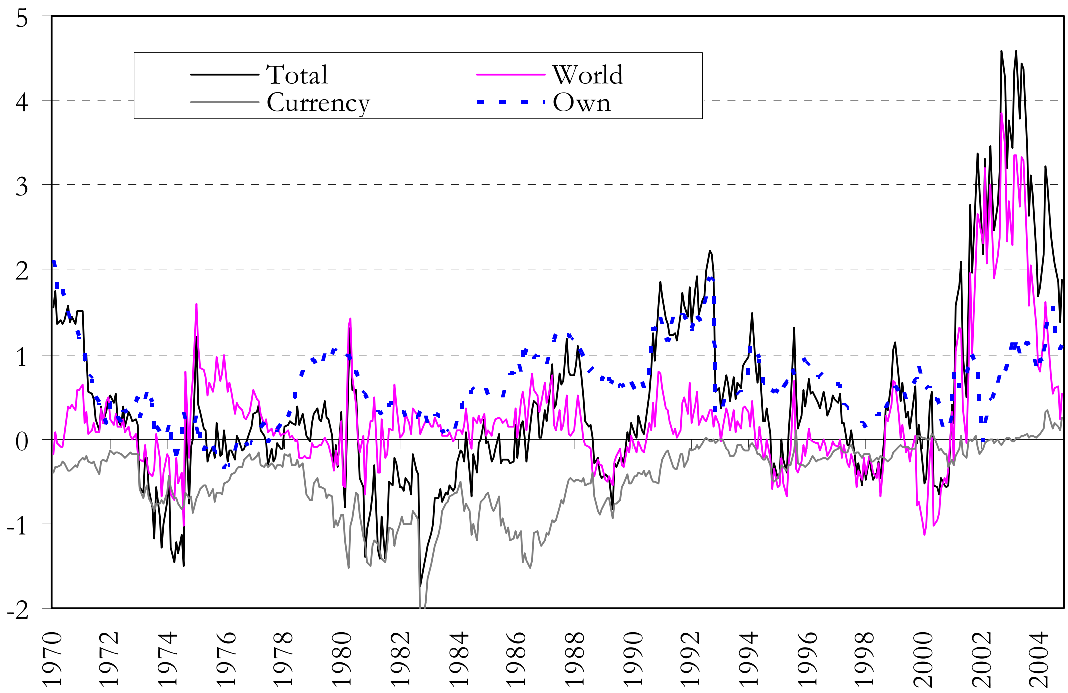

Figure 4. Risk premia decomposition for the Finnish stock market (based on Table 7).

5 SUMMARY AND CONCLUSIONS

In this paper we study the world asset pricing model and currency risk on Finnish stock market using monthly data from 1970 to 2004. We take the stance of a US investor investing both domestically and internationally. All returns are expressed in US Dollars We take Finland as our test country. Finnish stock market offers an interesting test laboratory for many aspects of the international asset pricing models. The long sample period includes, for example, a gradual liberalization of the Finnish financial markets (completed in the end of 1992) and several currency regimes starting from gold standard to fixed and floating currency regimes ending with the EMU membership 1999. Many East-European new EU members and e.g. China are currently experiencing similar development.

In our empirical specification, we utilize De Santis and Gerard (1998) multivariate GARCH-M framework, allowing a time-varying variance-covariance process. First, we estimate the unconditional world CAPM. Second, we allow the price of world risk to be time-varying with respect to four international information variables. Third, we also include a time-varying factor for the exchange rate risk of the Finnish currency. In our final model we also let the local price of risk to be time-varying. All models are estimated both including and excluding an asset specific risk component.

The results show that the unconditional price of world risk is positive but insignificant, which is in line with De Santis and Gérard (1998). Using a time-varying specification for the price of world and currency risk, we find the currency risk significantly different from zero. Both of them are found to be time-varying and they are also found out to be influenced by the local information.

The local price of risk is found significant for the Finnish stock market, but insignificant for the US equity market. If the time-varying local risk is added into the model, the currency risk is no longer found time-varying which may indicate that the currency risk is partly reflected in the local risk. The local price of risk is found to be affected by the inflation difference between the US and Finland. Furthermore, the price seems to have become lower after the liberalization of Finnish equity market in 1993. However, the indicator variable (DLIB) is marginally insignificant.

The results differ partly from those of De Santis and Gérard (1998) for the four large stock markets. Finding the price of local market risk for Finland to be significant indicates that financial returns in smaller countries at least partially follow a segmented asset pricing model. The results give some evidence that a model with time-varying segmentation could be more appropriate in modeling the stock returns in Finland. This is left for future study.

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Table 2. Descriptive statistics for the monthly asset returns.

Descriptive statistics are calculated for the monthly asset continuously compounded returns. The global market portfolio is proxied by the Morgan Stanley Capital International world index. The US market return is proxied by the Morgan Stanley Capital International US index in USD. The Finnish market return is proxied by the WI-index (1970-1989) and HEX/OMXH index (1990-2004). FIMUSD is the logarithmic difference in the Markka value of one USD. Risk-free rate is proxied with one month Eurodollar rate. All returns are measured in USD. The mean and standard returns are annualized (multiplied with 12 and the square root of 12, respectively). The sample size is 418 monthly observations from March 1970 to December 2004. The *p*-value for the Bera-Jarque test statistic of the null hypothesis of normal distribution is provided in the table.

Asset return series	**Mean** (%)	**Std. dev.** (%)	**Skewness**	**Excess Kurtosis**	**Normality** (p-value)	**Autocorrelation**[a] ρ_1	ρ_2	ρ_3	ρ_{12}	**Q(12)**[b]
World market portfolio	10.164	14.545	-0.617	1.696	<0.001	0.080	-0.044	0.036	0.070	0.336
U.S.	10.417	15.502	-0.572	2.487	<0.001	0.024	-0.025	0.022	0.058	0.647
Finland	14.755	23.531	-0.133	2.630	<0.001	0.180*	-0.016	0.080	0.086	<0.001
FIMUSD	-0.123	10.084	-0.519	2.412	<0.001	0.076	0.043	0.016	0.008	0.051
Risk-free rate (Eurodollar)	7.449	1.061	0.954	1.506	<0.001	0.948*	0.920*	0.902*	0.729	<0.001

a) Autocorrelation coefficients significantly (5%) different from zero are marked with an asterisk (*).

b) The *p*-value for the Ljung and Box (1978) test statistic for the null that autocorrelation coefficients up to 12 lags are zero.

Table 3. Descriptive statistics of the monthly information variables data.

The global information set contains: world index dividend yield in excess of one-month Eurodollar rate (XDYD), the change in the U.S. term premium (ΔUSTP), the change in the one-month Eurodollar rate (ΔEuro$), and the U.S. default premium (USDP). The local information set contains the difference in the U.S. and Finnish annual inflation rate (dINF). All variables are lagged by one month except dINF is lagged by two months to allow for publication delay. The sample size is 418 monthly observations from February 1970 to November 2004.

Information variables	**Mean**	**Standard Deviation**	**Skewness**	**Excess Kurtosis**	**Normality** (p-value)	**Autocorrelation**[a] ρ_1	ρ_2	ρ_3	ρ_{12}	**Q(12)**[b]
Panel A: Summary statistics										
XDYD	-0.342	0.254	-0.848	1.804	<0.001	0.914*	0.870*	0.843*	0.610*	<0.001
ΔUSTP	1.696	1.283	-0.492	-0.343	<0.001	0.935*	0.868*	0.807*	0.386*	<0.001
ΔEuro$	-0.001	0.099	-0.013	6.691	<0.001	-0.237*	0.096	0.219*	0.135	<0.001
USDP	1.089	0.429	1.227	1.305	<0.001	0.961*	0.909*	0.874*	0.596*	<0.001
dINF	-0.012	0.033	-6.683	0.105	<0.001	0.959*	0.936*	0.893*	0.671*	<0.001
Panel B: Pairwise correlations	XDYD	ΔUSTP	ΔEuro$	USDP	dINF					
XDYD	1	0.601	-0.218	-0.335	0.012					
ΔUSTP		1	-0.099	0.150	-0.116					
ΔEuro$			1	-0.118	-0.003					
USDP				1	-0.293					
dINF					1					

a) Autocorrelation coefficients significantly (5%) different from zero are marked with an asterisk (*).

b) The *p*-value for the Ljung and Box (1978) test statistic for the null that autocorrelation coefficients up to 12 lags are zero.

Table 4. Conditional fully integrated world CAPM and partially segmented APM models with constant prices of risk

Quasi-maximum likelihood estimates of the conditional international CAPM with constant price of risk where the U.S. and Finland are assumed to be either fully integrated to the world market or partially segmented which leads to two factor model. QML standard errors are in parentheses. The sample size is 418 monthly observations from March 1970 to December 2004. Coefficients significantly (5% or 1%) different from zero are marked with one or two asterisks, respectively.

	Full Integration			Partial Segmentation		
	U.S.	Finland	World	U.S.	Finland	World
Panel A: Parameter estimates						
World market price of risk, λ_w			0.017			0.017
			(0.011)			(0.012)
Local market price of risk, λ_l				0.003	0.008	
				(0.004)	(0.005)	
a_i	0.266**	0.232	0.232**	0.268**	0.233**	0.236**
	(0.029)	(0.042)	(0.033)	(0.029)	(0.041)	(0.034)
b_i	0.951**	0.965**	0.960**	0.950**	0.964**	0.958**
	(0.012)	(0.015)	(0.014)	(0.012)	(0.014)	(0.014)
Panel B: Diagnostic tests						
Average standardized residual	-0.006	0.062	-0.014	-0.016	0.013	-0.011
Standard deviation of z	1.02	0.99	1.02	1.02	0.99	1.02
Skewness of z	-0.71**	-0.03	-0.81**	-0.72**	-0.02	-0.81**
Kurtosis of z	2.39**	1.12**	2.22**	2.41**	1.14**	2.22**
Bera-Jarque test for normality	131.36**	21.02**	128.18**	133.45**	21.66**	128.04**
Q(12)	11.42	56.12**	16.58	11.45	56.73**	16.53
$Q^2(12)$	6.94	8.95	6.10	6.90	8.48	6.08
Absolute mean pricing error	3.41	5.02	3.18	3.40	5.02	3.18
Likelihood function		-8.120			-8.116	

Table 5. Conditional fully integrated world CAPM and partially segmented APM models with time-varying price of global risk

Quasi-maximum likelihood estimates of the conditional international APM with time-varying price of global market risk and constant price of local market risk. QML standard errors are in parentheses, *p*-values in brackets. The sample size is 418 monthly observations from March 1970 to December 2004. Coefficients significantly (5% or 1%) different from zero are marked with one or two asterisks, respectively.

	Full Integration			Partial Segmentation		
	U.S.	Finland	World	U.S.	Finland	World
Panel A: Parameter estimates						
World market price of risk, λ_w						
Constant, κ_0			0.008			0.007
			(0.013)			(0.014)
Excess dividend yield, κ_{XDYD}			0.151**			0.153**
			(0.050)			(0.051)
Default premium, κ_{USDP}			0.061*			0.061*
			(0.030)			(0.030)
ΔOne-month rate, κ_{D1m}			0.002			0.005
			(0.085)			(0.093)
ΔLong term premium, κ_{DLTP}			0.029			0.029
			(0.024)			(0.024)
Local market price of risk, λ_l				0.002	0.009	
				(0.005)	(0.005)	
a_i	0.260**	0.232	0.231**	0.262**	0.235**	0.235**
	(0.029)	(0.039)	(0.032)	(0.029)	(0.039)	(0.032)
b_i	0.952**	0.964**	0.959**	0.951**	0.963**	0.957**
	(0.012)	(0.014)	(0.013)	(0.012)	(0.014)	(0.014)
Panel B: Diagnostic tests						
Average standardized residual	0.017	0.074	0.017	0.011	0.022	0.022
Standard deviation of z	1.02	0.99	1.02	1.02	0.99	1.02
Skewness	-0.62**	-0.03	-0.69**	-0.62**	-0.02	-0.69**
Kurtosis	2.23**	1.13**	2.02**	2.24**	1.15**	2.01**
Bera-Jarque test for normality	109.90**	21.16**	101.58**	110.96**	22.09**	101.02**
Q(12)	15.44	62.21**	18.40	15.46	63.96**	18.29
$Q^2(12)$	7.84	7.78	5.85	7.77	7.14	5.86
Absolute mean pricing error	3.36	5.04	3.13	3.36	5.04	3.13
Likelihood function		-8.103			-8.100	

Panel C: Robust Wald tests for joint significance

	Integrated model		Part .segm.	
Info variables for world risk, $\chi^2(4)$	14.80**	[0.005]	14.60**	[0.006]
Asset specific risk, $\chi^2(2)$	12.55	[0.051]	3.03	[0.220]

Table 6. Conditional fully integrated world CAPM and partially segmented APM models with time-varying prices of global risk and currency risk

Quasi-maximum likelihood estimates of the conditional international CAPM with constant price of risk where the U.S. and Finland are assumed to be either fully integrated to the world market or partially segmented which leads to two factor model. QML standard errors are in parentheses, *p*-values in brackets. The sample size is 418 monthly observations from March 1970 to December 2004. Coefficients significantly (5% or 1%) different from zero are marked with two an asterisk (*) or asterisks (**).

Panel A. Parameter estimates for the prices of risk

	Z_{t-1}						
	Constant	XDYD	USDP	ΔEuro$	ΔUSTP	DEMU	DINFL
Integrated APM							
Price of world risk, λ_w	0.020	0.108*	0.081*	-0.024	0.035		
	(0.014)	(0.053)	(0.034)	(0.142)	(0.027)		
Price of currency risk, λ_c	-0.090**	0.160*	-0.074	0.109	0.007	0.034	0.214
	(0.020)	(0.080)	(0.061)	(0.141)	(0.031)	(0.048)	(0.414)
Partially segmented APM							
Price of world risk, λ_w	0.019	0.109*	0.080*	-0.021	0.034		
	(0.015)	(0.052)	(0.034)	(0.163)	(0.029)		
Price of currency risk, λ_c	-0.090**	0.165*	-0.075	0.109	0.008	0.025	0.247
	(0.019)	(0.083)	(0.061)	(0.180)	(0.050)	(0.048)	(0.441)
Constant price of local risk, λ_l	USA	Finland					
	-0.004	0.012*					
	(0.004)	(0.005)					

Panel B. Robust Wald tests for joint significance

	Integrated model		Part .segm.	
Info variables for world risk, $\chi^2(4)$	14.20**	[0.007]	14.03**	[0.007]
Info variables for currency risk, $\chi^2(6)$	12.55	[0.051]	11.64	[0.071]
Asset specific local risk, $\chi^2(2)$			6.49*	[0.039]

Table 6. *Continued.*

Panel C: Diagnostic tests

	Integrated APM				Integrated APM			
	USA	Finland	World	Currency	USA	Finland	World	Currency
Average standardized residual	-0.030	0.141	0.022	0.012	-0.007	0.065	0.030	0.018
Standard deviation of *z*	1.02	1.00	1.02	0.99	1.02	1.01	1.02	0.99
Skewness	-0.64**	-0.06	-0.70**	-0.55**	-0.64**	-0.04	-0.70**	-0.55**
Kurtosis	2.29**	1.08**	2.00**	2.40**	2.27**	1.11**	2.00**	2.42**
Bera-Jarque test for normality	116.85**	19.64**	100.30**	117.31**	114.11**	20.60**	100.49**	119.33**
Q(12)	16.45	71.75**	20.00*	117.31**	16.07	76.63**	19.70	15.96
$Q^2(12)$	7.33	8.90	6.03	8.46	7.53	8.11	6.06	8.30
Absolute mean pricing error	3.35	5.12	3.14	2.12	3.35	5.10	3.14	2.12
Likelihood function		-10.431				-10.425		

Table 7. Conditional partially segmented APM model with time-varying prices of global, currency, and local risk

Quasi-maximum likelihood estimates of the conditional international CAPM with time-varying prices of global, local, and currency risk where the U.S. and Finland are assumed to be partially segmented which leads to three factor model. The price of local market risk is assumed to be constant for the U.S.A. and time-varying for Finland. QML standard errors are in parentheses, *p*-values in brackets. The sample size is 418 monthly observations from March 1970 to December 2004. Coefficients significantly (5% or 1%) different from zero are marked with two an asterisk (*) or asterisks (**).

Panel A. Parameter estimates for the prices of risk

	Z_{t-1}							
	Constant	XDYD	USDP	ΔEuro$	ΔUSTP	DEMU	DINFL	D93
Partially segmented APM								
Price of world risk, λ_w	0.017	0.116*	0.081*	-0.020	0.034			
	(0.015)	(0.055)	(0.034)	(0.110)	(0.028)			
Price of currency risk, λ_c	-0.090**	0.167*	-0.076	0.110	0.008	0.026	0.238	
	(0.019)	(0.082)	(0.061)	(0.156)	(0.037)	(0.048)	(0.433)	
Constant price of local risk, λ_l	-0.004							
USA	(0.004)							
Time-varying price of local risk, λ_{lt}								
Finland	0.025*						0.425*	-0.026
	(0.010)						(0.212)	(0.015)

Table 7. *Continued.*

Panel B: Robust Wald-tests		
	Partially segmented APM	
Constant price of world risk, $\chi^2(4)$	14.23**	[0.007]
Zero price for world risk, $\chi^2(5)$	28.90**	[<0.001]
Constant price of currency risk, $\chi^2(6)$	12.10	[0.060]
Zero price of currency risk, $\chi^2(7)$	33.43**	[<0.001]
No local influence for currency risk, $\chi^2(2)$	6.88*	[0.032]
Constant price of local risk for Finland, $\chi^2(2)$	4.39	[0.112]

Panel C: Diagnostic tests				
	Partially segmented APM			
	USA	Finland	World	Currency
Average standardized residual	-0.003	0.051	0.035	0.017
Standard deviation of *z*	1.02	1.01	1.02	0.99
Skewness	-0.63**	-0.03	-0.69**	-0.55**
Kurtosis	2.26**	1.09**	1.99**	2.43**
Bera-Jarque test for normality	112.95**	19.64**	99.12**	120.04**
Q(12)	16.16	70.86**	19.85**	15.92**
$Q^2(12)$	7.59	7.59	6.08	8.25
Absolute mean pricing error	3.35	5.06	3.14	2.12
Likelihood function		-10.419		

Table 8. Descriptive statistics for the price of world risk, currency risk and local risk, and risk premium decomposition

The risk premiums are based on the partially segmented model specification with time-varying global, local, and currency risk in Table 7.

	Mean	Std. dev.	Skewness	Excess kurtosis	Minimum	Maximum
Price of world risk, λ_w	0.017	0.043	0.548	0.819	-0.117	0.173
Price of currency risk, λ_{fx}	-0.085	0.068	-0.836	0.901	-0.319	0.068
Price of local risk, $\lambda_{l,FIN}$	0.016	0.013	0.501	-0.010	-0.017	0.052
Risk premium for the USA						
Total risk	0.305	0.789	1.192	3.169	-1.976	4.668
World component	0.351	0.818	1.357	3.262	-1.770	4.941
Currency component	0.031	0.183	1.015	6.591	-0.708	1.114
Local component	-0.077	0.028	-1.463	3.364	-0.210	-0.037
Risk premium for Finland						
Total	0.429	1.105	1.320	2.195	-1.733	4.589
World component	0.259	0.742	2.169	6.093	-1.140	3.851
Currency component	-0.466	0.420	-0.953	0.688	-2.121	0.338
Local component	0.636	0.449	0.407	0.092	-0.356	2.126