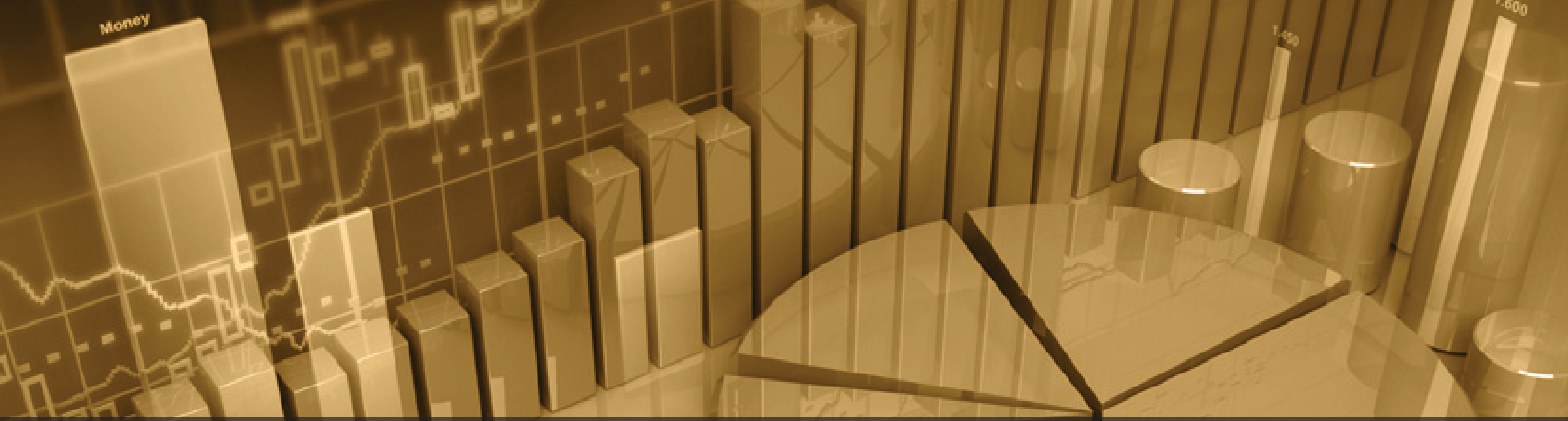

Pricing Currency Risk in Two Interlinked Stock Markets

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We investigate the role of currency risk on stock markets in two interlinked Nordic countries exhibiting a gradual move from fixed to floating exchange rate regime. Tests are conducted for a conditional asset pricing model using the Ding and Engle (2001) specification which allows estimation of multivariate GARCH-in mean models. Using a sample period from 1970 to 2009, we find that the currency risk is priced in both stock markets, and that the price and the risk premium are lower after the flotation of the currencies. We also find some evidence of cross-country exchange rate effects. Our model has many practical applications and can easily be applied to study other countries, different asset classes, or industries that are closely connected.

Keywords: international asset pricing model, currency risk, devaluation, multivariate GARCH-M

1. Introduction

Nowadays it is considered commonplace to invest abroad. The general liberalization of the financial markets as well as lower costs and improved technology have all provided investors access to more investable assets than ever before. As part of this development, many developed countries have abolished foreign-exchange controls and adopted market-determined floating exchange rates. However, there are still many emerging countries with currencies that are still fixed, managed, or tied to certain target zones.

In Antell and Vaihekoski (2012) we study the pricing of stocks in two Nordic countries, Finland and Sweden, from the 1970s to 2009. Here we review the results and implications from a more practical point of view. Both Finland and Sweden are small export oriented countries whose currencies were first pegged against a currency index within a pre-specified band but were both forced to let their currencies float almost at the same time in 1992. They were also known to use competitive devaluations of their currencies to improve their international competitiveness. This gives us a unique opportunity to study cross-country effects in currency risk. In addition, we test for the effect of fixed and floating currency regimes on the pricing of currency risk.

We combine a number of important features in our model. First, our model is based on the mildly segmented asset pricing model which allows for both global and local market risk to affect the pricing of both equity and currency risk. Furthermore, we estimate a conditional version of the pricing model which allows the parameters of the model to be time-varying (in practice market risk premium or beta are unlikely to stay constant over time). In particular, we allow the price of currency risk to differ for the periods before and after the flotation decision. We also utilize a GARCH-M approach to model the time-variation in the conditional (co)variances. In order to estimate the model for six assets jointly, we utilize the multivariate GARCH where the number of parameters is reduced using the Ding and Engle (2001) approach. Finally, we allow for the two countries' expected returns to depend on each other not only through their covariances but also through the prices of risks.

Including two rather similar, yet in many ways different countries allows also for interesting comparison between the countries. Our primary goal is to explore how the currency risk is priced in these stock markets. In particular, we study the role of the exchange rate mechanism. Second, we also study the differences in the pricing of local sources of risk in Finland and Sweden. The results can shed light on the role of currency risk and local risk on the pricing of stocks in countries that are currently emerging from segmentation and also restricting the free valuation of their currencies.

2. Research Methodology

2.1 Theoretical background

If capital markets are economically fully integrated, the expected return is driven by the same pricing model with a common set of risk factors with common risk premium in all countries. Return differences are exclusively explained by differences in the exposure to the risk factors. Suppose the correct model is given by the one-factor market model or the CAPM. Then the expected return is driven by the exposure to the value-weighted global equity benchmark portfolio (often measured using e.g. the MSCI world equity index).

However, if some assets deviate from pricing under full integration, their risk-adjusted return will differ from the world CAPM. Errunza and Losq (1985) suggested including the local market portfolio as an additional source of risk in the pricing equation. This leads to a mildly segmented version of the CAPM where both the global and local market portfolios appear as separate risk factors. Further, keeping in mind that an international investment is a combination of the direct investment into the asset itself and an indirect investment into the foreign currency, the conditional expected return for asset i can be stated under the assumption of non-stochastic inflation as

$$\mathrm{E}_t\left[r_{i,t+1}\right] = \lambda^w_{m,t+1}\mathrm{Cov}_t(r_{i,t+1}, r^w_{m,t+1}) + \sum_{c=1}^{C}\lambda_{c,t+1}\mathrm{Cov}_t(r_{i,t+1}, f_{c,t+1}) + \lambda^l_{m,t+1}\mathrm{Cov}_t(r_{i,t+1}, r^l_{m,t+1})$$

where $\lambda^w_{m,t+1}$, $\lambda^l_{m,t+1}$, $\lambda_{c,t+1}$ and are the conditional prices of global and local market risk, and exchange rate risk for currency c. However, including a larger set of currencies in the model might become infeasible. In this case one can focus on a subset of currencies, as we have done here, or one could use an aggregate currency risk factor (e.g., trade-weighted currency index), in which case the model would boil down to a three-factor model.

Note that the price of risk in this model may look different from the standard beta-models. It is still the same model; we have only first broken down the definition of beta to separate the numerator term (covariance). Then we have divided the equity premium with the denominator of the beta. This ratio, $E[r_{m,t+1}]Var(r_{m,t+1})^{-1}$, is defined to be the conditional price of global market risk $\lambda_{m,t+1}$. The same is done for all risk factors.

2.2 Empirical formulation

Even though the theoretical background of asset pricing models is quite old, the estimation of conditional asset pricing models in practice has been a rather recent development as there are a number of issues that have required further theoretical development as well as computational power. The first hurdle has been the formulation of the conditional expectations. Typical alternatives have been either using conditioning variables or GARCH-type of models. Here, we combine both approaches.

For the coefficients of price of risk we use the conditioning variables approach, i.e., each parameter is a (linear) function of selected variables. Different prices of risk can have their own set of variables. For example, to study the effect of the floating decision in 1992 on the price of currency risk, we use an indicator variable for the post-floating period when modeling the price of currency risk. In theory, we should pick variables that reflect the changes in the market prices of risk. However, from the analysts' point of view, one cannot obviously observe all variables, and empirically one has to settle for a fairly limited number of variables which one considers relevant for future forecasting. In practice, one has more freedom setting up the model, as the model can be estimated in a rolling fashion, which allows one to change the variables from time to time as their importance in the market might change.

For the conditional (co)variances, we employ a multivariate GARCH-in-mean specification similar to De Santis and Gérard (1998). GARCH models have been commonly used in practice since the 1980s, but when one estimates multivariate models with more than two or three assets, one runs into problems, e.g. with the convergence, despite having an abundance of time series observations as the number of parameters to be estimated grows exponentially. In our case, we estimate the model using six assets: world, USA, Finland, Sweden, and two currencies. There are a number of alternative ways to limit the number of parameters. We use the covariance stationary specification of Ding and Engle (2001) which is convenient and reduces the number of GARCH parameters considerably.

3. Results

3.1 Case: Sweden and Finland

Historically, both Finland and Sweden have deployed a fixed exchange rate policy until the 1990s, tying their currencies to gold, the USD, or some exchange rate index. From 1970 to 1990 both currencies experienced several devaluations and a few occasional revaluations. In many cases, a devaluation decision in one country sparked a similar devaluation in the other. In fact, Sweden and Finland at times accused each other for using devaluations as tools to improve their export industries' (especially metal and forestry) competitive position.

From the beginning of 1991, both FIM and SEK were linked to the European Currency Unit (ECU) with fixed rate. However, after several speculative attacks in September 1992, Finland was forced to let its currency float. Sweden had to follow two months later in November 1992. Soon afterwards, both started to strengthen against the USD. In October 1996 FIM became part of the European Exchange Rate Mechanism (ERM). Finally, as a result of the economic and political integration within the EU, Finland joined the Economic and Monetary Union (EMU) in 1999 and Euro replaced the FIM. Sweden, on the other hand, opted out from the EMU, keeping Swedish Krona floating against the Euro.

In addition, both countries are interesting for their economic structures that have changed markedly over the sample period. Originally, both countries had relatively closed financial markets which started to open up to foreign investors in the 1980s. Historically, Sweden was economically more developed and had closer ties to the global financial markets. These developments began earlier than in Finland. In Sweden, the regulation took mostly place in the 1980s. Final steps were taken in the beginning of 1990, when restrictions on foreign ownership were abolished. In Finland, the regulation started in the 1980s and ended in the beginning of the 1990s. At the beginning of 1993, all restrictions on foreign ownership were abolished.

3.2 Data

It is typical for GARCH studies that a lot of data are needed, typically hundreds of time series observations. In our paper, the estimation is conducted using 474 months of data from March 1970 to August 2009. We take the view of a US investor. Thus, all returns are measured in US dollars in excess of U.S. investors' risk-free return. We use continuously compounded returns.

Global market portfolio returns are proxied by returns on the MSCI global equity market index with reinvested gross dividends. Local market portfolios' returns are calculated from local market indices (USA using the MSCI US index). As a proxy for the exchange rate risk, we use local bilateral currency exchange rates against the dollar, i.e., USD/FIM or USD/SEK exchange rates for Finnish and Swedish stocks, respectively.

Table 1 shows basic descriptive statistics for the assets. The annualized mean returns for the world equity market and the US market are 9.1% and 9.0%, respectively. Similarly, the corresponding returns for Finland and Sweden are 13.6% and 12.9% per annum. Hence, Finland has offered the highest returns for US investors during the sample period, but in general both Sweden and Finland have offered more than two-times the excess return of the US market. On the other hand, the world and the US market portfolios show clearly lower volatility.

Table 1. Mean asset return and volatility per annum.

	Mean (%)	Std. dev. (%)
World market portfolio	9.081	15.081
Risk-free rate	4.433	0.563
U.S.	9.024	15.675
Finland	13.614	24.067
Sweden	12.911	22.657
USDFIM	0.031	10.192
USDSEK	-0.805	10.664

To track predictable time-variation in asset returns, risk exposures, and the required rewards to risks, we use global and local predetermined forecasting variables. When modeling the price of currency risk, we select two currency specific information variables for both currencies on top of the floating indicator variable. The first variable is the difference between the Finnish (Swedish) and the US one month interest rates. It is aimed at detecting devaluation risk in the short run as central banks typically increase the local interest rates to fight against the pressure of devaluation.

Further, it is expected to capture longer-term pressure on the value of the Finnish (Swedish) currency. The second variable is the absolute value of lagged cross-currency return, i.e., the lagged Swedish absolute currency return for Finnish currency risk, and vice versa. It is expected to capture devaluation risk and currency shocks in the short run and potential uncertainty in the long run in the other currency.

Finally, we use two variables to model changes in the price of local risk in the case of Sweden and Finland. The first is the same variables as before. The second is a liberalization indicator that gets a value of one beginning in 1990 for Sweden and 1993 for Finland when all restrictions on foreign ownership in the Swedish (Finnish) stock market were removed.

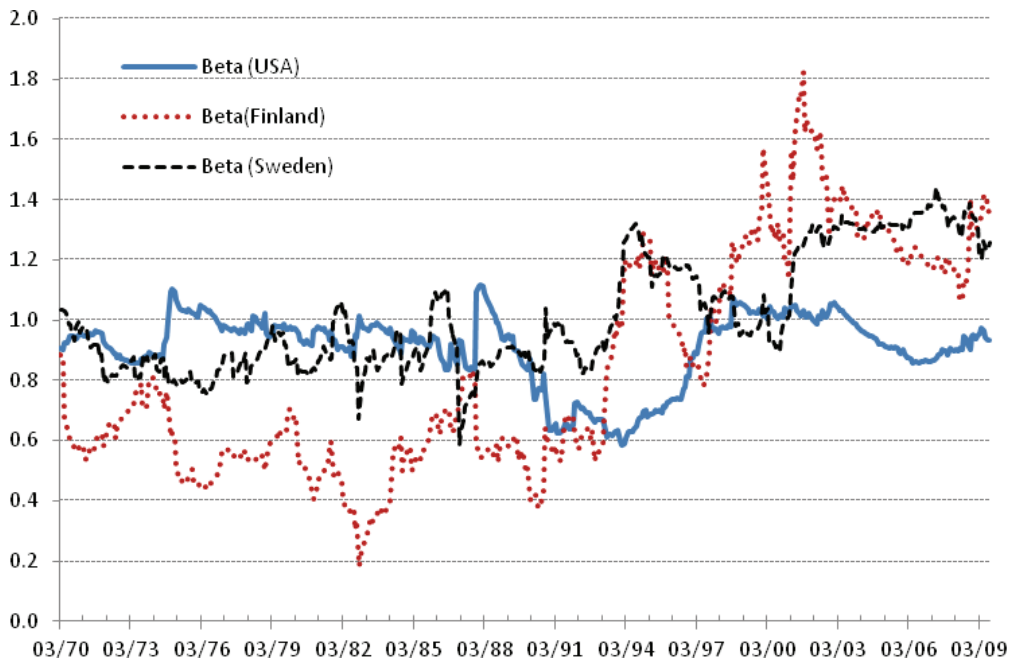
3.3 Empirical Results

Our initial empirical tests concentrate on constant price of risk specifications of the asset pricing model with currency risk. The results show that all three risk factors are relevant for the pricing of stocks in Finland and Sweden. Next we allow for prices of global, currency, and local risk to be time-varying, with the exception of the price of US local market risk, which is kept constant. Our model also allows the price of currency risk to differ before and after the floating decision in 1992.

The results for the global and local market risk remain basically unchanged. Global and local market risk are priced in both countries. Using the estimated (co) variances, we can also calculate time series values for the beta coefficients. Figure 1 shows the development of the global market betas for all three stock markets. We can see especially in the case of Finland that the sensitivity to global market risk has increased after 1980s.

We find the prices of local risk to be time-varying in Finland but not for Sweden. Somewhat surprisingly, the liberalization indicator is not found to have an impact on the price of the local market risk. This might be related to the fact that the floating decision almost coincides with the liberalization especially for Finland. The currency risk is also clearly priced in both countries, and the price is found to be time-varying. After the floating decision, the price of the currency risk has remained relatively stable (especially for Finland) but notable smaller than before.

Figure 1. Time-varying (conditional) global market beta.



4. Conclusions

The model presented in this paper is suitable for modeling the pricing of currency risk as well as global and local market risk in mildly segmented stock markets. Empirical results from Finland and Sweden support the pricing of the currency risk on their respective stock markets, as well as global and local market risk, and evidence is found on the importance of cross-currency linkages.

Although the model is quite tedious to estimate in practice, it offers wide flexibility in its setup. For example, instead of analyzing currency risk, one can study other sources of risk. The model is especially useful if one is interested to study countries (say, e.g., New Zealand and Australia) or different asset classes or industries that are closely linked. In practice, the benefits of conditional (multifactor) models for the portfolio management industry compared to, e.g., the CAPM, comes from their ability to incorporate the time-varying nature of the parameter values instead of using long-term averages. Furthermore, it allows the breakdown of the market risk into its components. The outputs from the model (expected returns, covariances, and variances) can be in turn used as inputs into the portfolio optimizer. As circumstances change, the practical applicability of the model can be even further improved by using alternative sets of forecasting variables and/or time series models.

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