Financial Integration and Exchange Rate Risk Premium in CEECs: Evidence from the ICAPM

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Abstract: the aim of this paper is to study the dynamics of financial integration of the CEECs towards the euro area, and to address the timing of membership to this area. Our empirical analysis is based, successively, on a MGARCH model with time-varying correlations, a state-space model and a Markov-switching model. Our results show that financial integration is not perfect, but increases between the CEECs and the euro area. However, the growing financial integration at the end of 2008 seems rather to be the result of the propagation of the shock induced by the bankruptcy of Lehman Brothers.

Keywords: financial integration, euro area, Central and Eastern European Countries (*CEECs*), exchange rate risk premium, international capital asset pricing model (*ICAPM*).

JEL Classification: C32, F36, G11.

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1. Introduction

Between 2004 and 2007, 12 CEECs (Poland, Hungary, Czech Republic, Estonia, Cyprus, Lithuania, Latvia, Malta, Slovenia, Slovakia, Bulgaria and Romania) joined the European union. Beyond the efforts they have provided for this purpose and benefits of such membership (structural funds...), those countries have expressed their desire to rapidly integrate the euro area. The literature on this topic (Bénassy-Quéré and Lahrèche-Révil, 1999; Boone and Maurel, 1999; Artus, 2003; Doisy and Hervé, 2003; Babetskii et al., 2004) tends to show that, in general, CEECs are not yet an optimal currency area with the euro area.

Artus (2003) shows that the CEECs aim at integrating more quickly the euro area to avoid currency crises generated by financial imbalances. Indeed, with the current crisis, some countries like Poland, Romania and Hungary, encounter problems with their exchange rate. One proposed solution is then to accelerate the integration process in the euro area to avoid a currency crisis that could turn into a twin crisis, given current account imbalances that those countries face. Moreover, membership would also be a way to protect banks that are experiencing great difficulties (and their partners in the euro area as Austrian or Swedish banks) by allowing them to refinance directly with the European Central Bank. In this context, we must distinguish two types of countries: those with a fixed exchange rate or pegged to the euro and those with a flexible exchange rate. For the first (Latvia, Lithuania), devaluation is impossible and attacks against local currencies are favored with the fundamental imbalances. For the latter (Romania, Poland, Hungary), imbalances cause an increase in the currency volatility and a depreciation which increase the debt, mainly expressed in foreign currency.

However, if some problems could disappear with changing membership, other issues remain unresolved, particularly in terms of monetary policy. Indeed, the CEECs are characterized by an inflation rate above the European average due to the Balassa-Samuelson effect (Doisy and Hervé, 2003; Coudert, 2004). Yet, there is no convergence of monetary shocks (Babetskii et al., 2004) although the CEECs share some common characteristics with the countries of the euro area regarding the transmission mechanism of monetary policy (Hericourt and Matei, 2007). Furthermore, Aglietta et al. (2003) noted that a hasty accession would destroy the delicate balance that the CEECs have been established to join the European Union. Thus, "modulation" of the current criteria of nominal convergence might be a solution. This would delay the accession process, but also allow CEECs to fit a less restrictive in the euro area given their real differences with the euro area members.

Financial integration may then play a role in the choice of the timing for joining the euro area. Indeed, as we have already noted, accession of CEECs to the euro area implies that these countries have a monetary policy consistent with that of the euro area. Giving up monetary policy can have significant costs for these countries, particularly in the absence of capital mobility. According to Mundell trinity, a country that would give up its autonomous monetary policy must choose a fixed exchange rate in case of perfect capital mobility. Furthermore, if the CEECs knew perfect financial integration with the euro area, this would allow the risk sharing of asymmetric shocks (Maurel, 2004). There are different methods to measure financial integration: quantity-based approach of Feldstein and Horioka (1980), price-based approach of Harberger (1980), index based on legal restrictions, volume indicators. However, none of these methods account for the impact of the risk premium rates.

The aim of this paper is to study the dynamics of CEECs’ financial integration taking into account the importance of the currency risk premium. Analysing this dynamics will allow us to study the convergence of CEECs towards the euro area, but also whether the proposed membership of the euro area is still relevant in light of the current economic crisis. To conduct this study, we rely on the theoretical framework of the international capital asset pricing model (ICAPM). To estimate this model, we rely on various processes: (*i*) a multivariate GARCH model to estimate terms of variance-covariance between local market and European market; (*ii*) a state-space model for the evolution of the price of risk (market and currency); (*iii*) a model for regime changes in the dynamics of financial integration.

The rest of the paper organized as follows. Section 2 describes the theoretical framework of ICAPM. Section 3 explains the estimation strategy. Section 4 presents the data, and resultants are provided in Section 5. Section 6 gives some concluding remarks.

2. The model

Our goal is to determine the degree of financial integration of the CEECs vis-à-vis the euro area. Two polar cases of financial integration can be distinguished: perfect integration, in which capital is perfectly mobile, and market segmentation, referring to a complete absence of capital mobility. However, these cases do not reflect the reality of financial markets. Indeed, there are still barriers to free capital movements between financial markets, due to the existence of transaction costs. The reality of financial markets lies between these two extreme cases and financial integration is generally more partial (see Bekaert and Harvey (1995, 1997), Griffin (2001), Karolyi and Stulz (2002), Dumas et al. (2003), Barr and Priestley (2004), Boubakri (2009)).

When investing in an asset, a risk-averse investor requires a risk premium. The later plays a crucial role in purchasing decisions and sales of financial stocks, and therefore in any strategy of portfolio management. When the investment takes place in an international market, a second risk premium appears: the exchange risk premium. The extent of such risk premium requires designing a model of international asset pricing to distinguish the influence of different premiums. To this end, we rely on the international capital asset pricing model (ICAPM) of Adler and Dumas (1983). It is an extension of the original model (CAPM) developed by Sharpe (1964) and Lintner (1965) in which only the risk of the market portfolio is taken into account[1]. The ICAPM combines the influence of international market, in our case the influence of the euro area, exchange rates[2] and local market in asset pricing. The model can be written as follows[3]:

$$E\left(r_{i,t} / \psi_{t-1}\right) - r_{f,t} = \phi_{t-1}^{i}\left[\lambda_{t-1}^{m} Cov\left(r_{i,t}, r_{m,t} / \psi_{t-1}\right) + \sum_{k=1}^{l} \lambda_{t-1}^{k} Cov\left(r_{i,t}, s_{k,t} / \psi_{t-1}\right)\right] \quad (1)$$
$$+ \left(1-\phi_{t-1}^{i}\right)\left[\lambda_{t-1}^{i} Var\left(r_{i,t} / \psi_{t-1}\right)\right]$$

Where $E\left(r_{i,t} / \psi_{t-1}\right)$ is the conditionally expected return on the local stock market index, $r_{f,t}$ is the risk-free rate, $r_{m,t}$ is the excess return on the European stock market index, $s_{k,t}$ is the change of the real exchange rate. λ_{t-1}^{m} is the price of international (here European) market risk, λ_{t-1}^{k} is the price of currency risk and λ_{t-1}^{i} is the price of local risk. *Var* and *Cov* respectively denote the variance and covariance operators. All expectations are conditioned on ψ_{t-1}, the information that investors use to set prices at time $t-1$.

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[1] The classical CAPM of Sharpe (1964) and Lintner (1965) considers that the expected return of a financial asset, the excess return on a risk-free rate is proportional to the systematic risk of assets, measured by its covariance with performance of the market portfolio. For more details see Adler and Dumas (1983), De Santis and Gerard (1997, 1998), Coudert and Gex (2007) among others.

[2] Unlike Barr and Priestley (2004), we do not consider that the purchasing power parity (PPP) holds. Similarly if exchange rates are fixed we believe that currency risk exists.

[3] See, for example, Adler and Dumas (1983), Bekaert and Harvey (1995) and Barr and Priestley (2004) for a more detailed presentation.

The different risk premiums to be estimated are, resptectively, $\lambda_{t-1}^{m}Cov\left(r_{i,t},r_{m,t}\right)$ the international market risk premium; $\lambda_{t-1}^{k}Cov\left(r_{i,t},s_{k,t}\right)$ the currency risk premium; $\lambda_{t-1}^{i}Var\left(r_{i,t}\right)$ the local risk premium.

ϕ_{t-1}^{i} is the conditional financial integration measure and falls in the interval [0, 1]. If $\phi_{t-1}^{i}=1$, it implies that only covariance with the world portfolio is priced. In this case, we can reject the hypothesis of market segmentation. If $\phi_{t-1}^{i}=0$, then only variance is priced. This is consistent with a segmented capital market. Finally, if $\phi_{t-1}^{i}\in\left]0,1\right[$, financial markets are partially integrated.

Equation (1) is a Markow switching model. ϕ_{t-1}^{i} is a conditional measure of the degree of financial integration between local and international markets (Bekaert and Harvey, 1995).

Following Hardouvelis et al. (2006), the degree of financial integration is described by the following equations:

$$r_{m,t}=\lambda_{t-1}^{m}Var\left(r_{m,t}\right)+\sum_{k=1}^{l}\lambda_{t-1}^{k}Cov\left(r_{m,t},s_{k,t}\right)+\varepsilon_{t}^{m} \quad (2)$$

$$r_{i,t}=\lambda_{t-1}^{i}Var\left(r_{m,t}\right)+\sum_{k=1}^{l}\lambda_{t-1}^{k}Cov\left(r_{i,t},s_{k,t}\right)+\varepsilon_{t}^{l} \quad (2')$$

$$s_{k,t}=\lambda_{t-1}^{m}Cov\left(r_{m,t},s_{k,t}\right)+\lambda_{t-1}^{k}Var\left(s_{k,t}\right)+\varepsilon_{t}^{k} \quad (3)$$

$$r_{i,t}-r_{f,t}=\phi_{t-1}^{i}\left[\lambda_{t-1}^{m}Cov\left(r_{i,t},r_{m,t}\right)+\sum_{k=1}^{l}\lambda_{t-1}^{k}Cov\left(r_{i,t},s_{k,t}\right)\right]+\left(1-\phi_{t-1}^{i}\right)\left[\lambda_{t-1}^{i}Var\left(r_{i,t}\right)\right]+\varepsilon_{t}^{i} \quad (4)$$

Where $\varepsilon_{t}=\left(\varepsilon_{t}^{m},\varepsilon_{t}^{l},\varepsilon_{t}^{k},\varepsilon_{t}^{i}/X_{t-1}\right)$ is the vector of unexpected excess returns given the set of infomation X available at time $t-1$. This vector follows a normal law, with zero mean and variance H_{t}. H_{t} is the conditional variance-covariance matrix of excess returns. As in

Hardouvelis et al. (2006), the time-varying parameter is conditionned on a set of variables that measure integration:

$$\phi_{t-1}^{i} = \exp\left(-\left|g_{i}^{'} X_{t-1}^{i}\right|\right) \tag{5}$$

Where X_{t-1}^{i} is a vector of country specific information variables on local market integration with the euro area at time $t-1$, and g_{i} is the weight associated to each variable X_{t-1}^{i}, with $X_{t-1}^{i} \subset \phi_{t-1}^{i}$.

In our study, we take into account five variables that we consider as the most significant factors of integration (see section 4.3). We have:

$$\phi_{t-1}^{i} = \phi_{t-1}^{i}\left(X_{t-1}^{i}\right) = \exp\left(-\left|\alpha_{0} + \alpha_{1} X_{1,t-1}^{i} + \alpha_{2} X_{2,t-1}^{i} + \alpha_{3} X_{3,t-1}^{i} + \alpha_{4} X_{4,t-1}^{i} + \alpha_{5} X_{5,t-1}^{i}\right|\right) \tag{6}$$

Equation (1) includes changes in the price of international (here European) market risk, the price of currency risk and the price of local risk. De Santis and Gérard (1997) and Gérard et al. (2003) show that these prices vary over time. Merton (1980), Adler and Dumas (1983) show that the price of risk is the aggregation of risk aversion of all investors, the later being assumed risk averse.

Based on the works of Adler and Dumas (1983), Harvey (1991), Bekaert and Harvey (1995), De Santis and Gérard (1997, 1998), De Santis et al. (2003), the price of the market risk is described by an exponential function of macroeconomic and financial international information variables:

$$\lambda_{t-1}^{m} = \exp\left(\delta_{m}^{'} X_{t-1}\right) \tag{7}$$

With $X_{t-1} \subset \phi_{t-1}$, where X_{t-1} is a vector of global information variables available at time $t-1$.

Following Hardouvelis et al. (2006), we use the same model in order to describe the price of local risk[4]:

$$\lambda_{t-1}^{i} = \exp\left(\gamma_i^{'} X_{t-1}^{i}\right) \qquad (8)$$

Where X_{t-1}^{i} is the vector of local information variables available at time $t-1$ and $\gamma_i^{'}$ are the weights of each variable in the vector.

The price of currency risk can be, theoretically, positive or negative. Therefore, a linear specification is chosen for the price of currency risk[5]:

$$\lambda_{t-1}^{k} = \left(\delta_i^{'} X_{t-1}\right) \qquad (9)$$

Where $\delta_i^{'}$ is the weight of each variable in the vector X_{t-1}.

3. Methodology

3.1. Estimating the ICAPM model

Our model, described by equation (1), is estimated in three steps. First, we estimate a system of six equations: (2), (2'), (3), (7), (8) and (9). This first step allows us to obtain the estimated values of the European portfolio returns ($r_{m,t}$), the stock market returns ($r_{i,t}$), the change of real exchange rate ($s_{k,t}$), the price of European market risk (λ_{t-1}^{m}), the price of currency risk (λ_{t-1}^{k}) and the price of local risk (λ_{t-1}^{i}). In a second step, the series of yield and price risk are integrated, after having been estimated in relation (4). Taking into account equation (6), we

[4] It should be noted that a number of studies (Dumas and Solnik, 1995; De Santis and Gerard, 1998; Alder and Qi, 2003; De Santis et al., 2003) use the same information vector to model risk prices of global market and currency.

[5] See, for example, Bekaert and Harvey (1995) or Hardouvelis et al. (2006).

then estimate the degree of integration ϕ^{i}_{t-1}. Values estimated in these two steps are used in a third step to calculate the total market risk premium using equation (1).

Equation (1) can be rewritten as follows:

$$r_{i,t} - r_{f,t} = \phi^{i}_{t-1}\left(\lambda^{m}_{t-1}h^{ii}_{m,t} + \sum_{k=1}^{l}\lambda^{k}_{t-1}h^{k}_{t-1}\right) + \left(1-\phi^{i}_{t-1}\right)\left(\lambda^{i}_{t-1}h^{i}_{t}\right) + \varepsilon^{i}_{t} \qquad (10)$$

Where ε^{i}_{t} are conditional errors to the degree of integration at time $t-1$ and follow a normal law, with zero mean and variance H_t. $h^{ii}_{m,t}$, h^{k}_{t-1} et h^{i}_{t} are columns of the (N,N) variance-covariance matrix H_t, which measure the exposition to (i) the European market risk, (ii) the country k currency risk, and (iii) the risk of local market. The conditional variance-covariance matrix of excess returns H_t follows a MGARCH (1,1) process as proposed by Ding and Engle (1994) and generalized by De Santis and Gérard (1997).

Equation (10) involves the simultaneous estimation of the conditional covariance of local market *i* with the international market and each of the remaining portfolios with country *i*. The use of multivariate GARCH (1,1) may be a solution in order to model stock market series and quantifies changes in the level of financial integration[6]. Following Engle and Kroner (1995), the $BEKK(p,q,K)$ specification is given by:

$$H_t = C^{*'}C^{*} + \sum_{k=1}^{K} A^{*'}_{k}\varepsilon_{t-1}\varepsilon^{*}_{t-1}A^{*} + \sum_{k=1}^{K} B^{*'}_{k}H_{t-1}B_{k} \qquad (11)$$

Where, $p=1$, $q=1$ and K is the number of assets. C^{*} denotes a symmetric matrix of dimension (N,N), A^{*} and B^{*} two matrices of dimension (N,N). The matrix C^{*} assumes the positivity of the variance covariance matrix. Moreover, the number of parameters to be estimated for the matrix H_t is very high. For example, a $BEKK(1,1,8)$ model requires to estimate up to 164 parameters. As a consequence, a new approach was proposed by Bollerslev

[6] See, for example, Gouriéroux et al. (1997), Lardic and Mignon (2002) or Racicot and Théoret (2005).

(1990) which allows to reduce the number of parameters to be estimated: the *CCC* (Constant Conditional Correlation) model[7].

The basic assumption of the *CCC* model is that conditional correlations are constant over time. Admittedly, this model reduces the number of parameters to estimate, but as for the *BEKK* model, the assumption of constant correlation between assets is not verified in reality[8].

This restriction has led to the *DCC* method (Dynamic Conditional Correlation) proposed by Engle (2002) and Tse and Tsui (2002), allowing to model both variances and conditional correlations of several series. The later depend on market conditions, and on the evolution of the economy, being in recession phase or expansion phase. Cappiello et al. (2006) incorporate the mechanism of asymmetry in the *DCC* model by allowing the conditional correlations to react differently to the sign of shocks. The advantage is that this model takes into account the temporal variation of correlations between variables and the possible effect of asymmetry of shocks on conditional variance.

The *DCC* model proposed by Engle (2002) is written as follows:

$$\begin{cases} H_t = D_t R_t D_t \\ D_t = diag\left(\sqrt{h_{11,t}}, \sqrt{h_{22,t}}, \ldots, \sqrt{h_{NN,t}}\right) \\ R_t = diag(Q_t)^{-\frac{1}{2}} Q_t \left(diag Q_t\right)^{-\frac{1}{2}} \end{cases} \tag{12}$$

where D_t is the diagonal matrix of conditional standard deviations and R_t is the matrix representing the structure of correlations between variables. Q_t is a matrix of dimension (N, N), symmetric and positive definite. It is given by:

$$Q_t = (1 - \theta_1 - \theta_2)\overline{Q} + \theta_1 u_{t-1} u'_{t-1} + \theta_2 Q_{t-1} \tag{13}$$

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[7] Considering 8 assets requires only the estimation of 52 parameters, which is quite low compared to the *BEKK* model.

[8] Tse (2000) rejects the null hypothesis of constant correlations between stock markets of Hong Kong, Japan and Singapore estimated from a multivariate *BEKK* GARCH model.

where $\overline{Q}_t$ denotes the unconditional matrix of variance-covariance of dimension (N,N), symmetric and positive definite, and $u_t = (u_{1,t}, u_{2,t}, ..., u_{N,t})^{'}$ is a column vector of standardized residuals of the *N* assets in the portfolio at time *t*.

$u_{it} = \frac{\varepsilon_{i,t}}{\sqrt{h_{ii,t}}}$ with $i = 1,...,N$. The coefficients θ_1 and θ_2 are parameters to estimate. The sum of these coefficients must be less than 1 to satisfy the positivity of the matrix Q_t .

The estimation of multivariate models' parameters is based on the maximum likelihood method. Assuming that the residuals are Gaussian, the likelihood function is written as:

$$L_T(\theta) = -\frac{1}{2}\sum_{t=1}^{T}\left(\log\left|D_t R_t D_t\right| - u_t^{'} R_t^{-1} u_t\right) \tag{14}$$

Where $u_t = D_t^{-1}(y_t - u_t)$ and $u_t^{'} R_t^{-1} u_t = (y_t - \mu_t)' D_t^{-1} R_t^{-1} D_t^{-1} (y_t - \mu_t)$.

The process of estimating the *DCC* model involves two stages. Firstly, the conditional variance of each variable of the system is estimated. Secondly, the standardized residuals of the first-stage regressions are used to model the correlations in an autoregressive way, thus obtaining the conditional correlation matrix which varies over time.

3.2. Kalman filter

The system of equations (2), (2'), (3) and (4), has unobservable components: λ^m , λ^k and λ^i . The emergence of such models with unobservable parameters has resulted in many statistical procedures that can be reformulated in the framework of state-space models. This type of modelling is of a great interest since it provides maximum likelihood estimators for these unobservable risk prices. They are subsequently estimated using equations (7), (8) and (9), based on instrumental variables containing all information relating to macroeconomic aggregates. The state-space models include (Gourieroux and Monfort, 1990, Durbin and Koopman, 2001):

- one or more equation(s) of measurement that describes how the observed variables (here the expected returns) are generated by the explanatory variables (terms of covariance), the unobservable parameters (risk price) and residuals (equation (15));
- One or more state equation(s) describing how the unobservable parameters (here the price of risk) are generated from their lags and their innovations (equation (16)).

The question that arises here is to estimate at each time *t* the price of unobservable risk (state equation) conditional on observed variables (measurement equation). If we apply this model to equation (2) to obtain the price dynamic of the market risk (λ^m), the state-space model is described by the following equations:

$$r_{m,t} = \lambda_{t-1}^{m} Var(r_{m,t}) + \sum_{k=1}^{12} \lambda_{t-1}^{k} Cov(r_{m,t}, s_{k,t}) + \varepsilon_t^m \tag{15}$$

$$\lambda_t^m = A_{t-1} \lambda_{t-1}^m + \xi_t \tag{16}$$

Where $\begin{pmatrix} \varepsilon_t^m \\ \xi_t \end{pmatrix} \sim NID\left(0, \begin{pmatrix} Q_t & S_t \\ S_t & R_t \end{pmatrix}\right)$. The matrix A_{t-1}, R_t, Q_t and S_t have dimension (K,K). λ_0^m (initial state variable) is a random vector of normal law (*m*, *P*) independent from the normal white noise[9].

To estimate the state vector, the "optimal" algorithm, called the Kalman filter, is used. It allows, after a number of iterations, to update the variable extent from its past observations and predict over time the state vector. Each iteration can be summarized by the following set of equations:

$$\lambda_{t,t}^{m*} = \lambda_{t-1,t}^{m*} + K_t \left(r_{m,t} - \lambda_{t-1,t}^{m*} Var(r_{m,t}) - \sum_{k=1}^{12} \lambda_{t-1}^{k} Cov(r_{m,t}, s_{k,t}) \right) \tag{17}$$

[9] State variables ($r_{m,t}$) and space variables (λ_t^m) are expressed by the initial state variable (λ_0^m), innovations (ξ_t) and from the past of space residuals (ε_t^m) together with exogenous variables (*Var* and *Cov* terms).

$$\lambda_{t+1,t}^{m*} = A_t \lambda_{t,t}^{m*} \tag{18}$$

$$\Sigma_{t,t+1} = A_t \Sigma_{t,t} A_t^{'} + Q_t \tag{19}$$

$$K_t = \Sigma_{t-1,t} \lambda_t^{m*} \left(\lambda_t^{m*} \Sigma_{t-1,t} \lambda_t^{m*} + R_t \right)^{-1} \tag{20}$$

$$\lambda_{-1,0}^{m*} = m, \Sigma_{-1,0} = P \tag{21}$$

Where $\lambda_{t,t}^{m*}$ is the current estimate of state vector, $\lambda_{t-1,t}^{m*}$ is the prediction of the state vector at time $t-1$, $\sum_{t-1,t} = V(\lambda_{t-1,t}^{m} - \lambda_{t-1,t}^{m*})$ is the mean square error of prediction, K_t is the gain matrix of Kalman filter (its inclusion in equation (17) increases the precision of the estimate $\lambda_{t,t}^{m*}$ with respect to unobservable $\lambda_{t-1,t}^{m*}$). Equation (17) calculates the current estimate of the state vector $\lambda_{t,t}^{m*}$ as the sum of the forecast at time $t-1$ of the state vector λ_t^m and prediction error (weighted by the gain matrix K_t, updated every iteration by equation (20)) obtained from the last observed value $r_{m,t}$. Equation (18) calculates the prediction λ_t^m at time $t+1$ ($\lambda_{t,t+1}^{m*}$). Equation (19) on the covariance matrix, $\sum_{t,t+1}$, takes into account the errors related to the innovations of the state (price risk) plus a term $A_t \sum_{t,t} A_t^{'}$ associated with errors on the state at time *t*. Equation (21) allows the initialization of the state vector $\lambda_{t-1,t}^{m*}$.

This model is also applied to equation (2'), to recover the dynamics of the price of local market risk, λ_t^i, as well as equation (3) on the price of currency risk λ_t^k. These three parameters estimated through the state-space model, are included in the equation (4) allowing the estimation of ICAPM.

3.3. Financial integration and regime switching

Modeling financial time series with linear equations is generally inappropriate (Lardic and Mignon, 2002; Racicot and Théoret, 2005). The nonlinear models allow defining different states or regimes in the series. The level of financial integration such as it is introduced in equation (4) is part of time series requiring a nonlinear modeling. According to Bekaert and Harvey (1995), the level of integration can be modeled using a regime switching model. If markets are perfectly integrated ($\phi_{t-1}^{i} = 1$), the expected return is only represented by the international risk premium ; in contrast, if markets are strictly segmented ($\phi_{t-1}^{i} = 0$), the expected return is only estimated by the local risk premium. When the level of integration varies between 0 and 1, the markets are partially segmented and the two sources of risk determine the estimation of expected return.

In this study we are particularly interested in regime switching models developed by Hamilton (1988, 1989, 1990), and more specifically to their proposed extensions by Garcia and Perron (1996), Gray (1995, 1996), and Schaller and Van Norden (1997). They used Markov regime switching models with time-varying transition probabilities allowing the conditional variance to be a stochastic function of the variance from previous periods. The model of Gray (1996) is constructed to allow the coefficients of the estimated parameters to be different from one regime to another, taking into account a number of information variables reflecting the economic markets situation. Moreover, the time-varying transition probabilities can better characterize the level of integration at each moment *t*. As shown in equation (5), the information variables that affect the estimated level of integration, involved in the coefficients of estimated parameters by allowing them to vary depending on whether markets are perfectly integrated or partially segmented. In other words, the level of integration can be explained by the weight of various macroeconomic and financial policies taken at each time *t* in each market. Thus, the level of financial integration is considered here as reflecting the overall macroeconomic and financial policies decided on the market. Therefore, using time-varying transition probabilities in a Markov regime switching model, the measure of financial integration is dynamic and can thus vary over time.

As Gray (1995, 1996), we assume that we can not know the level of integration with certainty but that's statements progress following a Markov process of order 1:

$$\Phi_t = \mu_0 (1 - S_t) + \mu_1 S_t + [\sigma_0 (1 - S_t) + \sigma_1 S_t] \varepsilon_t \tag{22}$$

Where ε_t follows a normal distribution with mean equal to zero and unit variance.

If we consider two levels of financial integration : perfect (state 1) and strict segmentation (state 2), the stochastic process of S_t is represented by the following matrix of transition probabilities:

$$A = \begin{bmatrix} P_{00} & P_{10} \\ P_{01} & P_{11} \end{bmatrix} \tag{23}$$

Where $P_{ij} = \Pr(S_t = j | S_{t-1} = i)$ is the probability of moving from state *i* to state *j*[10]. By design, $\sum_{j=0}^{1} P_{ij} = 1$. The transition probabilities can vary over time and take the following form:

$$\begin{aligned}
\Pr(S_t = 0 | S_{t-1} = 0) &= P_{00} = \frac{\exp(\beta_0 X_{t-1})}{1 + \exp(\beta_0 X_{t-1})} \\
\Pr(S_t = 1 | S_{t-1} = 1) &= P_{11} = \frac{\exp(\beta_1 X_{t-1})}{1 + \exp(\beta_1 X_{t-1})} \\
\Pr(S_t = 0 | S_{t-1} = 1) &= P_{10} = 1 - P_{11} \\
\Pr(S_t = 1 | S_{t-1} = 0) &= P_{01} = 1 - P_{00}
\end{aligned} \tag{24}$$

Where X_{t-1} designates all the information on global variables available at time $t-1$ and β_j, with $j = 1,2$, are the vectors of weights associated with these variables that play an important role in determining the probabilities of transition from one regime to another. The parameters of equation (22) and transition probabilities of the matrix (23) are jointly estimated by the maximum likelihood method assuming normally distributed error terms[11].

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[10] i.e. the probability of switching regime.

[11] For more details about the likelihood function, see, for example, Gray (1995, 1996).

4. Data

Our study focuses on the integration of Central and Eastern European Countries (CEECs) vis-à-vis the euro area[12]. In addition to the European market, the data cover the following countries: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Romania, Slovakia, Slovenia and Poland.

Three groups of data are considered: (i) monthly returns of the stock market index in each market and the euro area, (ii) real exchange rates expressed vis-à-vis the euro, (iii) macroeconomic and financial variables used to condition the estimates of risk price and the degree of financial integration. The data are monthly and extend from January 2001 to June 2009.

4.1. Asset returns data

Stock indexes are calculated including dividends, and are from the *Datastream* database. Stock market returns are defined as $r_{i,t} = \ln\left(P_{i,t} / P_{i,t-1}\right)$ where $P_{i,t}$ is the stock market index at time t (including dividends). The excess return of each index is calculated from a risk-free rate at 1 month.

The series of nominal exchange rates are expressed relative to the euro. These data are extracted from *Eurostat* database. The real exchange rates are constructed by deflating the nominal exchange rate by the consumer price index (CPI) obtained from the *International Financial Statistics* of the International Monetary Fund. Moreover, the unit root tests show that all series of stock returns and changes in real exchange rates are stationary[13].

[12] The euro area considered here is that which was created in 1999 with 11 countries (Germany, Austria, Belgium, Spain, Finland, France, Ireland, Italy, Luxembourg, Netherlands and Portugal) which are joined by Greece in 2001.

[13] Detailed results of unit root tests are available upon request.

4.2. International and local instrumental variables

The instrumental variables are used in order to condition the estimated prices of different risk factors. As Hardouvelis et al. (2006) and Carrieri et al. (2007), to condition the estimate of the risk price of the euro area and risk price associated with unanticipated fluctuations of real exchange rate, we consider the following factors:

- A constant term;
- The monthly change in dividend yields on the market portfolio in excess of European interest rates to 30 days (*DRMDV*);
- The monthly change of premium term (*DPTERM*);
- The monthly change in the short term interest rate (*DSHORT*);
- The monthly change of default premium (*DPDEF*).

The term premium is the difference between a long-term interest rate (10-year Treasury bond) and a 1 month interest rate. Regarding the default premium, we follow Hardouvelis et al. (2006) by calculating it from the geometric mean of 10-year Treasury bills series of the euro area most industrialized nations (Germany, France, Italy, Netherlands and Spain) weighted by the series of market capitalizations of these same countries. All these information variables are from *Datastream*. They are used with a lag behind the series of excess returns.

Regarding the likelihood of each local market area, we retain the following set of information variables (see Gérard et al. (2003)):

- A constant term;
- The monthly change of excess stock returns of each area (*DRD*);
- The monthly change of 1 month interest rate (*DSHORT*);
- The monthly change of a forward local market premium (*DPTERML*). This premium is defined as the difference between a long-term interest rate (10-year Treasury bond) and a local 1-month interest rate.

4.3. Instrumental variables of integration

The level of financial integration follows a dynamic process related to all the new economic, financial and socio-political informations, from the local market or the external environment. It is therefore necessary to determine the fundamental responsibility of the variation over time in the level of market integration. To this end, we consider the following information variables:

- *FSPREAD*: the differential between interest rates of the European Central Bank and the local market. This variable plays a dual role. First, it can detect the probability that a country can join the euro area: a high probability of integration is synonymous with an interest rate close to that of the euro area, where a differential decline. Secondly, it captures the importance of transaction costs that are in close liaison with the value of the future nominal interest rate. These two characteristics are closely related to the degree of integration of financial markets. This variable is available for all CEECs except for Romania where the series does not begin until January 2005;
- *INFD*: the differential inflation rate between the local market and the euro area. One of the criteria set by the Maastricht Treaty requires countries wishing to join the euro area to have an inflation rate not exceeding by more than 1.5% average of the three weaker inflation rate. The inflation rate in each country is measured using the logarithmic variation of the consumer price index. The rate of inflation in the euro area comes from the *International Financial Statistics* of the International Monetary Fund;
- *SRD*: the differential between interest rates of the ECB and the local market. This variable is considered, in addition to the differential rate of inflation as a proxy for the nominal convergence of local markets to euro area;

- *VTCR*: the monthly variation of real exchange rate vis-à-vis the euro. This variable can warn investors to avoid a market where prices may exceed the benefits of portfolio diversification. Indeed, if the exchange rate of a currency is very volatile, the investment costs in that currency would rise and remain on the market less diversified and more confined, leading to a low level of integration;
- *DGDP*: Gross domestic product (GDP) in volume of each country, reported to that of the euro area. Carrieri et al. (2007) argue that GDP is a better approximation to capture the level of economic integration and should lead to greater integration of capital markets. Moreover, this is the only variable used by Bhattacharya and Daouk (2002) to condition the estimate of the degree of financial integration.

All these variables are from *Datastream* unless otherwise stated.

5. Results

5.1. Degree of financial integration

The degree of financial integration is reported on figure A.1 and shows that financial integration of the CEECs compared to the euro area is not homogeneous. Indeed, countries like Estonia, Czech Republic and Poland have a very high level of integration, while it is very low for Hungary, Latvia or Lithuania.

The current financial crisis seems to have had two effects. A first effect occurred at the end of 2007 where integration increased or decreased depending on the country. For example, in Bulgaria, financial integration, initially low, increased while it decreased in Poland. The second effect occurred following the collapse of U.S. bank Lehman Brothers. This collapse triggered a systemic risk that spread to the entire international financial system (*domino effect*). Thus, greater financial integration of the CEECs with the euro area, for example in Poland, in Slovenia, Malta or Bulgaria, should not be interpreted as a convergence of financial markets of CEECs with those of the euro area but as the effect of spreading the financial shock.

Before the collapse of Lehman Brothers, the dynamics of the degree of financial integration is a function of fundamentals in each country and measures taken following the submission by the local financial markets of new information. After the fall of Lehman Brothers, the dynamics of integration is influenced by the impact and spread of financial crisis. Between 2002/2003 and 2007, the dynamics of integration is almost stable, on average, for most of the countries. Entry into the EU of those countries does not seem to have affected this dynamic with a few exceptions such as Slovenia and Estonia.

Compared to the timetable set for each country regarding the adoption of the euro, most CEECs have set a target by 2013. The next membership shall normally occur in 2012[14] with Czech Republic and Poland. Currently, even if no targets in terms of convergence have been set by the Maastricht Treaty, it seems that the financial integration of these countries vis-à-vis the euro area is sufficiently high to allow membership in good conditions. For countries which have set a date of accession to 2013[15], Hungary seems less integrated than Bulgaria in 2009 and on average over the entire period (0.4 against 0.6). For the four countries that have already adopted the euro (Slovenia (2007), Cyprus and Malta (2008), Slovakia (2009)), degrees of integration are different. If Cyprus, Slovakia and Slovenia are experiencing high financial integration (between 0.58 and 0.6 on average), it is not the same for Malta (Table A.3). Compared to their date of accession, we note that Slovenia had a high degree of integration (around 0.8), Malta had a small degree of financial integration (just under 0.2) and

[14] The accession of Lithuania, Estonia and Latvia, originally scheduled for 2010 has been postponed without further details on dates, following the current financial crisis.

[15] Bulgaria, Romania, Hungary.

Slovakia had a moderate degree of integration less than 0.5[16]. After accession, financial integration increased in Slovenia and Malta, and fell for Slovakia. It seems that the first two countries have benefited from better gains from the adoption of the euro (risk sharing, access to capital markets to finance their growth)[17]. Slovakia has not had the same earnings. It appears that the transition period between entry into the European Union and accession to the euro area does not permit the necessary upgrading to a better financial integration.

5.2. Financial integration and transition probabilities

The purpose of this section is to compare the results previously recorded on the degree of integration with its dynamics over time by analyzing the probability of transition from one regime to another. In other words, for countries with a low degree of financial integration during the period under study and compared with their dates of accession to the euro area, we seek to know from their dynamic integration whether they may converge to the euro area (perfect integration) and thus comply with the deadlines already set. In some countries, the gap between the degree of financial integration and the probability of transition from one regime to another is low (eg Bulgaria, Estonia, Lithuania, Malta and Poland). This indicates that the degree of financial integration has a low probability of change. By cons, this degree has a high probability of evolving to Cyprus, Hungary, Latvia and Slovakia (Figure A.2). For these countries, the likelihood of regime changes[18] is significantly different from 0 (see Table A.3), showing a level of financial integration more dynamic that may change significantly over time.

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[16] In Cyprus data are available until 2007 and therefore we can not obtain his degree of integration in 2008.

[17] Indeed, CEECs are characterized by a need for significant funding (lack of national savings relative to investment needs) driven by faster growth than the countries of the European Union (Jacquelain, 2004; Maurel, 2004 ; Sokic, 2006).

[18] *P(1,2)*, transition probability from regime 1 to regime 2 between time *t-1* and time *t*.

These changes can be explained by several factors:

- The volatility of the series ;
- Banking and financial restructuring which is taking place;
- Market expectations on the date of accession to the euro area in these countries;
- The asymmetric response to [common] shock inherent to the current financial crisis;
- The macroeconomic fundamentals of these countries.

This last point may be of crucial importance. Indeed, further financial integration, the accession to the euro area is the final step of the process of economic integration (the overall meaning of the term). Thus, each country, along with the criteria of nominal convergence, can follow macroeconomic policies, including exchange rate policy (as the ERM allows some degrees of freedom on the exchange rate fluctuations) different from its neighbours. Thus, the anchor vis-à-vis the euro may be decided prior to entry into the ERM, while some countries may adopt a flexible exchange rate.

Countries with a high dynamic integration degree (Hungary, Latvia and Slovakia) are characterized by strong fundamentals: low current account deficits, high growth prospects. Therefore the probability of convergence to the euro area is higher compared to countries with a very low dynamics of integration. For other countries, current account deficits related to banking problems are feared risk of crises and binoculars are not favourable conditions for capital inflows.

5.3. Financial integration and dynamic conditional correlation

The level of integration, estimated for each market, reflects not only the extent suggested by the ICAPM, from terms of conditional correlations between the markets of CEECs and the euro area, but also the contribution of other economic fundamentals within each country as suggested by Carrieri et al. (2007). According to Dumas et al. (2006)[19], it is inappropriate to conclude to full integration of financial markets (or partial segmentation) from simple calculations of correlations between stock returns, thus justifying the use of information variables related to macroeconomic fundamentals to explain the level of financial integration[20].

It is not surprising that the correlations are much lower compared to the level of integration, because the level of integration provides a complete view of the financial and economic reality of each market to the investors. Overall, the conditional correlations indicate a relatively small variation from the level of integration (Figure A.3), except during the crisis period (2008-2009). Most CEECs have a degree of integration 2 to 4 times higher compared to correlations between markets[21]. This finding is explained, in addition to periods of economic and financial crises, by increasing opportunities for international investors to access these markets and their ability to diversify portfolios. This is confirmed by the estimation of the degree of integration based on information variables. We note that these variables are insignificant, except those related to unanticipated changes in real exchange rate (VTCR). Indeed, this variable contributes significantly to the explanation of the dynamics of

[19] See also Longin and Solnik (1995), Ang and Beakaert (1999), Bansal and Lundblad (2000).

[20] Some studies, Borgy and Mignon (2009) for example, rely on moving correlations or on the interest rate parity to investigate the degree of financial integration. For emerging countries, including CEECs, this type of calculation may appear insufficient given the importance of the currency risk premium.

[21] These include Estonia, Latvia, Slovakia, Slovenia and Poland. Malta registers a very low average conditional correlation compared to other CEECs. This can be explained by the geographical position of this country, with financial market weakly correlated with that of the euro area but very close economic fundamentals including the adoption of the euro since 2008.

integration for 6 countries (Bulgaria, Cyprus, Estonia, Latvia, Slovenia and Poland)[22]. We also note that, for all CEECs, the variation of real exchange rate (*VTCR*) is characterized by low volatility relative to other information variables and series of stock returns.

The relative stability of exchange rates for selected CEECs can give a positive signal to international investors, informing them that the benefits of diversification in these countries exceed the investment costs (risk premiums...). The markets are thus more diverse and less closed position with a higher level of integration, thanks in part to the relative stability of local currency[23].

In summary, the idea that increasing the degree of financial integration can cause a high correlation between capital markets, remains unfounded. In this case, there are other variables related to macroeconomic fundamentals (exchange rate, inflation rate ...) which may explain the process of financial integration, and which are not directly controlled by the correlations between capital markets. These findings show that there is a significant relationship between the dynamics of financial integration and the exchange rate. Therefore, it is interesting to analyze in greater detail changes in real exchange rates in CEECs. Specifically, it is studying the significance of the risk price associated with possible unanticipated fluctuations of real exchange rate and its importance relative to other sources of risk.

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[22] The estimation results are presented in appendices as a single variable (*VTCR*) explains significantly the degree of integration. The other information variables explain generally too low level of integration. This may be because they were calculated in relation to indicators of the euro area while they are still far from the level of seamless integration.

[23] According to Maurel (2004), international diversification is not limited solely to money, but can be generalized to all assets. Furthermore, Vranceau and Daianu (2002) show that the outward and market diversification depend on a number of specific factors: the success of macroeconomic stabilization, construction of a credible international level deficit and public debt, the quality of the financial system and the effectiveness of prudential law.

5.4. Price of currency risk

In this study, the main sources of risk related to the European market and local market are integrated simultaneously in the same model (ICAPM)[24]. This allows the integration coefficient (ϕ) to vary over time to detect the dynamics of financial integration and the convergence of each market to that of the euro area. If ϕ is close to 1, the local market risk is overlooked. The total risk premium is mainly formed by the international risk premium and the local market converges to the euro area. The stock returns of the local market portfolio are more influenced by international economic fluctuations than by changes in monetary and financial aggregates related to the local market. If ϕ is near 0: the market is partially integrated and the total risk premium is mainly composed of the local market risk premium.

Recall that the price of currency risk was first estimated using the Kalman filter applied to equation (3). Then, the same price is conditional based on local instrumental variables (equation (8)) to account for all information related to macroeconomic fundamentals. The estimation results are presented in Table A.2.

Overall, we find that the evolution of currency risk prices is poorly explained by the information variables. For Bulgaria, Cyprus and Estonia, two instrumental variables significantly explain the price of currency risk (in addition to the constant): the monthly change in the premium end of the ECB (*DPTERM*) and the monthly change in the 1-month interest rate of the ECB (*DSHORT*). The price of currency risk of Latvia and Slovakia are respectively explained by the monthly change in the default premium of the ECB (*DPDEF*)

[24] But there is a liquidity risk not incorporated into the ICAPM model. However, as demonstrated by Balli (2009), liquidity risk, within the euro area, may be important in explaining the total risk premium but this importance is dependent on the level of financial integration. Given the level of financial integration of CEECs that we find from our estimates, we can consider that the factors derived from the ICAPM are the most significant.

and the monthly change in the 1 month interest rate of the ECB (*DSHORT*) (in addition to the constant).

The price of risk is negative for 6 CEECs (Bulgaria, Cyprus, Hungary, Latvia, Lithuania and Malta) and positive for the others (Figure A.4).

Overall, prices of currency risk are fluctuating, but the application of the Hodrick-Prescott filter reveals several phases of expansions and recessions, especially during the crisis period 2007-2009 (Figures A.4 and A.5).

After analyzing the results of estimating the price of currency risk, we find that:

- Among the six CEECs whose level of integration is significantly explained by variations in the real exchange rate, three of them have a negative price of currency risk (Bulgaria, Cyprus and Latvia). The hypothesis of the possibility of diversification is confirmed and these markets can attract foreign investors. Their level of integration, being around 0.3 for Latvia (Table A.3), can significantly increase notably by the end of the current crisis. Three other CEECs, also have a negative price of currency risk (Hungary, Lithuania and Malta) promoting the diversification of markets and increase the level of integration. As we have shown previously, Hungary and Latvia have a high dynamic integration, which accelerates the process of accession to the euro area;
- for Estonia, Slovenia and Poland, despite a higher level of financial integration, respectively, 0.64, 0.58 and 0.75 (Table A.3), their markets are characterized by a positive price of currency risk. This can be explained by the stability of other factors (macroeconomic, political...). But these three countries are characterized by a low dynamics of integration. Finally, Slovakia and Czech Republic have also a price of risk related to unanticipated positive real exchange rate fluctuations, but a relatively high level of integration, above 0.6. It is probably related to the stability of other macroeconomic variables.

Other sources of risk associated with local and European markets are also analyzed (Figures A.6 and A.7) and can provide a comparison between the different risk premiums in their respective contributions to the formation of the overall premium.

Recall that the premium for currency risk is defined as the product between the price of risk, estimated and discussed above, and the terms of covariance between the stock market returns of each country and its exchange rate vis-à-vis the euro . The risk premium on the European market has been calculated from the product from its price of risk and its covariance with the financial returns of the local market. The risk premium on the local market is equal to the product of its price of risk and variance of returns of its equity portfolio.

After the price analysis of each source of risk, it has been assigned to covariances terms in order to calculate the various risk premiums. The objective is to compare the significance of the currency risk premium relative to the market risk premium in order to explain the formation of the total premium and its variance over time. This helps the international investors in their choice to invest in the local market or on the European market.

Table A.4 reports the variances related to the three risk premiums (European market, currency and local market) and that of the total premium. Among the CEECs, 7 of them (Bulgaria, Cyprus, Latvia, Lithuania, Malta, Slovakia and Czech Republic) are characterized by a relatively high variance of currency risk premium compared to other risk premiums, contributing significantly to the formation of the total risk premium. However, its overall value remains relatively low and does not block the influx of foreign capital into these countries. This is confirmed by the fact that half of these countries have a level of integration higher than 0.6, highlighting that they are close to perfect integration and reflects their openness degree. For other countries (Hungary, Estonia, Slovenia and Poland), the variance of the total risk premium is mainly explained by the variances related to European market risk and local market premiums. The level of financial integration of these countries is around 0.5

(partial integration). We recall that for Hungary, Slovenia and Poland, the dynamics of integration is significantly different from 0 (Table A.3). This indicates a high probability to converge rapidly towards the euro area, convergence is driven in part by a very low currency risk premium.

In summary, for the CEECs, as in the case of most emerging countries, currency risk premiums are significantly different from 0. However, even if it contributes to the formation of the total premium, its value remains relatively low and does not prevent the installation of foreign investors in these markets. This is confirmed by a higher level of financial integration than 0.6 for at least 7 countries.

5.5. Are CEECs ready to join the euro area?

The question is now being posed of the adhesion of some countries whose level of integration seems to converge to 1 before the crisis (eg Poland) or even from the beginning of 2009. Cyprus, Slovakia and Slovenia, whicgh are characterized by a high level of integration have succeeded in their prior membership to the euro area. However, Malta does not seem to reach successful integration to the euro area (0.17) even with a negative price of currency risk, which would suggest that the study of integration must take into account all the information and not be constrained to the simple price of risk associated with unanticipated fluctuations of the real exchange rate. A positive price of currency risk does not provide any indication concerning the timing of joining the euro area. The 12 new Member States that joined the European Union since May 2004 were destined to join the European Exchange Rate Mechanism (ERM) II when they are preparing for euro adoption. Among these 12 states, Slovenia came out successfully in January 2007. It was followed in January 2008 by Cyprus and Malta and Slovakia in January 2009. Bulgaria, despite having joined the European Union and unilaterally implementing a policy of fixed exchange rate with the euro for several years, does not yet participate in ERM II, especially in policy interest rates and accession to the objectives of nominal convergence. It is therefore in the same position as Romania, or Poland, Hungary or Czech Republic. Like other countries, it still may decide at any time only a change in its exchange rate (within the limits set by the accession Treaty). However, participation in ERM II does not mean strict rigidity of the local currency against the euro, margins of fluctuations exist. The question that arises now is that on an immediate accession of countries whose currencies (whether fixed or flexible in relation to the euro) are experiencing difficulties. If such an accession becomes a reality, the exchange rate question and the danger of twin crises do not arise anymore, but most other questions or problems arise. Aglietta et al. (2003) reminded that membership, if it may occur, must take place gradually and in no case be done faster because the CEECs catching up on European level takes time and requires a "flexible" exchange rate policy in order to encourage investment needed by these countries. By joining immediately the euro area, the CEECs are deprived of their exchange rate policy as well as their monetary policy. However, the divergence of inflation rates, partly due to the Balassa-Samuelson effect, no incentive to adopt this solution. Finally, joining more or less rapidly the euro area is also a political issue.

6. Conclusion

The aim of this paper was to study the dynamics of financial integration of the CEECs vis-à-vis the euro area, taking into account the importance of the currency risk premium. This analysis not only allowed us to study the convergence of CEECs towards the euro area, but also to determine whether the proposed membership was still relevant or should be postponed. Relying on the ICAPM, our results show that the degree of financial integration of the CEECs vis-à-vis the euro area is not perfect, but increases after the bankruptcy of Lehman Brothers. This increase, however, must be interpreted with caution because it may be more a common movement of CEECs linked to the propagation of the shock of the financial crisis rather than a movement in each country. Moreover, it seems that Cyprus, Slovakia and Slovenia have successfully integrated the euro area, as opposed to Malta. In addition, the observation of financial integration and dynamic correlations of financial markets shows that significant differences exist between these two concepts: financial integration vis-à-vis the euro area can not be explained only by measuring the dynamic correlations of financial markets, others [macroeconomic] factors should be accounted for. Finally, our results show that membership of CEECs to the euro area seems premature because of problems they know about the exchange rate. Indeed, if the question of the exchange rate would be eliminated, it would deprive the CEECs of an important tool in order to facilitate the transition to the EMU and to facilitate the real catching vis-à-vis the European economies.

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Appendix

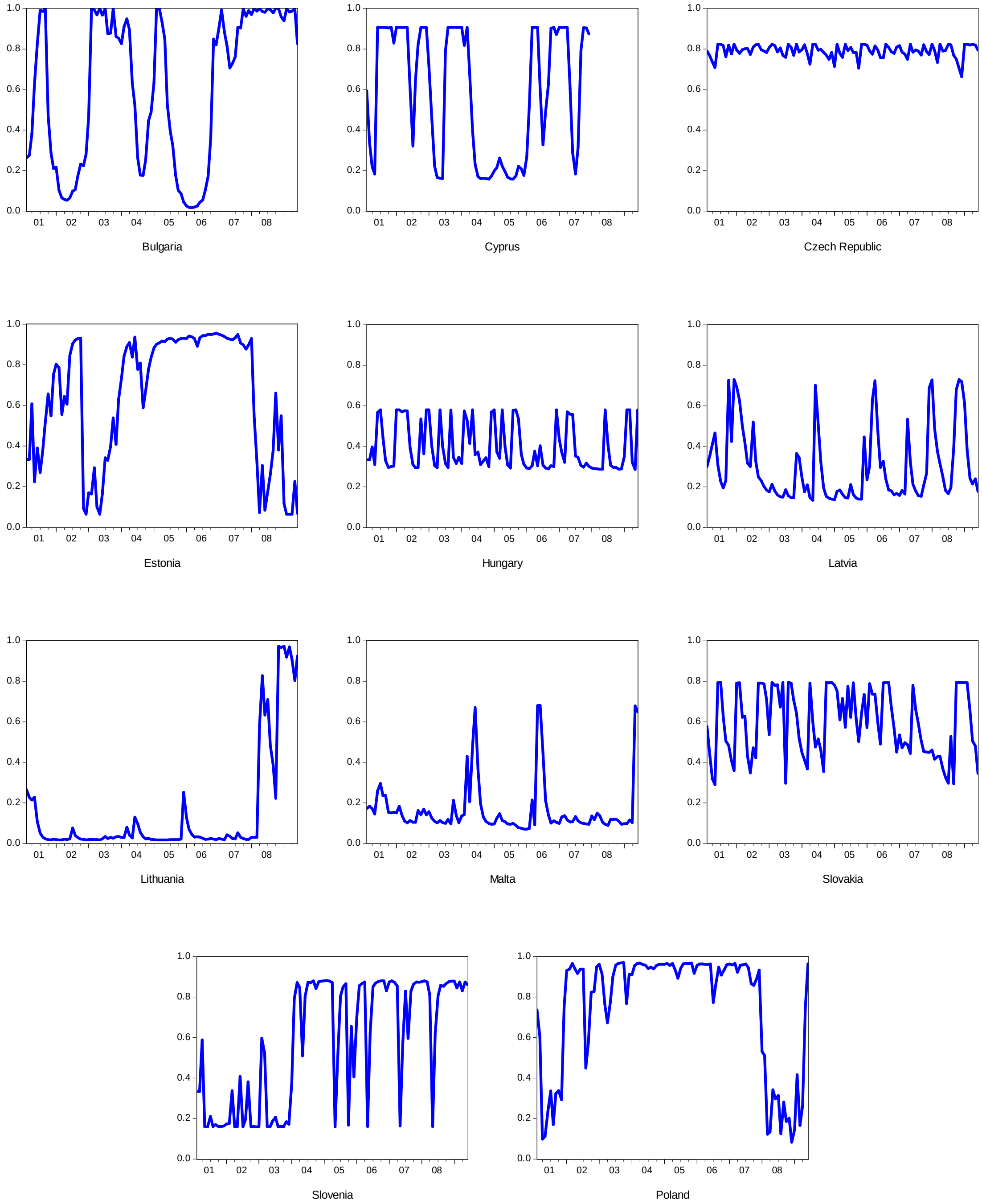
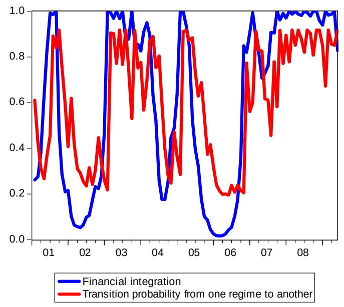


Figure A.1: the degree of financial integration between CEECs and euro area.



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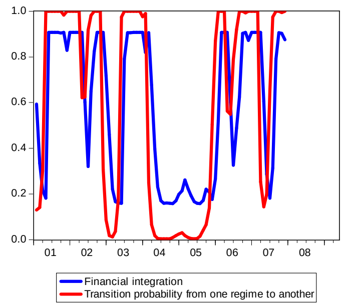

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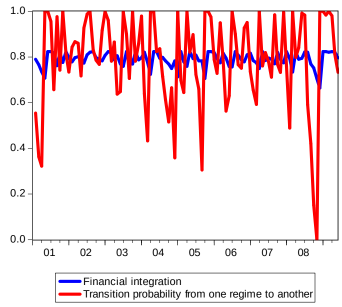

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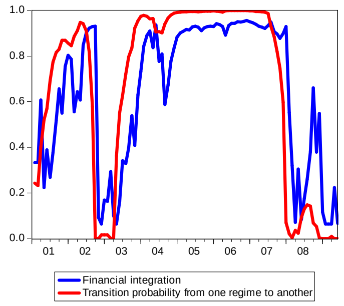

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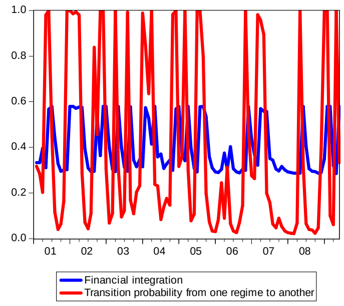

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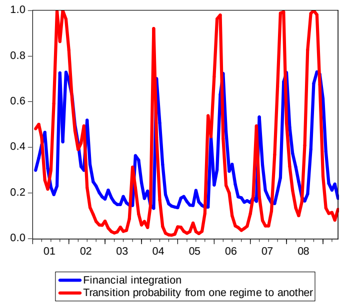

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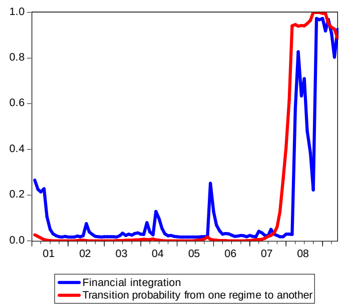

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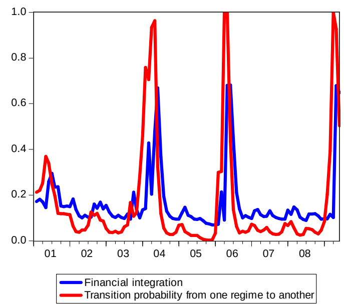

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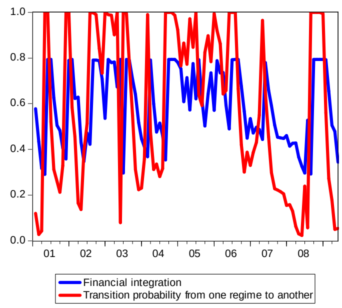

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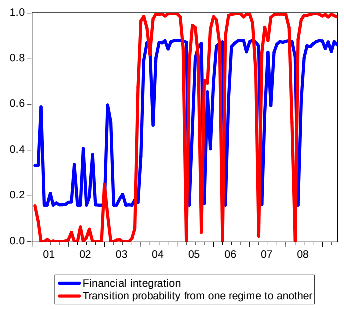

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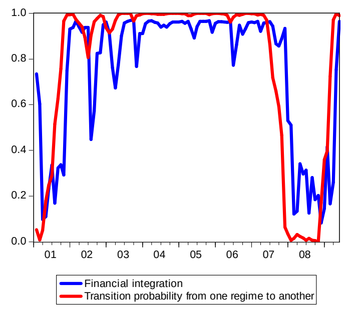
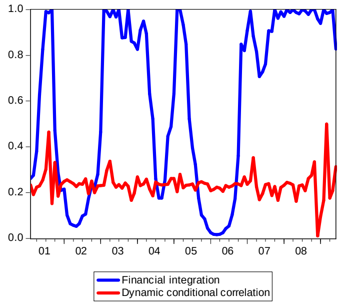
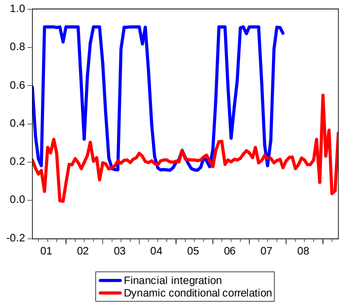


Poland

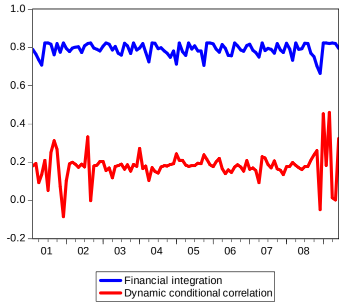
Figure A.2: financial integration and transition probabilities.



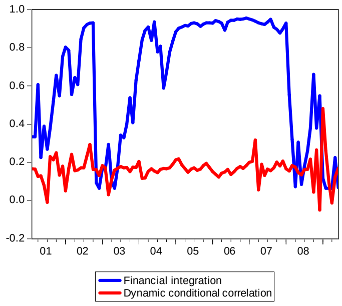
Bulgaria



Cyprus



Czech Republic



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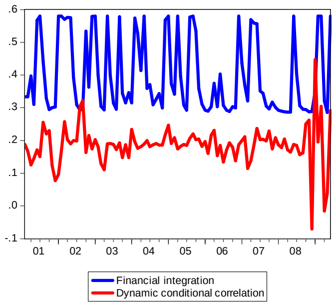
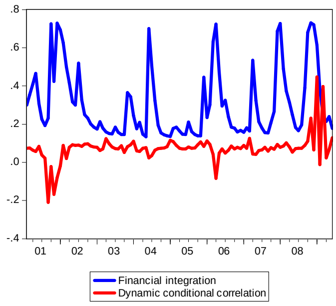
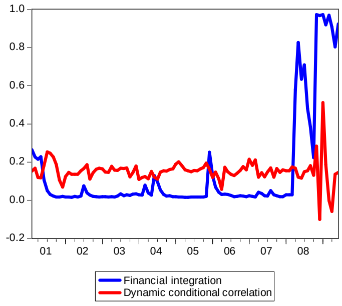


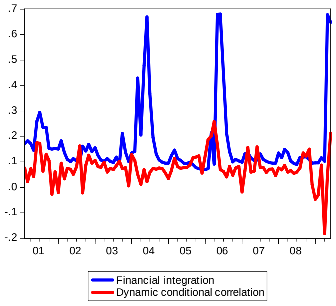
Hungary



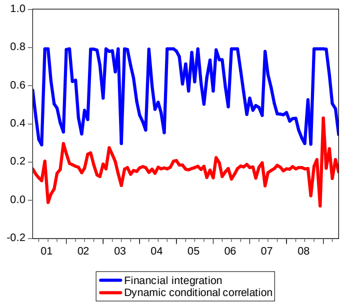
Latvia



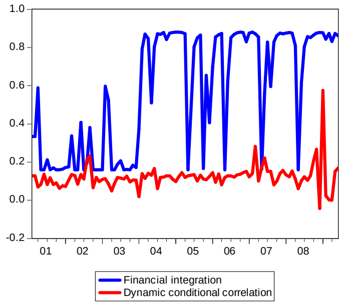
Lithuania



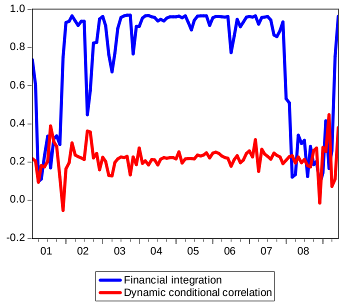
Malta



Slovakia



Slovenia



Poland

Figure A.3: financial integration and dynamic conditional correlation with the euro area.

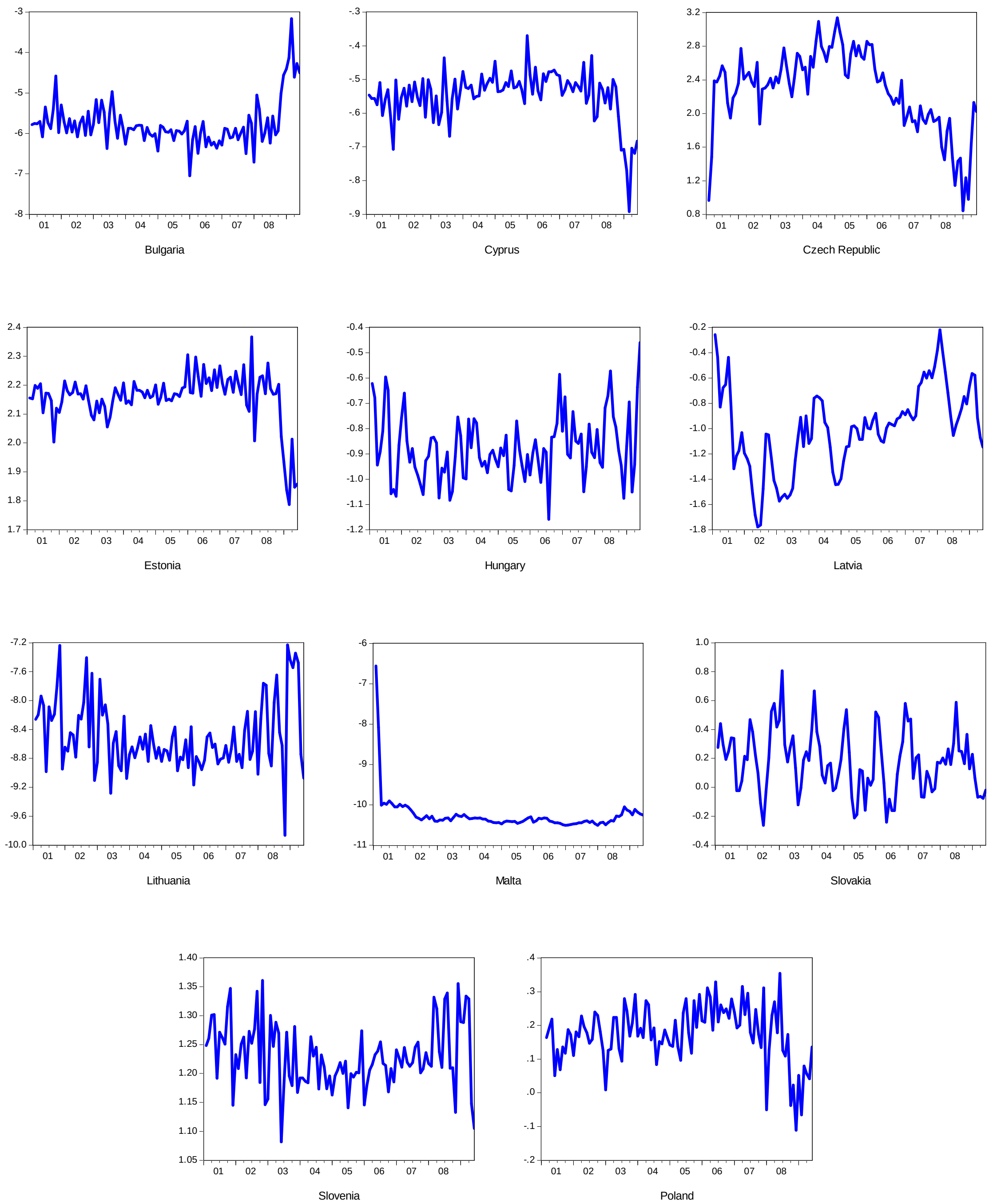


Figure A.4: price of currency risk of CEECs.

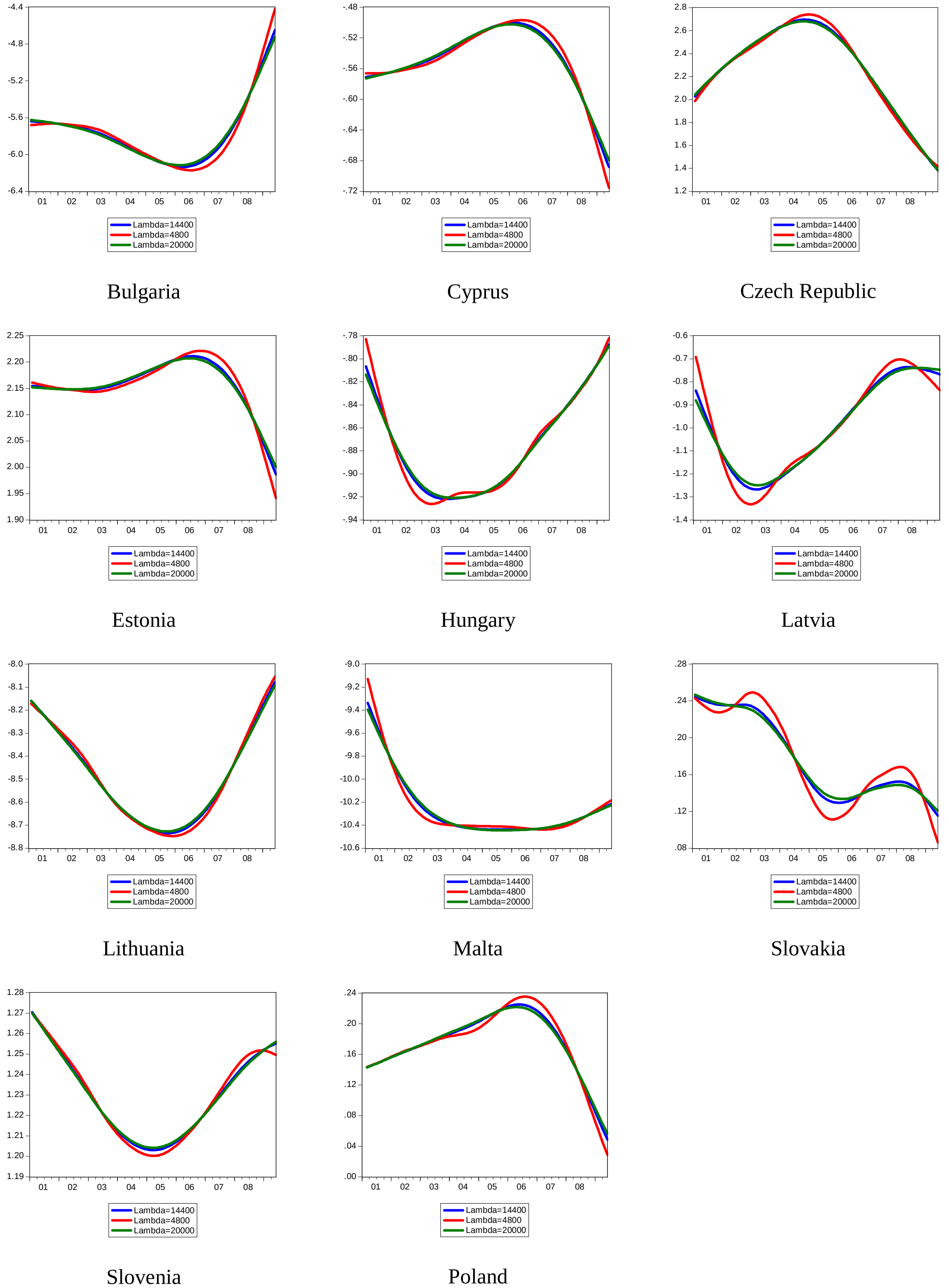


Figure A.5: trend of price of currency risk of CEECs[25].

[25] The Hodrick-Prescott filter (1997) is applied to the series of price of currency risk. The choice of smoothing parameter (λ) is important as stressed Agénor et al. (2000) and Rand and Tarp (2002). However, those authors

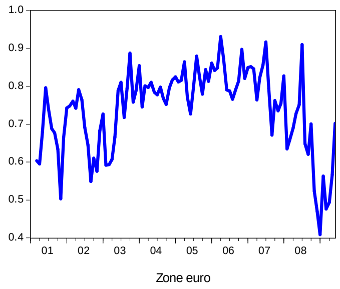


Figure A.6: price of European market risk.

discuss the choice of smoothing parameter for emerging countries such as the study of business cycles. Here, we do not study the business cycle. However, we calculate the trend of the price of currency risk by assigning different values to the smoothing parameter. Each figure contains estimates of trends from these parameters.

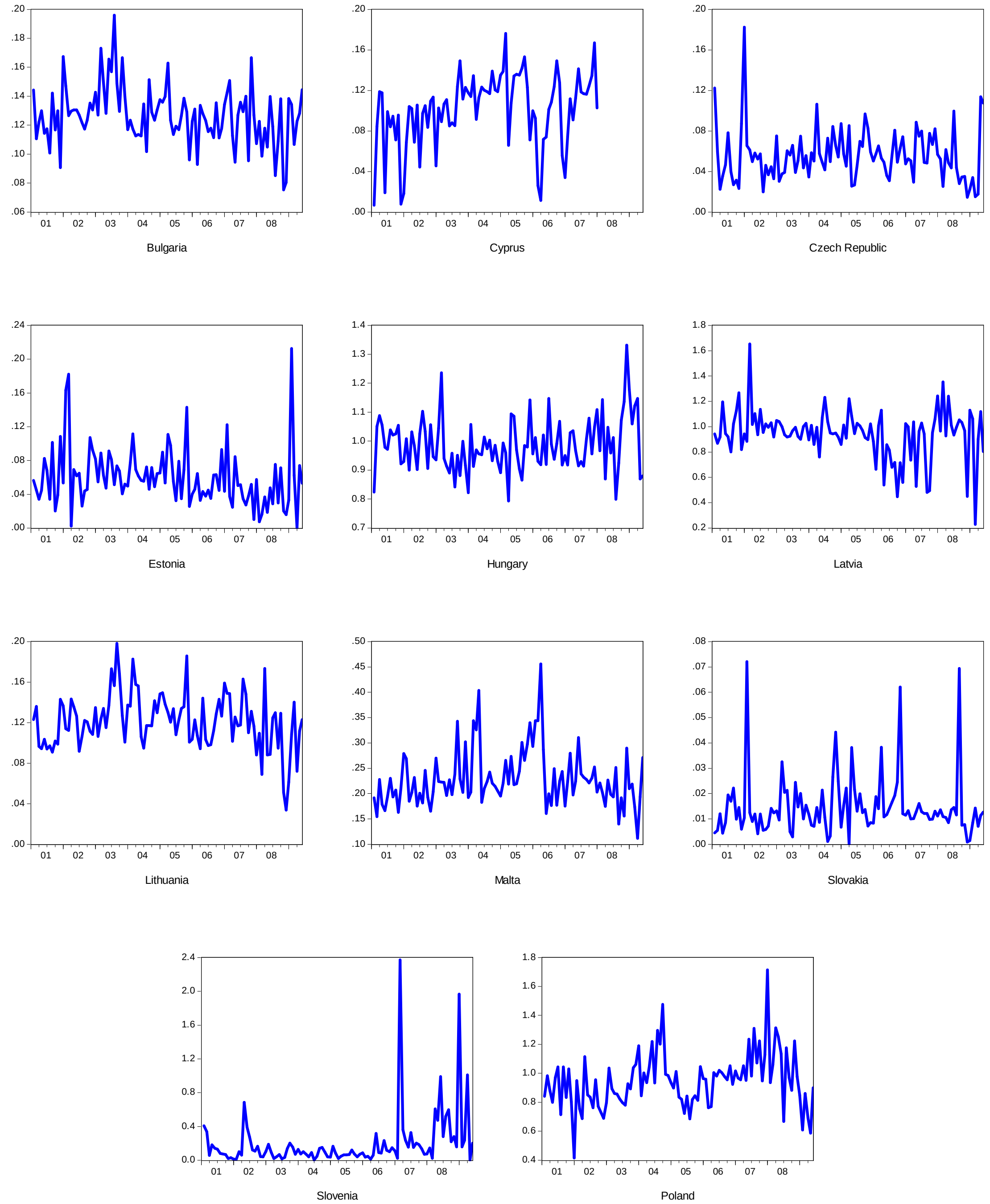


Figure A.7: price of local market risk.

Table A.1: distributional statistics

	Bulgaria	Cyprus	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Malta	Romania	Slovakia	Slovenia	Poland	Euro area
						Panel A: stock market returns							
Mean	0,022	-0,001	0,018	0,007	0,008	0,003	-0,002	-0,009	0,017	0,006	0,010	0,003	-0,003
Standard deviation	0,113	0,107	0,074	0,086	0,073	0,092	0,083	0,056	0,101	0,062	0,059	0,074	0,063
Skewness	-0,423	-0,112	-0,656	-0,904	-0,976	-0,249	-2,370	0,235	-0,433	-0,013	-0,812	-0,441	-0,778
Kurtosis	2,127	1,132	1,421	1,994	3,898	7,313	10,479	0,901	0,990	2,168	1,667	0,934	0,582
Box-Jenkins	28,281	21,286	17,464**	20,266**	10,729**	11,994**	37,230	32,351	19,956**	21,058**	55,214	10,584**	12,981**
						Panel B: local instrumental variables							
DRD	0.029	0.005	0.022	0.009	0.012	0.007	0.157	-0.007	0.022	0.008	0.012	0.007	-
DSHORT	0.001	-0.003	-0.902	0.001	0.003	0.036	0.002	-0.008	-0.007	-0.005	-0.019	-0.014	-
DPTERML	-0.113	0.037	0.048	0.039	0.188	-0.678	-0.211	0.085	-	0.105	0.165	0.096	-

Note: significant at 1% (***), 5% (**) and 10% (*) level.
DRD is the monthly variation of stock market returns, *DSHORT* is the monthly variation of the 1 month interest rate and *DPTERML* is the monthly variation of the local market term premium.

Table A.1 *bis*: distributional statistics

	Bulgaria	Cyprus	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Malta	Romania	Slovakia	Slovenia	Poland	Euro area
Panel C: international instrumental variables													
DRMDV	-	-	-	-	-	-	-	-	-	-	-	-	-0,032
DPTERM	-	-	-	-	-	-	-	-	-	-	-	-	-0,081
DSHORT	-	-	-	-	-	-	-	-	-	-	-	-	-0,014
DPDEF	-	-	-	-	-	-	-	-	-	-	-	-	-0,002
Panel D: instrumental variables of integration													
FSPREAD	0,012	0,009	0,003	0,020	0,031	0,013	0,014	0,007	-	0,009	0,014	0,022	-
SRD	0,003	0,012	-0,001	0,005	0,055	0,014	0,011	0,006	0,126	0,018	0,023	0,036	-
INFD	0,002	0,001	0,001	0,002	0,003	0,004	0,001	0,001	0,007	0,002	0,002	0,001	-
VTCR	0,002	0,000	0,003	0,002	0,003	0,001	0,001	-0,000	0,001	0,006	0,001	-0,001	-
DGDP	0,206	0,197	0,137	0,161	-0,012	0,323	0,013	0,391	0,145	0,315	0,089	0,208	-

DRMDV is the monthly change of dividend yields on the market portfolio in excess of European interest rates at 30 days, *DPTERM* is the monthly variation of a term premium, *DSHORT* is the monthly change of the short-term interest rate. *DPDEF* is the monthly change in the default premium. *FSPREAD* is the differential between interest rates of the European Central Bank and the local market, *INFD* is the differential inflation rate between the local market and the euro area, *SRD* is the differential between interest rates of the European Central Bank and the local market, *VTCR* is the monthly change of real exchange rate vis-à-vis the euro, *DGDP* is the variation of the real *GDP*.

Table A.2: price of currency risk

	Bulgaria	Cyprus	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Malta	Romania	Slovakia	Slovenia	Poland	Euro area
Panel A: estimation of the price of currency risk and price of euro area risk with the international information variables													
Constant	-5,944***	-0,522***	0,497***	2,169***	-0,522***	-0,128**	-8,716***	-5,061***	-0,075**	0,066**	1,203***	0,229***	-0,555***
DIV	-0,021	0,004	0,003	-0,002	0,003	-0,002	-0,062**	-0,003	0,001	0,002	-0,009***	0,002	0,011***
DTERM	-0,001**	0,000	0,000	0,000***	0,000	0,000	0,001	-0,000	-0,000	-0,000	0,000	0,000	0,000
DSHORT	-0,081***	0,010***	0,002	0,013**	-0,002	0,005*	-0,022	-0,005	0,009	0,003	-0,001	0,012**	0,010**
DEF	0,035	-0,007	0,005	0,003	0,006	-0,010**	-0,009	0,003	0,006	-0,014***	0,005	0,008	0,006
Panel B: residual analysis													
Jarque-Bera	11,06	0,16**	3,22**	195,30	0,58**	5,13**	22,94	5914,17	0,14**	1,98**	10,86***	4,31**	3,93**
Box-Jenkins	644,96	317,09	27,12**	200,40	16,77**	25,60**	1373,37	14,29**	25,00**	30,08**	488,78	23,07**	29,61**
White	22,50**	10,43**	41,71***	10,94**	36,03**	24,87**	9,23**	98,14	34,02**	38,07**	10,93**	27,90**	62,26
ARCH	37,92	63,02	0,95**	35,63	1,72**	7,55**	65,80	48,88	3,84**	4,23**	67,16	2,37**	0,84**
Wald	462,18**	120,10**	919,58**	410,42**	168,78**	613,08**	419,25**	560,25**	30,94**	20,27**	1137,26**	7,58**	-

Note: significant at 1% (***), 5% (**) and 10% (*) level.
DRMDV is the monthly change of dividend yields on the market portfolio in excess of European interest rates at 30 days, *DPTERM* is the monthly variation of a term premium, *DSHORT* is the monthly change of the short-term interest rate. *DPDEF* is the monthly change in the default premium. *FSPREAD* is the differential between interest rates of the European Central Bank and the local market, *INFD* is the differential inflation rate between the local market and the euro area, *SRD* is the differential between interest rates of the European Central Bank and the local market, *VTCR* is the monthly change of real exchange rate vis-à-vis the euro, *DGDP* is the variation of the real *GDP*.

Table A.3: transition probabilities and degree of financial integration

	Bulgaria	Cyprus	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Malta	Slovakia	Slovenia	Poland
					Transition probabilities						
$P(1,1)$	0,916***	0,907***	0,823***	0,958***	0,579***	0,729***	0,972***	0,681**	0,794***	0,888***	0,970***
$P(1,2)$	0,131	0,135***	0,663***	0,064	0,277**	0,116**	0,010	0,066	0,282**	0,159**	0,083
					Degree of financial integration						
Mean	0,608	0,584	0,790	0,643	0,398	0,305	0,148	0,166	0,594	0,576	0,749

Notes: significant at 1% (***), 5% (**) and 10% (*) level. $P(i, j)$ is the probability of transition from regime *i* to regime *j*.

Table A.4: contribution of each risk premium in the global risk premium

	Bulgaria	Cyprus	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Malta	Slovakia	Slovenia	Poland
					Standard deviation						
PRME	1.084	0.778	2.329	3.242	0.239	2.412	2.754	0.524	0.448	0.778	1.212
PRC	2.528	1.308	3.349	1.118	0.535	2.442	10.26	0.837	1.003	0.592	0.037
PRML	0.162	0.958	1.362	3.506	0.914	0.213	1.604	1.139	0.741	1.884	1.497
PRT	2.035	1.039	2.816	2.877	0.862	1.335	10.16	1.008	0.795	0.740	1.600

Note: *PRME*, *PRC*, *PRML* and *PRT* are, respectively, the price of European market risk, the price of currency risk, the price of local market risk and the price of total risk.