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Modeling the exchange rate using price levels and country risk

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Abstract: This paper builds two factor discrete time models in order to investigate the effect of sovereign risk on the nominal exchange rates in a Markov switching framework. The empirical section of the paper uses seven currencies from Chile, the Czech Republic, Hungary, Iceland, Japan, Korea, and Mexico. To measure the sovereign risk, we use the credit rating agencies' ratings classes as proxy variable. In the empirical part, four different versions of the model are calibrated and their in-sample and out-of-sample data will be analyzed leading to the conclusion that none of the four versions dominates the others. As an additional result, it is revealed that risk has significant effect on the nominal exchange rates.

Subjects: Econometrics; Economic Forecasting; International Economics; Macroeconomics; Public Finance

Keywords: exchange rate; multifactor model; ratings classes; Markov-switching model

JEL classifications: C15; C33; C53; F31

1. Introduction

In this paper, *evaluation of nominal exchange rates* is analyzed with a well-known class of models presented by Jarrow, Lando, and Turnbull (1997), Schönbucher (2002, 2003). In the study, the model of Abaffy, Betocchi, Dupacova, Moriggia, and Consigli (2007) is applied and upgraded. In their discrete-time model (similarly to this paper's one), the interest rate of the risky bond can be determined as the *sum of the risk-free interest rate* (r_t) and the ratings class depending risk premium (s_t^i). The original model as well as the other applications of these models is generally employed to analyze interest rates, so the main contribution of the paper is to apply such models to exchange rates.

The aim of this paper is to build a discrete time model framework in which the development of exchange rates can be followed and forecasted and to analyze sovereign risk's effect on nominal exchange rates. The empirical segment presents four calibrated versions of the model—the performance of these versions is analyzed and compared with in-sample and out-of-sample data.

ABOUT THE AUTHOR

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PUBLIC INTEREST STATEMENT

This paper presents a method to describe the relation between country ratings and exchange rates. Up to now, in the literature, only the effect of exchange rates to country risk has been introduced, but now a model is built to the other direction of this relationship: how does the change of country risk (shown by ratings of different agencies) influence the exchange rate. We receive through the example of seven countries that as a result of a higher risk, the currency depreciates.

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The paper is organized as follows. Section 2 summarizes the literature, Section 3 presents the model and the data, Section 4 calibrates the different versions of the model applying a panel regression, Section 5 measures the performance of the model's different versions, Section 6 presents a case study where the model is applied while Section 7 draws the conclusion.

2. Theory

Exchange rate models are widely discussed in the literature. Taylor and Taylor (2004) summarize the debate whether the PPP (*purchasing power parity*) holds, thus, the exchange rate of two currencies is the same as their price levels' ratio. This economic debate began early after the theory appeared more than a century ago. Unfortunately the data does not support PPP theory—at least in the short run. In the long run, Sarno and Taylor (2002) found some evidence, however the debate still remained contentious. Akram (2006) discovered that the purchasing power parity is invalid in case of significant shocks, although he found evidence that it holds between Norway and its trade partners in the medium run. Akram also analyzed why previous studies found no evidence to the PPP: he found its reason was either the shortness of time series, the overparametrization or the exclusive use of bilateral data. Betts and Devereux (2000) analyzed the changes in the exchange rates and found that pricing has a serious effect on the exchange rate's determination. They discovered that if a product's price is not determined according to the law of one price but rather by national segmentation. The PPP does not hold and the exchange rate's volatility increases according to a general equilibrium model. Our model also gives a possible explanation to the deviation from the PPP.

In the literature some papers can also be found that utilize *term structure models* to analyze exchange rate movements such as the work of Inci and Lu (2004) which applies 3 and 5 factor models to explain currency movements. Inci (2007) simultaneously modeled the exchange rate dynamics and the term structure of interest rates.

Sarno and Valentea (2005) summarized the *empirical exchange rate models* including a Markov-switching vector equilibrium correction model. Rossi (2013) summarized the literature of exchange rate's predictability; he obtained that exchange rates can be predicted only under some conditions. Engel (1994) and Cheung and Erlandsson (2005) found some evidence that *Markov-switching models* can be applied to forecast exchange rates. This paper extends the literature by building different kinds of Markov-switching models: the different states are given by the countries' ratings classes.

Few papers investigated the relation between *exchange rates and sovereign risk*—in spite of this problem's importance. Bordo, Meissner, and Weidenmier (2009) showed that depreciation in the exchange rate can increase sovereign risk of a country if it has to pay back its debts in foreign currency but receives its revenues in local currency. In this case, depreciation can increase the probability of a default, so the sovereign risk. Thus, they found that exchange rate was an important factor of this risk—in this paper, we approach this relation from the other side: we find that sovereign risk is an important factor of the exchange rate, as it could have been seen during the recent crisis in case of several currencies (e.g. Hungarian Forint, Icelandic Krona). Keblowski and Welfe (2010) emphasizes the importance of risk in the determination of exchange rates in his paper introducing a risk-driven approach to exchange-rate modeling and determining a Zloty/Euro equilibrium exchange rate. Groen and Balakrishnan (2006) estimated the risk premium for pound sterling exchange rate against the Australian Dollar applying a conditional factor model. Verschoor and Wolff (2001) investigated the risk premium in the Mexican Peso/US Dollar forward exchange rate and they detected large average risk premia varying in time.

3. Methodology and data

3.1. Methodology

Following Abaffy et al.'s (2007) model *exchange rate is divided into two parts*. Abaffy et al. (2007) prepared a model to risky interest rates, dividing them into two factors: risk-free interest rate and risk-dependent credit spread. Risk premium is caused by the chance of a possible default which would result in the investors loosing part of their invested amount. They modeled the transition among the different risk classes as a *Markov-chain* —we also utilize this method. They estimated six months and three years transition matrices—we will only apply monthly transition matrices as the monthly average exchange rate is modeled. The elements of the transition matrix will be q^*_{ij}, where $\sum_{j=1}^{n} q^*_{ij} = 1$ and $q^*_{ij} \geq 0$ for all i, j.

Denote the logarithm of the exchange rate at time t by e_t. Let f_t be the logarithm of the price levels' ratio at time t. Let r^i_t denote the risk-dependent factor for class i at time t. So the exchange rate's logarithm is: $e^i_t = f_t + r^i_t$. If a country is considered to be riskier than the other, its currency will be undervalued. The general *two-factor model* is the following:

$$e^i_{uu}(t+1) = f_u(t+1) + r^i_u(t+1) \text{ w.p. } p_{uu}$$
$$e^i_{ud}(t+1) = f_u(t+1) + r^i_d(t+1) \text{ w.p. } p_{ud}$$
$$e^i_{du}(t+1) = f_d(t+1) + r^i_u(t+1) \text{ w.p. } p_{du}$$
$$e^i_{dd}(t+1) = f_d(t+1) + r^i_d(t+1) \text{ w.p. } p_{dd}$$

where f_u means an up-move in the logarithm of price levels' ratio, f_d means a down-move in the logarithm of price levels' ratio, r^i_u means an up-move in the risk-dependent factor of class i, and r^i_d means a down-move in the risk-dependent factor of class i compared to period t. Of course a change in the ratings class is also allowed—it is modeled with a Markov-chain. Sum of the probabilities is 1, thus $p_{uu} + p_{uu} + p_{uu} + p_{uu} = 1$ within each ratings class.

What can be the effect of a *downgrading*? Empirically the effect cannot be determined unequivocally from the data. In the model, a downgrading has the effect that r^i_t changes to r^j_t. Under the assumption that the riskier currency's exchange rate is higher (so currency B becomes more expensive expressed in currency A if currency A becomes riskier) it means, that $r^i_t < r^j_t$, so the currency depreciates. But what happens to r^i_t and r^j_t? To this question no exact answer can be given. From one side these risk premia can decrease as a riskier country left the category i and a less risky country entered category j. But from the other side it can be the sign of general problems, which means that the riskiness of each currency of the class increases.

The *four different versions* of the model are the followings [(applying and extending the models introduced in Abaffy et al. (2007)]:

(1) A model where the size of up and down movements and their probability is the same in case of each given factor (but different for different factors). Factors are assumed to be independent.

(2) A model where the size of up and down movements and their probability can be different for each factor. Factors are assumed to be independent.

(3) A model where the size of up and down movements and their probability is the same in case of each given factor (but different for different factors). Factors are assumed to be correlated.

(4) A model where the size of up and down movements and their probability can be different for each factor. Factors are assumed to be correlated.

3.2. Data

In this paper only the Fitch agency's major *rating classes* are going to be considered (AAA, AA, A, BBB, BB, B, CCC—the worse states were added to the last class) for 64 countries. As different agencies' ratings move together, applying the ratings of other agencies would not make any significant difference at the results. Period of investigation for ratings was between January 2000 and March 2011. If the data of ratings begins later, data from this time were used. During the calculation of the one-month transition matrices, the first day of each month was considered as observation point, and the transition was analyzed between the first days of two consecutive months. This time period is long

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enough to build the model but perhaps it does not involve too many structural changes in the data. We must emphasize that country ratings do not express the riskiness of the country/currency but the risk perceived by the actors on the market. These ratings are decided not only by objective factors but also by subjective ones as the risk cannot be easily measured (see the example of defaulting assets with the best ratings at the beginning of the current economic crisis).

During the estimation and the simulation we considered the *currency* of seven countries. Countries and currencies are the following: Chile: Chilean Peso (CLP), Czech Republic: Koruna (CZK), Hungary: Forint (HUF), Iceland: Icelandic Krona (ISK), Japan: Yen (JPY), Korea, South: Won (KRW), Mexico: Mexican Peso (MXN). The currencies are from different parts of the world, so the model is applied not just for one region.

All currencies were compared to the US dollar and the monthly average exchange rate was taken from the OECD database.

To the *price level ratio*, the monthly consumer price indexes and the exchange rates were applied from the OECD database.

4. Estimation

We first calibrated the *transition matrix*. Table 1 contains the one-month transition matrix.

To determine the *initial difference* among ratings classes for the simulation, a general difference (a unified difference between each two consecutive ratings classes) was determined and used for each currency. It is needed as at the beginning only the risk-related term of the given rating class is known, no information is available about the other ratings classes, in which the given currency is not present at this time. This difference was calibrated using the following panel regression:

$$e_{it} = \alpha_0 + \alpha_1 p_{it} + \alpha_2 ra_{it}$$

where e_{it} is the logarithm of the currency i's exchange rate compared to the dollar at time t, p_{it} is the logarithm of the price levels' ratio for currency i at time t, and ra_{it} is the rating of currency i's country at time t. ra_{it} is a variable measured on an ordinal scale where 1 means the least risky rating (AAA), 2 means AA, and so on. Regression's results with fixed effects are shown in Table 2. It can be seen

Table 1. One-month transition matrix according to the Fitch agency's ratings

	AAA (%)	AA (%)	A (%)	BBB (%)	BB (%)	B (%)	CCC (%)
AAA (%)	99.84	0.16	0.00	0.00	0.00	0.00	0.00
AA (%)	0.08	99.51	0.41	0.00	0.00	0.00	0.00
A (%)	0.00	0.22	99.30	0.49	0.00	0.00	0.00
BBB (%)	0.00	0.00	0.43	99.00	0.57	0.00	0.00
BB (%)	0.00	0.00	0.00	0.92	98.67	0.41	0.00
B (%)	0.00	0.00	0.00	0.00	1.28	98.08	0.64
CCC (%)	0.00	0.00	0.00	0.00	0.00	28.57	71.43

Table 2. Results of the panel regression

	Coefficient	Standard error	*p*-value
Constant	3.4816	0.3764	0.0000
p	0.2223	0.0850	0.0091
ra	0.1100	0.0112	0.0000

that all variables are significant at a 5% level. Trend is not contained in the regression as the other factors of the simulation can contain it.

So, the initial difference between the neighboring ratings classes is 0.1100. We assumed that this difference is the same between each pair of neighboring classes. We could have also assumed that the difference is diverse at the ratings classes, but to such estimation much more data would have been necessary. The regression proved that the exchange rate of a currency against the dollar is higher if the currency is considered to be riskier.

Initial values of the variables do not need to be calibrated, as they are given or can easily be received. Five values before and after a ratings class change are omitted at the estimation in order to filter the effects of the change as they are already included in the regression. *Size of movements* are calibrated by taking the average of the appropriate logarithms' changes' absolute values. The calibrated values are given in Table 3 (models 1, 3, and the correlation) and Table 4 where p denotes the probability, thus, pf_{up} means the probability of an up-move in the price-level ratio.

Table 3. Estimation of the first and third models' parameters

	CLP	CZK	HUF	ISK	JPY	KRW	MXN
f	0.0035	0.0042	0.0045	0.0053	0.0040	0.0035	0.0044
r	0.0206	0.0272	0.0274	0.0283	0.0192	0.0181	0.0160
Correlation	−0.4058	0.1480	−0.8825	0.2555	−0.1603	−0.0431	0.6048

Table 4. Estimation of the second model's parameters

	CLP	CZK	HUF	ISK	JPY	KRW	MXN
f_{up}	0.0059	0.0071	0.0079	0.0059	0.0025	0.0052	0.0077
f_{down}	0.0020	0.0025	0.0002	0.0029	0.0046	0.0022	0.0016
r_{up}	0.0241	0.0240	0.0162	0.0319	0.0156	0.0395	0.0342
r_{down}	0.0177	0.0303	0.0310	0.0221	0.0246	0.0087	0.0082
pf_{up}	0.3333	0.2601	0.3252	0.5631	0.3414	0.3821	0.3717
pr_{up}	0.4103	0.4471	0.5041	0.3883	0.6098	0.1789	0.2212

Table 5. Results of the simulations for the standard deviation

	CLP	CZK	HUF	ISK	JPY	KRW	MXN	Error	Ranking
Real	0.1241	0.2766	0.1688	0.2425	0.1139	0.1169	0.1142		
Model 1	0.1048	0.1457	0.1419	0.1352	0.0918	0.1019	0.0932	0.0044	3
Model 2	0.1082	0.2607	0.2096	0.1298	0.1192	0.1099	0.1528	0.0023	1
Model 3	0.1079	0.1409	0.1453	0.1329	0.0936	0.1009	0.0934	0.0046	4
Model 4	0.1071	0.2576	0.2070	0.1271	0.1167	0.1040	0.1454	0.0024	2

Table 6. Results of the simulations for the last value (February 2011)

	CLP	CZK	HUF	ISK	JPY	KRW	MXN	Error	Ranking
Real	6.1692	2.8770	5.2890	4.7582	4.4132	7.0190	2.4904		
Model 1	6.2999	3.5961	5.5690	4.2864	4.6710	7.0605	2.2565	0.1369	4
Model 2	6.3203	2.7975	4.9293	4.4319	4.3826	7.1491	2.6485	0.0440	1
Model 3	6.3046	3.6053	5.5619	4.3247	4.6884	7.0824	2.2529	0.1353	3
Model 4	6.4168	3.0367	5.1504	4.4113	4.3813	7.3591	2.9917	0.0849	2

Tables contained the values with five digits accuracy, but during simulation the 10 digits values were used.

5. The simulation's results

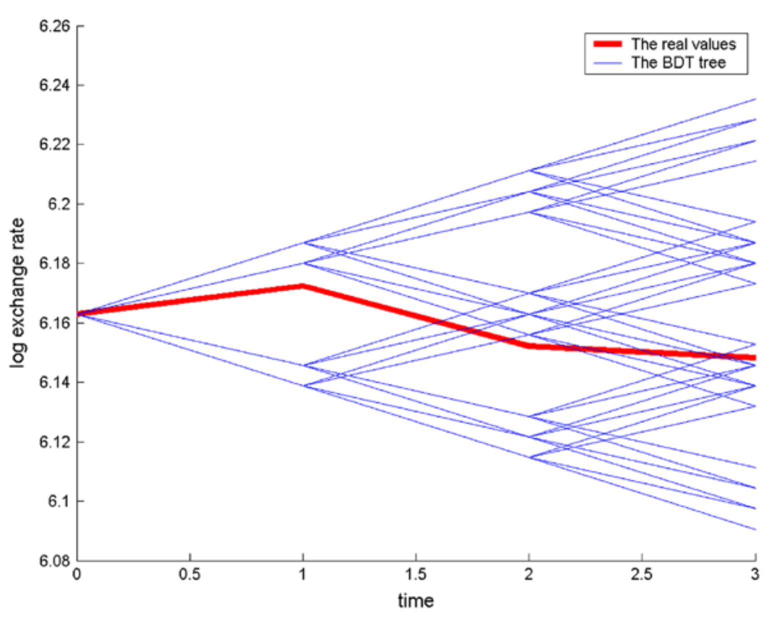
First a simulation for the base period (from January 2000 to February 2011) was prepared in order to check the *in-sample* performance of the model versions. During the simulations the initial values and ratings were given. Evolution of ratings is according to the transition matrix calculated by the data of the Fitch agency. A total of 1,000 simulations were prepared for each currency with each model version. After each simulation the standard deviation of the exchange rate's logarithm was calculated. Having the simulations done, the average of the standard deviations and the final values (the values received by the simulation to February 2011) was taken. Table 5 shows the simulations' results and the real values for the standard deviation. The last two columns contain the average of the difference's square from the real value and the ranking order of the model's different versions. Table 6 shows the simulations' results and the real values for the exchange rate's logarithm in February 2011. It also contains the errors and the ranking.

Considering the *standard deviations*, the first version of the model always underestimates the empirical value. The standard deviations of the first and third and the second and fourth versions are very similar. We can find enormous underestimations for the standard deviation of the Icelandic Krona but it is not at all surprising as this currency's ratings class fell three times and such values are taken out of the sample, and the probability of such a change in the transition matrix is very low. According to the standard deviation the second and the fourth models performed very well.

Considering the *final values* there were no versions of the model that would have given a higher or lower value for each currency compared to the real one. Each model estimated a higher final value than the real one for the Chilean Peso and the estimates of the models fell below the real value in case of the Icelandic Krona—the latter can be explained by the rating changes that are not contained ex ante in the ratings used by the model and it shows that a worse rating truly means a higher exchange rate. The same can be observed at the Korean Won but in the opposite direction: the initial ratings class A changed to AA and the final value was overestimated as the effects of the class change were filtered.

From the *final values'* point of view, the ranking order is almost the same at the standard deviations. The second and the fourth versions showed the best performance while the first was the worst.

Figure 1. BDT tree for the Chilean Peso with the first model.



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The first and the third versions as well as the second and fourth ones bore similar results, but in the latter pair the difference was greater. Altogether the second and fourth versions showed the best performance according to the comparison with in-sample data but it cannot be clearly declared that any of the model's versions would give better performance than the others. From the in-sample analysis, we also obtained that ratings class changes has an effect on the exchange rate.

The data up to February 2011 were used for the estimation, therefore, the values of the *next month's* can be used to test the model—according to our estimates, we prepared to the period between March 2011 and May 2011. Initial values were those of 2011 February. At the construction of the BDT trees, we assumed that there is no change in the rating classes. Figure 1 shows the BDT tree prepared using the first model for the Chilean Peso as an example. According to the model there are four possible steps from each node. After the second movement some of these ways arrived at the same node as the order of the movements is not important, so a first up and after down movement has the same result as a first down and after up movement. The up and down movements have the same size at this version of the model. Of course at the model it is not expected to get back the real values as a forecast but it can be expected that the result should not be far from the average and it should follow approximately one of the possible paths. The model performed well, the exchange rates logarithms remained between the minimum and the maximum of the possible values and almost followed one of the possible paths.

We also prepared simulations for the *logarithm of the exchange rate's for May 2011* in order to compare the different versions of the model. We prepared 10,000 simulations with each version and for each currency, while this time also allows the change among the ratings classes. Table 7 shows the average of the estimated values for May 2011 as well as the real values. Considering the *average*

Table 7. Average of the simulated values for May 2011

	CLP	CZK	HUF	ISK	JPY	KRW	MXN	Error	Ranking
Real	*6.1482*	*2.8345*	*5.2282*	*4.7406*	*4.3955*	*6.9886*	*2.4556*		
Model 1	6.1645	2.8780	5.2920	4.7609	4.4152	7.0211	2.4928	7.65×10^{-6}	1
Model 2	6.1645	2.8602	5.2770	4.7637	4.4087	7.0218	2.5023	9.26×10^{-5}	4
Model 3	6.1642	2.8786	5.2922	4.7605	4.4145	7.0209	2.4932	8.03×10^{-6}	2
Model 4	6.1649	2.8600	5.2781	4.7642	4.4081	7.0224	2.5022	9.13×10^{-5}	3

Table 8. Minimum of the simulated values for May 2011

	CLP	CZK	HUF	ISK	JPY	KRW	MXN
Real	*6.1482*	*2.8345*	*5.2282*	*4.7406*	*4.3955*	*6.9886*	*2.4556*
Model 1	5.9944	2.6813	5.0852	4.5492	4.2417	6.8581	2.3208
Model 2	5.9939	2.6686	5.0869	4.5748	4.2559	6.8764	2.3525
Model 3	6.0288	2.6813	5.0852	4.5054	4.2417	6.8511	2.3296
Model 4	5.9880	2.6616	5.0992	4.5621	4.2611	6.8653	2.3337

Table 9. Maximum of the simulated values for May 2011

	CLP	CZK	HUF	ISK	JPY	KRW	MXN
Real	*6.1482*	*2.8345*	*5.2282*	*4.7406*	*4.3955*	*6.9886*	*2.4556*
Model 1	6.3470	3.0828	5.4978	4.9721	4.6669	7.2631	2.7669
Model 2	6.3646	3.0627	5.4665	4.9849	4.5792	7.2426	2.7201
Model 3	6.3470	3.0828	5.4978	4.9721	4.5944	7.1885	2.7172
Model 4	6.3468	3.0718	5.4856	4.9813	4.5839	7.2158	2.7544

of the error's square, the first and the third versions showed the best performance—but these differences are small. Altogether the average error of the estimations is low.

Table 8 shows the *minimum values* of the 10,000 simulations while Table 9 shows the *maximum values*. In each case, the real values remained between these two values. At the first glance the difference between the minimum and the maximum can seem quite large, but as transitions among ratings classes were allowed, and we were left with no ex ante information whether the given currency's country will be downgraded or upgraded, the difference did not seem high at all.

Altogether during the forecasts, all versions of the model performed well and it could not be unequivocally declared that one of the models is better than the others.

In this section, the different versions of the model were tested according to their in-sample (reproduction of standard deviation and last value) and out-of-sample (minimum, maximum, and average of forecasts) performance. It was shown that the model performs well although it could reach a good performance only if the ratings classes were considered too. Thus, a random walk or a model without country risk was not enough to model the evaluation of exchange rates, inclusion of the Markov-switching part (country risk) was also necessary. However, there is no significant difference among the different versions.

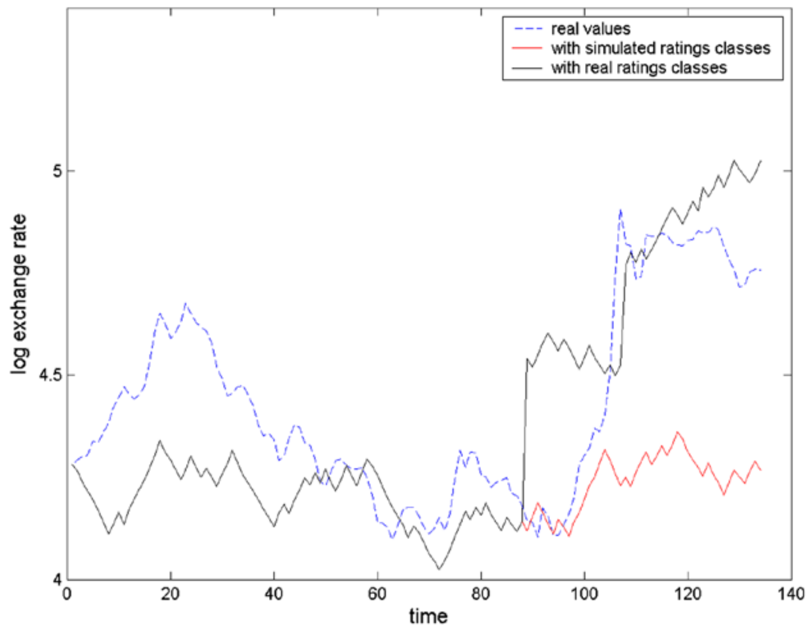
6. A special case: the Icelandic Krona

In case of the *Icelandic Krona*, we found that the different models *underestimated* the final value and the standard deviation. It is due to the three changes in the rating classes, the probability of which is very low in case of the empirical transition matrix. Thus, it supports one of the paper's conclusion that *risk has an effect on the exchange rate*. We now present Iceland's case as a case study and analysis whether this framework can be applied.

Why did it happen? As Jackson (2010) and Carey (2009) wrote, Iceland was extremely strongly hit by the *financial crisis*. Before the crisis in Iceland consumption was very high and a lot of credit was taken. Iceland's three main banks followed an expansionary policy which resulted high risk taking. After the collapse of the Lehman Brothers everyone reassessed the risks of the world which resulted in the collapse of the Icelandic banks, and the national bank had to increase the base rate in order to prevent the collapse of the currency. Iceland had to request credit from the IMF. Vaiman, Sigurjonsson, and Davidsson (2010) found the cause of Iceland's problems in the corruption and in the unethical decisions. So, the *downgrading* from AA to BBB can be explained by the effects of the global financial crisis. Fridriksson (2008) states that the problems of Icelandic Banks were already clear in 2005: high risk taking and strong expansion were known, thus the problems must have emerged earlier—as the downgrading from AAA to AA shows. Buiter and Siber (2008) stated that the business model of Iceland was not viable: Iceland had much debt in foreign currencies, so the authors proposed entering the euro-zone or letting its banks work only in countries that are in the euro-zone. They also found that the foreign exchange reserves of Iceland was not enough, although they were relatively high compared to other countries.

So, what happens if we used the real ratings classes of Iceland as input in our models? If this type of *simulation gives better results*, we can conclude that our model works well and the risk premiums are well calibrated. We made the simulation with the real ratings classes using the fourth model. The average of the standard deviations was 0.2220 and the average of the final values was 4.7618. The empirical values were 0.2425 and 4.7582, so the model performed well. Figure 2 shows a possible realization of the simulation with both real and calculated ratings classes. The shocks visible among the results of the simulation are the same regardless using empirical or simulated ratings classes, therefore, the two simulated time series have the same values for the first 87 months during which the empirical and the simulated ratings classes were both AAA.

Figure 2. Simulation for Icelandic Krona with and without empirical ratings classes and the real values.



7. Conclusion

In this paper, we modeled the evolution of the *nominal exchange rates* using two factor models which apply the Black–Demarn–Toy tree, thus we used binomial trees for each factor. The applied models were Markov-switching models where the different states of the Markov chain were the ratings classes of the countries. We used the data of seven currencies to the empirical part of the research.

This paper had two purposes. The first one was to explore whether sovereign risk has an effect on exchange rates. As an answer to this question we concluded that sovereign risk (or its proxy variable, the ratings class) has a significant effect on the exchange rate, so should a country be considered riskier, its currency is expected to depreciate. This effect was the most spectacular in the case of Iceland—the ratings class of which became BBB from AAA, suffering a serious downgrade. Simultaneously the Icelandic Krona also depreciated. Thus, through some examples it was presented that a Markov-switching model with country ratings for exchange rates *performs better than a random walk*.

The other aim of the paper was to test the different versions of the model and to test whether this model framework can be applied to exchange rates. It turned out that the model framework can be applied to exchange rates, the different versions of the model could be useful tools for the analysis, but there are no versions that could be declared best.

A main advantage of our model is its simplicity compared to some other models in the literature. Up to now in the literature there were some Markov-switching models for exchange rates, however, they did not consider the country risk. Our model performed well for monthly exchange rate and for ratings classes, but as further research it could be also tested with other risk measures or frequency. A weakness of this type of model can be the timing: change of ratings classes does not surely happen at the same time as the change of risk.

The effects of the different exchange rate regimes on the rate itself in this model framework could be considered as a potential subject for further research, along with the exchange rates' and ratings classes' effects on the exchange rate regime.

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