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Abstract

The aim of the article is to examine the degree of the long-run interest rate convergence in the context of Poland's joining the EMU. In this perspective, it is frequently argued that the expectations of Poland's participation in the EMU should manifest themselves in long-run interest rate convergence. This should be visible in the long-run fall of interest rate risk premium in Poland. In contrast, the paper raises the question of the actual speed of such convergence and questions the existence of this phenomenon in Poland. Confirmation of the hypothesis concerning slow convergence in the risk premium is essential to the analysis of costs of the Polish accession to the EMU. The main hypothesis of the article is verified using a Vector Error-Correction Mechanism model of an Uncovered Interest Rate Parity and several parametric hypotheses concerning the speed and asymmetry of adjustment.

Keywords:
empirical analysis, Eurozone, interest rate convergence, monetary union

JEL:
E43, E52, E58, F41, F42, C32

1. Introduction

It is frequently argued that the expectations of country's participation in the monetary union (e.g. European Monetary Union, EMU) should manifest themselves in long-run interest rate convergence. According to the theory, a successful integration of the accession country ought to be reflected in the stability of the converging country's financial system. This should be visible in many areas - converging inflation, converging interest rates, and diminishing exchange rate risk premium over the corresponding variables in a common currency area. If the risk premium is still positive or negative, but fluctuates with low or diminishing variance that might be treated as an argument in favor of economic integration. However, the recent euro zone crisis has pushed the exchange rate premium in the EMU countries back to their pre-accession levels. During this time the markets have learned to differentiate assets of the EMU countries denominated in euro. In this paper we want to assess the influence of the crisis on the risk premium on polish zloty as compared to euro.

The paper raises the question of the actual speed of risk premium convergence in the case of Poland. The main hypothesis states that the risk premium convergence is slow but stable risk premium might be interpreted in favor of Poland's accession to the EMU. That would also suggest the high level of monetary integration between Poland and EMU. The main hypothesis of the paper is verified using cointegration testing of nominal interest rates and exchange rates in Poland and the EMU. Based on the results of cointegration testing a Vector Error Correction Mechanism (VECM) model is constructed showing a steady state interest rate parity cointegration equilibrium. The model is then used to test several parametric hypotheses concerning the speed and asymmetry of adjustment between interest rates in Poland and EMU that allow determining the risk premium in the domestic economy over the other currency area.

The first part of the article describes the empirical strategy and parametric hypotheses that are verified using the VECM model. The second part presents the results concerning historical relationships between interest rates in Poland and the EMU. The article concludes with a discussion of policy implications of the results in the context of Poland's joining the Eurozone. The research shown in this paper is an attempt to complement the existing state of the art in the field of economic research on the benefits and costs of Poland's adoption of the euro.

2. Empirical methodology and specification

The fundamental argument of target zone models (Krugman, 1979) is that a temporary deviation of domestic from foreign interest rates is possible only if the target zone is credible in its desire to target primarily domestic shocks. Hence, interest rates may diverge persistently from the equilibrium of the uncovered interest rate parity under a flexible exchange rate regime only if the domestic policies of upholding the floating exchange rate are credible. Therefore the size and the length of the deviation from the parity can be used to measure the degree of risk premium in the domestic economy over international interest rates. Considering the Polish case it is expected that this premium is positive, but it is exhibiting a negative trend due to the expectations of Poland's joining the EMU. In other words, this diminishing risk premium can be thought of as nominal interest rate convergence mechanism.

Both of these assertions (positive exchange risk premium and interest rate convergence) are testable empirically. To this end it is possible to employ cointegration testing between interest rates in both areas and the exchange rate between them. This is allowed for by the fact that all of the time series are I(1) which was confirmed by results of KPSS unit root test, shown in Table 2.

In the case of variables which are integrated of the same order it is possible to investigate the existence of a long-run relationship, which relates to the macroeconomic concept of a steady-state dynamic equilibrium. This can be determined in the data using tests for the existence of a cointegrating vector for the interest rates. Based on this assumption, the PLN/EUR exchange rate and the 3-month WIBOR and EURIBOR interest rates are used during the period starting from April the 1st 2000 to April 1st 2013 (after the floatation of zloty and joining the EU by Poland) with daily frequency. Figure 1 plots the three variables.

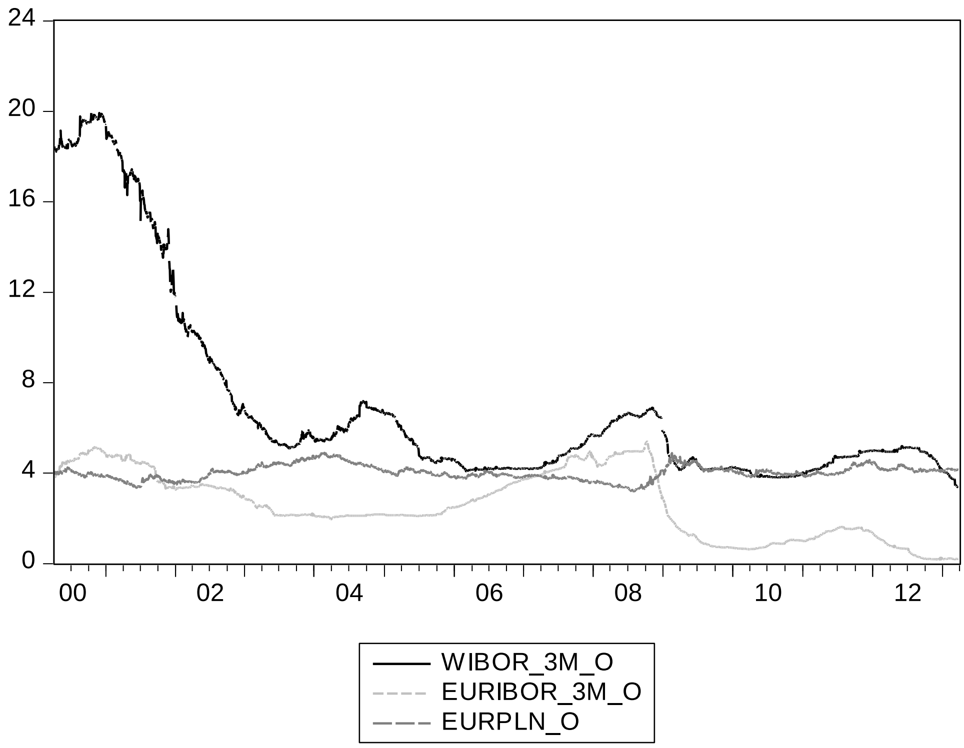

Figure 1. Three month WIBOR and EURIBOR interest rates and the PLN/EUR exchange rate
Source: Own calculations.

The empirical model follows Reade, Volz (2010), Goczek, Mycielska (2013). Let us consider three time series for domestic and international interest rates and the exchange rate that form a trivariate data vector X_t given by:

$$\mathbf{X}_t = \begin{pmatrix} r \\ r^* \\ d \end{pmatrix}_t \tag{1}$$

The domestic interbank interest rate (WIBOR_3M) is denoted by r_t, the international interbank interest rate (EURIBOR_3M) is denoted by r_t*, the exchange rate(EURPLN) is denoted by d_t*. The three variables are used to form a Vector Autoregressive (VAR) model described by the following equation:

$$\mathbf{X}_t = \Pi_0 + \Pi_1 t + \sum_{i=1}^{K} \Pi_i \mathbf{X}_{t-1} + \mathbf{u}_t \tag{2}$$

where the error term $\mathbf{u}_t \in N(0,\sigma^2)$ is uncorrelated over *t*, the data vector $\mathbf{X}_t$ is $p \times T$ dimension, Π_i is the deterministic coefficient matrix (constant and trend) of a dimension $p \times p$. If the data are non-stationary in levels and stationary in first differences, then the equation (2) can be rearranged to form a vector error correction mechanism:

$$\Delta\mathbf{X}_t = \Pi^* \mathbf{X}^*_{t-1} + \sum_{i=1}^{K-1} \Gamma_i \Delta\mathbf{X}_{t-i} + \mathbf{u}_t \tag{3}$$

where:

$\mathbf{X}^*_{t-1} = (\mathbf{X}_{t-1}, 1, t)'$, $\Pi^* = (\Pi, \Pi_0, \Pi_1)$, $\Pi = \sum_{i=1}^{K} \Pi_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{K} \Pi_j$.

For the ease of exposition, the coefficients for the lagged regressors and the deterministic terms were grouped together which is similar to taking of this problem in most econometric packages. Under the assumption that $\mathbf{X}_t \sim \mathrm{I}(1)$ and $\mathbf{u}_t \sim \mathrm{I}(0)$, the matrix Π is of reduced rank for the equation (3) to be balanced. If Π is of reduced rank, then there exists $p \times r$ matrices α and β such that $\Pi = \alpha\beta'$ and the equation (3) can be transformed to:

$$\Delta\mathbf{X}_t = \alpha\beta' \mathbf{X}^*_{t-1} + \sum_{i=1}^{K-1} \Gamma_i \Delta\mathbf{X}_{t-i} + \mathbf{u}_t . \tag{4}$$

The term $\beta' \mathbf{X}^*_{t-1}$ is the cointegrating vector showing the steady state relationship between the interest rates. In the context of interest rates those are linear combinations, which themselves are non-stationary, but the relationship between them is stationary with a steady state cointegrating vector forming uncovered interest rate parity.

If the matrix Π is of rank one, this means that a single cointegrating vector exists, and β' is $1 \times p$ +2 (constant and trend in the cointegrating relationship). Then the cointegrating relation can be rewritten to be:

$$\beta' \mathbf{X}^*_{t-1} = (\beta_0, \beta_1, \beta_2, \beta_3, \beta_4) \begin{pmatrix} 1 \\ t \\ r_t \\ r^*_t \\ d_t \end{pmatrix} = \beta_0 + \beta_1 t + \beta_2 r_t + \beta_3 r^*_t + \beta_4 d_t \tag{5}$$

If it is found during the empirical analysis of the two interest rates, that the rank is indeed one, this means that there exists a single cointegration vector - a single steady state relationship. This is an indication of upholding of the uncovered interest rates in the two currency areas. However, it could be argued that this relationship does not have bilateral causality or feedback properties. From a theoretical viewpoint it is very probable that the Poland's target zone is not credible enough for domestic interest rate deviation from international rates to hold over prolonged periods, since the Polish economy is financially and economically integrated with the Eurozone. In contrast, an inverse relationship is quite unlikely to hold - it seems impossible that the Polish interest rates influence the currency area orders of enormity larger than the Polish economy.

The properties of these relationships can be then verified using parametric test concerning coefficients from the matrix α. The statistical significance and the sign of the α coefficients indicate how a given interest rate reacts to a disequilibrium from the cointegrating vector. In the analyzed case it is therefore expected that the WIBOR rate changes towards the steady state relation with the EURIBOR and not the other way around. This is testable through the hypothesis that the adjustment coefficient is insignificant in the EURORIBOR equation and significant in the WIBOR equation.

It is expected that the interbank market in the smaller economy is going to exhibit a higher risk premium. This is modeled using the intercept and trend in the cointegrating equation. A formal test concerning the sign and significance of this coefficient allows this hypothesis to be tested in the date. At the same time it could be argued that because of the expected Poland's entry to the EMU and the intensifying financial integration of Poland into European capital markets since the early 1990s, this premium is expected to fall. This should be seen in the long run convergence of the two interest rates. This phenomenon can be measured using linear trend term coefficient in the cointegrating equation.

Summing up the discussion - the parametric hypotheses can be reduced to the following list:

1. H_0: Π is of rank one - *there exists a long run steady-state relationship between the interest rates in Poland and the Eurozone*.
2. H_0: $\beta_0 \leq 0$ - *test of the existence of a positive risk premium in Poland.*
3. H_0: $\beta_1 = 0$ - *no long-run convergence in risk premium between the two areas.*

Empirical results follow in the next chapter.

2. Empirical model results

The empirical analysis started with Granger Causality testing in order to determine the casual relations visible in the data. Based on the results, presented in Table 2, it was concluded that there exists a casual relationship between the three variables of interest, WIBOR, EURIBOR and EURPLN. Based on these preliminary results it can be hypothesized that WIBOR and EURIBOR exhibit a positive feedback relationship while the exchange rate is influenced by WIBOR only and that EURIBOR is an exogenous variable that impacts WIBOR in the Granger sense, while other variables do not exhibit causality in Granger sense on EURIBOR. These empirical relations point toward uncovered interest rate relationship between larger and smaller open economies.

Table 1. Pairwise Granger Causality Tests (Lags 30)

Null Hypothesis:	Obs	F-Statistic	Prob.
EURIBOR_3M_O does not Granger Cause WIBOR_3M_O	1491	3.64744	2.E-10
WIBOR_3M_O does not Granger Cause EURIBOR_3M_O		3.55969	4.E-10
EURPLN_O does not Granger Cause WIBOR_3M_O	1535	0.90925	0.6083
WIBOR_3M_O does not Granger Cause EURPLN_O		1.82613	0.0043
EURPLN_O does not Granger Cause EURIBOR_3M_O	2613	1.31055	0.1207
EURIBOR_3M_O does not Granger Cause EURPLN_O		0.76898	0.8115

Source: Own calculations.

As a second step, Unit Roots tests were run to check the stationarity of the time series in the trivariate data sample. Kwiatkowski et al. (1992) KPSS Unit Root test was used to determine the existence of unit roots so the order of integration of the investigated time series could be selected. This test was used as a more robust alternative to the more common ADF test. It was determined that all of the investigated series are integrated of order one, though WIBOR was a borderline I(2) process. This however is highly unlikely from the theoretical point of view.[1] Table 2 presents these results in detail.

Table 2. KPSS Unit Root Test

		WIBOR_3M	EURIBOR_3M	EURPLN
KPSS test statistic for the series in levels		4.059235	3.111717	1.962889
Asymptotic critical values*:	1%	0.739000	0.739000	0.739000
	5%	0.463000	0.463000	0.463000
	10%	0.347000	0.347000	0.347000
KPSS test statistic for the series in first differences		0.730250	0.092742	0.051268
Asymptotic critical values*:	1%	0.739000	0.739000	0.739000
	5%	0.463000	0.463000	0.463000
	10%	0.347000	0.347000	0.347000
Integration order at 1%:		I(1)	I(1)	I(1)

Source: Own calculations.

The analysis of the data generating process went further on to analyze simple VAR model. The reason for this analysis was to determine the number of lags necessary to perform an effective Johansen Cointegration test. The lag length selection was based on the Schwarz Information Criterion to penalize large over indentified models. Under this criterion lag length of three was selected. Based on this two versions of the Johansen Cointegration Test were run (the trace rank test and the maximum eigenvalue test) in order to determine the rank of the matrix Π. Table 3 lists the results of both tests. One steady state cointegrating relationship was found with a very large statistical significance. This precludes any possible errors coming from the "noise" from daily frequency of observations. Similar tests were run for weekly and monthly data obtaining same results. This confirms the first hypothesis of the article - there exists an uncovered parity relation between interest rates in Poland and the EMU.

[1] Actually from the economic theoretical point of view interest rates should be stationary, this behavior is however not seen in the data on interest rates. See a discussion and empirical results in Goczek, Mycielski (2013).

Table 3. Johansen Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.016617	57.82276	42.91525	0.0009
At most 1	0.002846	8.625515	25.87211	0.9700
At most 2	8.77E-05	0.257427	12.51798	1.0000
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.016617	49.19725	25.82321	0.0000
At most 1	0.002846	8.368088	19.38704	0.7874
At most 2	8.77E-05	0.257427	12.51798	1.0000

Source: Own calculations.
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Based on Johansen Tests results a VECM model was constructed with an intercept and trend in the cointegrating equation. The cointegrating vector of the model is presented in the Table 4. The estimated cointegrating equation relating a steady state long-run relationship exhibits the well known uncovered interest rate parity condition. The steady state relationship exhibits a positive constant (note that the Cointegrating Equation from Table 4 is set to be 0), which confirms the second hypothesis of the empirical investigation.

Table 4. Cointegrating Vector Estimates

Cointegrating Eq:	CointEq1
EURPLN_O(-1)	1.000000
WIBOR_3M_O(-1)	-0.005677 (0.01291) [-0.43979]
EURIBOR_3M_O(-1)	0.249655 (0.03570) [6.99342]
@TREND(3/01/89)	0.000354 (6.2E-05) [5.67254]
C	-6.239293

Source: Own calculations.

Moreover, there exists a significant negative trend relating to diminishing exchange rate premium. however, though significant statistically, this negative trend is really small in economic significance terms taking into account the size of the interest rates. This implies a very slow convergence in the exchange rate premium in Poland and Eurozone - the estimated coefficient on the trend term implies a convergence of 1 p.p over 8 years. Therefore, the verification of the third hypothesis of the article - of interest rate convergence - has brought mixed results. While there is convergence in statistical terms, in practical economic terms the adjustment is very slow.

Table 5. VAR part of the VECM Estimates

Error Correction:	D(EURPLN_O)	D(WIBOR_3M_O)	D(EURIBOR_3M_O)
CointEq1	-0.004118	0.020704	-0.003347
	(0.00193)	(0.00417)	(0.00097)
	[-2.13411]	[4.96210]	[-3.45088]
D(EURPLN_O(-1))	-0.043210	0.021149	-0.016924
	(0.01853)	(0.04006)	(0.00931)
	[-2.33189]	[0.52790]	[-1.81709]
D(EURPLN_O(-2))	-0.021367	0.020526	-0.012290
	(0.01845)	(0.03989)	(0.00927)
	[-1.15815]	[0.51460]	[-1.32527]
D(EURPLN_O(-3))	-0.038644	-0.066777	-0.006106
	(0.01833)	(0.03963)	(0.00921)
	[-2.10807]	[-1.68490]	[-0.66263]
D(WIBOR_3M_O(-1))	0.010796	-0.026283	0.009059
	(0.00855)	(0.01849)	(0.00430)
	[1.26245]	[-1.42162]	[2.10768]
D(WIBOR_3M_O(-2))	-0.014135	0.117547	-0.006860
	(0.00862)	(0.01863)	(0.00433)
	[-1.64075]	[6.31095]	[-1.58409]
D(WIBOR_3M_O(-3))	-0.011910	-0.045290	0.015149
	(0.00883)	(0.01909)	(0.00444)
	[-1.34907]	[-2.37294]	[3.41404]
D(EURIBOR_3M_O(-1))	-0.024242	0.012622	0.308635
	(0.03587)	(0.07754)	(0.01803)
	[-0.67591]	[0.16278]	[17.1199]
D(EURIBOR_3M_O(-2))	-0.008336	-0.008276	0.179977
	(0.03689)	(0.07977)	(0.01854)
	[-0.22595]	[-0.10375]	[9.70494]
D(EURIBOR_3M_O(-3))	-0.009614	0.480986	0.066640
	(0.03559)	(0.07694)	(0.01789)
	[-0.27018]	[6.25177]	[3.72567]
C	0.000214	-0.003336	-0.000242
	(0.00053)	(0.00114)	(0.00027)
	[0.40469]	[-2.92460]	[-0.91249]
R-squared	0.008052	0.041841	0.231347
Adj. R-squared	0.004661	0.038565	0.228719
Sum sq. resids	2.360852	11.03533	0.596466
S.E. equation	0.028410	0.061423	0.014280
F-statistic	2.374452	12.77280	88.03586
Log likelihood	6294.643	4030.870	8314.253
Akaike AIC	-4.280411	-2.738331	-5.656167
Schwarz SC	-4.257988	-2.715908	-5.633744
Determinant resid covariance (dof adj.)		6.04E-10	
Determinant resid covariance		5.98E-10	
Log likelihood		18679.34	
Akaike information criterion		-12.69914	
Schwarz criterion		-12.62372	

Source: Own calculations

The model has passed all relevant diagnostics. Most importantly it was stable as the Figure 2 shows (the error correction mechanism imposes one Unit Root in the model).

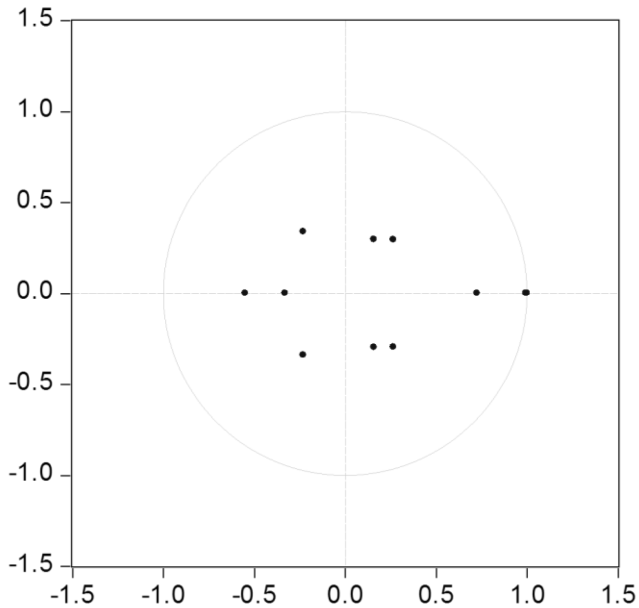

Figure 2. VECM Stability - AR Roots
Source: Own calculations.

Finally, the cointegrating equation has been plotted in the Figure 3. Based on the visual inspection, the residuals exhibit stationary behavior, as seen in the Johansen Test result.

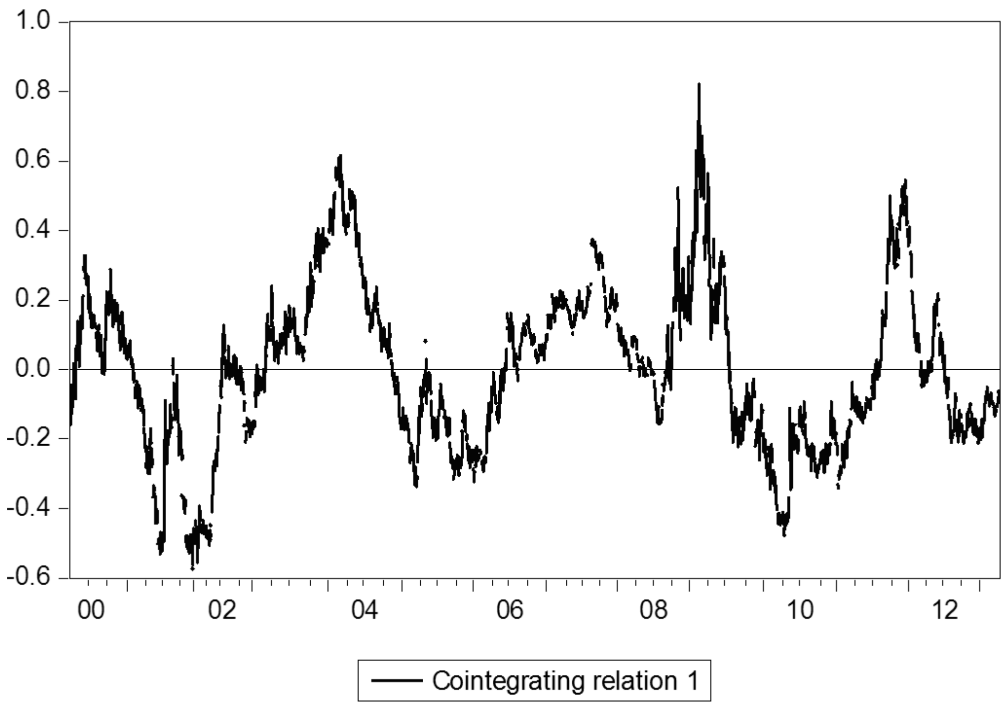

Figure 3 Cointegrating relation
Source: Own calculations.

Conclusions

The main hypothesis of the article has been confirmed. Since the Euro Area countries share a common currency, exchange-related premium differentials can, by definition, no longer exist in theory, and nominal interest rates on assets with similar characteristics cannot diverge significantly. This result have two explanations - one is that the Polish accession to the EMU is not seen as credible by the international investors. The second explanation is that the banking sector in Poland is seen as significantly less trustworthy than its European counterpart, hence higher credit risk.

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