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International Fisher Effect under Exchange Rate Regime Shifts: Evidence from 10 Examples

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Abstract

Petr Koráb, Svatopluk Kapounek**: International Fisher Effect under Exchange Rate Regime Shifts: Evidence from 10 Examples.**

This paper studies the behaviour of inflation rate, short-term interest rate and nominal exchange rate after leaving fixed exchange rate arrangement and move to floating. We find that countries with rigid exchange rate policy, less frequently adjusted central parity and narrow exchange rate bands experienced sharp depreciation after leaving peg, but the depreciation was only temporary with no long trend. In this group of countries the exchange rate adjustment is weakly exogenous to inflation and interest rate differentials and the theory of International Fisher Effect was not mostly confirmed. On the contrary, countries with flexibly adjusted central parity and wider exchange rate bands did not experience rapid depreciation. We applied Johansen's approach to cointegration (Johansen 1988, 1991 and 1994), based on estimation of the Vector Error Correction (VEC) Model, and the Johansen constraint test of exogeneity. Finally, we are discussing a parallel between leaving the peg and leaving the currency union. Since both are considered fixed exchange rate arrangements we argue that leaving the Eurozone by a member state may cause immediate depreciation without long trend and the adjustment would not be caused by inflation and interest rate changes.

Key words

purchasing power parity, uncovered interest parity, debt crisis, parallel currency, dual currency

JEL: F41, E 26, E42

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Introduction

After the collapse of Bretton-woods monetary system in 1970's, in other words a system of fixed exchange rates, floating exchange rate regime was an option. As the standard classification of exchange rate regimes developed over the time, the IMF currently (2011) classifies 71 countries which fix their currency to an anchor country's currency (e.g. USD), using either currency board, conventional peg, crawling peg, crawl-like arrangement or pegged exchange rate with horizontal bands. A more precise and detailed classification was introduced by Reinhart and Rogoff (2004) incorporating inflation criterion and parallel and dual market arrangements, and using de facto classification which often differs from de jure classification proclaimed by governments.

A choice of exchange rate regime is an important and sensitive decision of policy makers. As Rogoff et al (2003) state it is very difficult to draw general conclusions about how countries choose their exchange rate regimes. Several empirical studies have analysed the determinants of exchange rate regime choice in a cross section of countries. Among the first studies of this kind are Heller (1978), who analysed the determinants of exchange rate regimes with data from the mid-1970s, soon after the generalized floating that followed the breakup of the Bretton Woods system, Dreyer (1978), Holden, Holden, and Suss (1979), Melvin (1985), Bosco (1987), Savvides (1990), Cuddington and Otoo (1990), Rizzo (1998), and Poirson (2001). Some studies, such as those by Collins (1996), Edwards (1996) and, more recently, Frieden, Ghezzi, and Stein (2000), have used random effects panel data to analyze also the determinants of changes in exchange rate regime. Authors mostly conclude that trade openness, geographical trade concentration, frequency of monetary shocks, product diversification, capital mobility are factors supporting fixed (or peg) arrangement choice, and economic development, size of the economy, inflation differential size, and frequency of foreign price shocks provide arguments for floating regime.

The purpose of this paper is therefore to study the behaviour of the exchange rate and its short-term adjustment to the inflation and interest rate differential on the sample of countries which decided to shift the exchange rate regime from a form of fixed arrangement to floating. As a monetary union may be considered the form of fixed exchange rate arrangement, (as e.g. Frankel, 1999, or Frankel, 2003, categorize) and the exit from the Eurozone by one or more countries is an actual topic, our contribution is in discussion of parallels between leaving a form of peg arrangement and leaving the Eurozone by a member state.

1 A brief literature review

One of the foundations of international economics is the theory of purchasing power parity (PPP), which states that price levels in any two countries should be identical after converting prices into a common currency. Relative PPP requires that the growth in the exchange rate offset the differential between the rate of growth in home and foreign price indices. Uncovered interest parity implies that interest rate differential of two economies equals expected growth rate of nominal exchange rate, as changes in nominal exchange rates are not known precisely in advance. The idea behind the theory is that for the two interest rates to offer the same return. i.e. to have the parity in returns from assets, the expected growth of nominal exchange rate must compensate for the difference in returns. The Fisher Effect (IFE) should be considered as a combination of the Purchasing Power Parity and the uncovered interest parity theories. It postulates that nominal interest rate differential between two countries should equal to their anticipated inflation differential. The International Fisher Effect (IFE) theory postulates that the nominal exchange rate reflects changes in inflation and interest rate differentials between two economies.

Although the concept of purchasing power parity has been attempted to validate by numerous papers, the results are not always clear about the validity of PPP theory. Author mostly test the data on the presence of a unit root, and then proceed with cointegration (Carvalho, Júlio, 2010; Liew, Ling, Chia, Yoon, 2011), along with vector error correction model (Jiménez-Martin, Robles-Fernandez, 2009; Kim, 2011). Several factors may cause structural breaks in terms of relative PPP variables, therefore Papel (2001) and Snaith (2012) test for their presence. Kim and Moh (2012) conduct Monte Carlo experiments to provide empirical evidence of purchasing power parity condition. A rigorous empirical model for deviations from long-run purchasing power parity provide Sarno, Valente (2006) who claim that long-run PPP holds, that the relative importance of nominal exchange rates and prices in restoring PPP varies over time and across different exchange rate regimes, and reversion to PPP occurs nonlinearly at a speed that is fairly consistent with the nominal rigidities suggested by conventional open economy models. The problem of purchasing power parity theory under exchange regimes shifts is examined by Nusair (2008) who tests the long-run purchasing power parity (PPP) relationship for nine Asian countries relative to the USA and Japan during a period containing significant structural breaks due to the Asian crisis, erupting in Thailand in 1997 and spreading to Indonesia, Malaysia, the Philippines, Korea and Singapore. Although the countries have exhibited different arrangements, ranging from conventional peg (Malaysia) to independently floating (the Philippines), most of them have operated managed floating regimes. Author's results support long-run PPP validity for all the countries except in the case of the Philippines vis-à-vis Japan.

The Fisher Effect is analysed by Beyer et al (2009), Sharma and Liu (2008); and Lacerda, Fedderke, Haines (2010), among others, who test the theory in the presence of monetary and exchange rate regimes shifts. On the contrary the International Fisher Effect is a neglected issue in terms of the number of research papers. Ray (2012) tests it on the data of United States and India, Korea and Japan. The finding lends support to the existence of partial fisher effect in USA because both interest and inflation rates move in positive direction but do not move with one-for-one. But in case of India, Japan and Korea, there do not exist any signs of International Fisher Effect. When each country is treated interchangeably as home country and foreign country to show the direction of International fisher Effect, the results show a mixed picture. The theory holds when some countries were used as home country but was disproved when they were used as foreign countries. The study suggests that it finds evidence of a positive long run relationship between interest rate and inflation rate for the countries undertaken in the study but the notion of a full International Fisher Effect is rejected. Asari et al (2011) analyse the relationship for Malaysia and USA employing Vector Error Correction Model, cointegration test, Granger causality and impulse- response function. The results show that the inflation rate impacts the interest rate and, subsequently, the interest rate influences the exchange rate. Taking into account a long term relationship, interest rate moves positively while inflation rate goes negatively towards exchange rate volatility in Malaysia.

Our contribution is in analysis of time series before and after leaving peg arrangement in selected countries and discussions of parallels with possible exit from the Eurozone by a member state.

2 Methodology

The empirical analysis identifies long-term trend given by interest and inflation differentials in selected countries. The absolute form of Purchasing Power Parity (PPP) is specified in the form (1):

$$P_f(1+P_f)(1+e_f) = P_l(1+I_l), \tag{1}$$

where I_l represents changes in aggregate prices expressed in local currency, I_f is inflation rate in the country to which the local currency is pegged. Depreciation of the local currency is represented by increasing of e_f.

The international Fisher effect theory postulates that currencies with higher interest rates will depreciate because the higher rates reflect higher expected inflation. Hence, investors hoping to capitalize on a higher foreign interest rate should earn a return no better than what they would have

earned domestically. Therefore, the expected effective return on a foreign money market investment (r_f) should equal the effective return of domestic investment (r_l):

$$r_l = i_l = r_f = (1 + i_f)(1 + e_f) - 1, \tag{2}$$

where i_f represents interest rate in the foreign country, e_f percentage change of the foreign currency's value and $r_l = i_h$ is interest rate in the local country. Assume that the expected effective returns on investment in two parallel currencies are equalized by local currency's value changes. For the testing purposes we substitute the forms (1) and (2) to obtain the final form:

$$e_{ft} = a_0 + a_1\left(\frac{1 + I_{lt}}{1 + I_{ft}} - 1\right) + a_2\left(\frac{1 + i_{lt}}{1 + i_{ft}} - 1\right) + \varepsilon_t. \tag{3}$$

Based on the theory, we apply the Augmented Dickey Fuller test (ADF test) as a test for unit root and unit root with drift in the form:

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^{p-1} \phi_i \, \Delta y_{t-i} + \varepsilon_t, \tag{4}$$

where α represents deterministic term (constant). The p the lagged difference terms, Δy_{t-i}, are used to approximate the ARMA structure of the errors, and the value of p is set so that the error ε_t is serially uncorrelated. The optimal lag length of the AR-model is obtained on the basis of Akaike´s and Bayesian information criterion. The criterions are selected according to the parsimony optimality. We test empirical validity of the International Fisher Effect at the form:

$$\left(\frac{1 + I_{lt}}{1 + I_{ft}} - 1\right) + \left(\frac{1 + i_{lt}}{1 + i_{ft}} - 1\right) - e_{ft} \sim \mathrm{I}(0). \tag{5}$$

To identify the long-term causality and short-term adjustments we applied cointegration analysis. The cointegration analysis assumes that if two series are integrated to different orders, then linear combinations of them will be integrated to the higher of the two orders. '*If y_t and x_t are each drifting upward with their own trend, then unless there is some relationship between those trend, the difference between them should also be growing, with yet another trend. ... if the two series are both I(1), then this partial difference between them might be stable around a fixed mean. The implication would be that the series are drifting together at roughly the same rate'* as reports Greene (2003). Such as these time series are cointegrated, there exists a cointegrating vector [1; -β]. We applied

Johansen's approach (Johansen 1988, 1991 and 1994), which is based on estimation of the Vector Error Correction (VEC) Model in the form:

$$\Delta y_t = Cy_{t-1} + \sum_{i=1}^{q} B_i \Delta y_{t-1} + \varepsilon_t, \quad (6)$$

where $Cy_{t-1}=A(B'y_{t-1}+c_0)+c_1$ and represents error-correction term. We suppose intercepts in the cointegrating relations and linear trends in the data. This is a model of deterministic cointegration, where the cointegrating relations eliminate both stochastic and deterministic trends in the data. Matrix *A* represents adjustment speeds and matrix B represents specific relations among the variables in y_t. This approach reflects that all variables are possibly endogenous. All zero-rows in matrix A indicate a variable that is weakly exogenous with respect to the coefficients in matrix B. According to the Johansen approach, such a variable may affect other variables, but does not adjust to disequilibrium in the cointegrating relations.

In this methodological approach the time series involve nonstationary and trending variables. In this sense we use ADF test to test the variables for their order of integration. Under the null hypothesis, y_t is *I(1)* which implies that $\beta=1$. Based on the theory, we assume that $ln(I_f)\sim I(1)$, $ln(P_l)\sim I(1)$, $i_f\sim I(1)$, $i_f\sim I(1)$ and $ln(e_f)\sim I(1)$, simultaneously we expect that exchange rate time series contains structural change represented by leaving peg arrangement and the gap between the inflation rates is not balanced by interest rate differentials in selected countries but it is adjusted by changes of exchange rate in the short-term.

We used monthly data on nominal exchange rate, inflation rates (CPI or WPI), and interbank interest rate. Dataset was built up from OECD, IMF and national central banks' sources. Time series cover period before and after exchange regime shifts for 9 countries (Chile, Brasil, Mexico, Germany, Switzerland, Czech Republic, Australia, Indonesia and South Korea) and 10 cases of leaving the fixed arrangement (2 cases for Mexico). To identify the exchange regime we draw from detailed historical description for each country provided by Rogoff and Reinhardt (2002) and Rogoff and Reinhardt (2004) who reconsider currently used arrangement classification and incorporate parallel market and high inflation criteria highlighting the importance of de facto and marked determined exchange rate. Employing the de facto classification helps more objectively argue for estimated results.[1]

[1] For the purpose of the paper, based on Rogoff and Reinhardt classification, we consider currency board, peg, band, crawling peg, crawling band and moving band to be fixed exchange rate arrangements; managed floating and freely floating then floating arrangements.

Table 1: Dataset

	Data range		Exchange rate regime shift
Chile	1991 Jan	2001 Dec	1997 Nov
Brasil	1996 Oct	2001 Dec	1999 Feb
Mexico I.	1977 Mar	1988 Feb	1982 Feb
Mexico II.	1991 Nov	2001 Dec	1995 Jan
Germany	1971 Dec	1978 Dec	1973 Feb
Switzerland	1972 Jan	1975 Dec	1973 Feb
Czech republic	1993 Jan	1998 Dec	1997 Jun
Australia	1976 Jun	1988 Dec	1982 Dec
Indonesia	1990 Jan	2001 Dec	1997 Aug
South Korea	1991 Jan	2001 Dec	1997 Dec

Source: OECD: Main Economic Indicators, IMF: International Financial Statistics, central banks' sources.

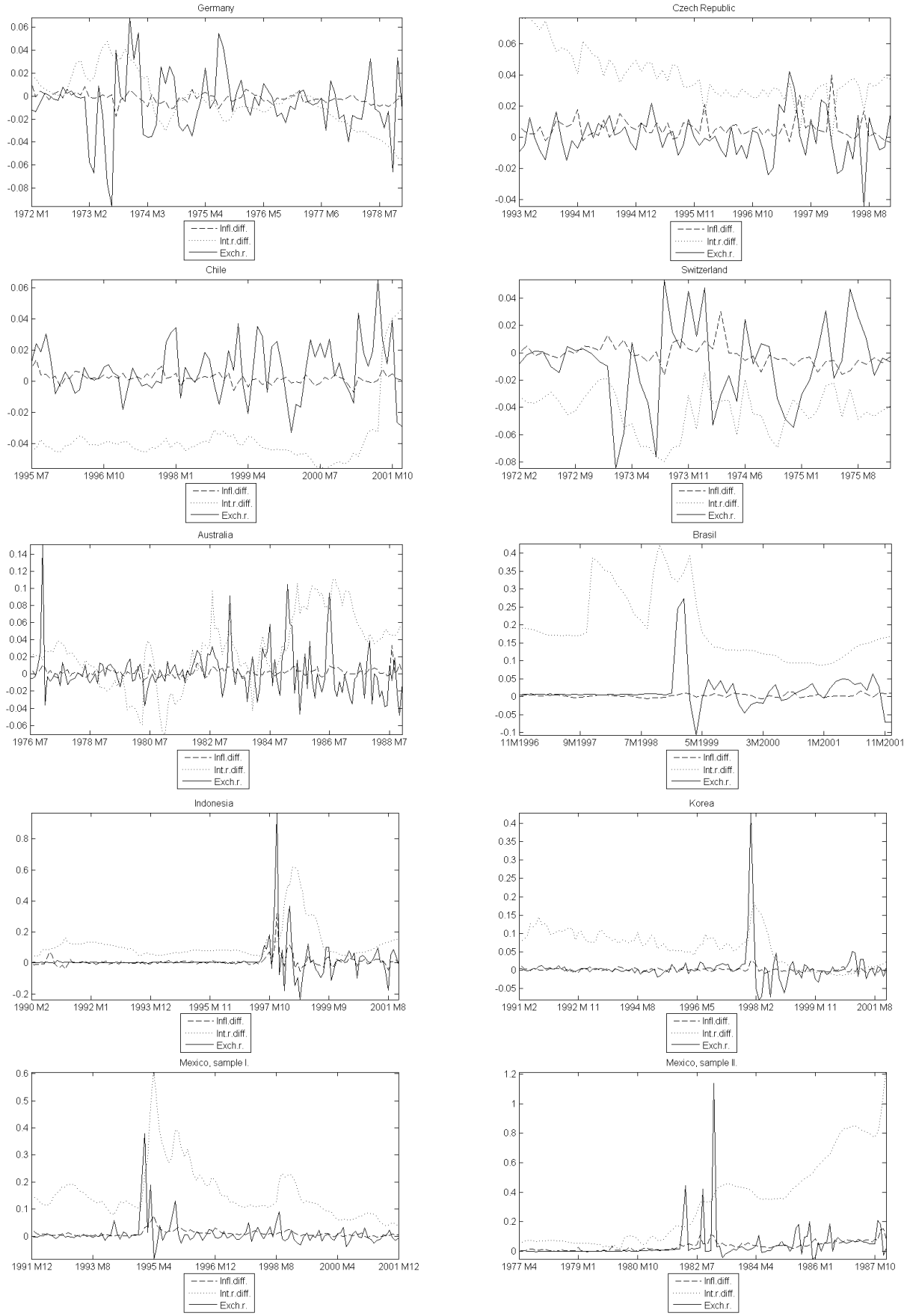
Note: Table shows dataset range and the period of exchange regime shift. Months are abbreviated.

We apply monthly changes to analyse international Fisher effect by unit root tests. For the purpose of cointegrated vectors and error correction terms estimation we transformed time series by natural logarithm, except the percentage values of interest rates.

3 Results

Firstly, we test validity of the international Fisher effect on the data of selected countries. Figure 1 presents changes in exchange rates, inflation and interest rate differentials before and after leaving the peg arrangement. We can identify higher volatility in most of the countries in flexible exchange rate system. However, there are significant differences between the countries. In the case of the Czech Republic, Brasil and Mexico (sample I.) we can see huge positive gap between the local and foreign interest rates before and after leaving the peg. Positive interest rate differential vanished after the year 1998 in Korea, while it increased in Mexico (samples I. and II.), Indonesia and Australia after the change of exchange rate regime. Negative interest rate differential is evident in Germany (after 1974), Chile (before 2001) and Switzerland. In most of analysed countries we can identify low variability of inflation differential. On the contrary, we can see increasing variability of exchange rate after the shift to floating, especially in the Czech Republic, Chile, Switzerland and Australia. In the case of Brasil, Indonesia, Korea and Mexico (samples I. and II.) exchange rate sharply depreciated. Subsequently, its changes stabilized around the zero.

Figure 1: Inflation and interest rate differentials in selected countries



Sudden depreciation of currencies in Brasil, Indonesia, Korea, Mexico (samples I. and II.) after leaving the peg may be explained by tougher exchange rate arrangement, where the central parity was adjusted less frequently and the band was narrow, in comparison to Germany, Czech Republic, Chile, Switzerland, Australia, where the currencies were allowed to fluctuate within wider bands and the exchange rate could more efficiently react to changes in inflation and interest rate differentials. We can therefore see a connection between the rate of flexibility of exchange rate regime in terms of adjustments of central parity or the band during the period of fixing the national currency, and the reaction of nominal exchange rate after the shift to floating regime.

Concerning the first group (Germany, Czech Republic, Chile, Switzerland, Australia), in the case of Germany, the floating regime was the option after the collapse of Bretton-woods monetary system, where the fluctuation was allowed at 1% from the parity. As the economy did not suffer strong macroeconomic imbalances, the exchange rate could absorb the deviations of inflation and interest rate differentials gradually. The same conditions apply for Switzerland. The Czech National Bank, from 1993 to October 1995, intervened when the exchange rate deviated from the parity by more than 0.5%. Since 1995 the band was widened to ±7.5 %. The resulting move towards floating did not make a sharp depreciation. In Chile, on 17 March 1992, the Central Bank was authorized to intervene in the Formal (Official) Market and operated within the established 10% margin. In January the Effective Rate was revalued by 5% and the margins were widened from 5% to 10%, (IMF, 1993). The bands were finally widened to 12.5% in 1997, before the country adopted floating regime. In the case of Australia the band width was ± 2%, (Reinhardt, Rogoff, 2002). Nevertheless, the central bank adjusted the exchange rate daily. Despite the fact that the de facto classification for Australia from June 1976 to December 1982 was “band around US dollar”, the daily adjustment was in nature close to managed floating arrangement. The central bank then could react to imbalances and after the move in 1993 the currency did not sharply depreciate.

In the second group (consisting of Brasil, Indonesia, Korea, Mexico), the central bank of Indonesia’s daily squaring session was allowed to deviate from the indicative rate posted in the morning by 1 Rp till November 1993 and from then till the introduction of floating by 2Rp, (IMF, 1994). This accounts for approximately 0.12 % adjustment. In South Korea the nominal exchange rate of Korean Won and US Dollar was fixed to Market Average Rate (MAR) which was determined in the interbank market, based on a weighted average of rates for Korean Won/U.S. Dollar spot transactions of the previous day. In South Korea in July 1992, the Korean Won-U.S. Dollar exchange rate in the interbank market was allowed to fluctuate within fixed margins of plus and minus 0.8% against the MAR of the previous day, (IMF, 1993). In October 1993 the band was widened to 1%, (IMF, 1994) and in

November to 1.5 % (IMF, 1995). Before allowing the currency to float the band was finally widened to 2.25 % in December 1995 (IMF, 1996). In the case of Mexico (sample I.), in October 1976, the Bank of Mexico announced that it will keep the exchange rate between Mex$ 26.24 and Mex$ 26.50 per U.S. Dollar which it did until the shift to floating in 1982. In November 1991, the Central bank of Mexico defined the band within which the market rate would fluctuate, and the daily rate of depreciation of the Peso against the Dollar was reduced to Mex$0.20 from Mex$0.40 (i.e. from an annual rate of 5% to 2.4%), (IMF, 1992).

We can then summarize that the exchange rate of countries where the exchange rate bands were wider and the parity was adjusted more frequently did not experience a sharp depreciation after the shift to floating, as the exchange rate could absorb the imbalances gradually. On the other hand countries where the fixing was tougher and the bands were narrow suffered the imbalance which was hidden by fixed exchange rate. After the shift to floating their currencies sharply depreciated to equilibrate the imbalance.

Main reasons for the shift from peg to floating were in most of the cases external imbalances and resulting speculative attacks. In Chile due to Russian crisis (1997) and inability to maintain the exchange rate using crawling band, in Brasil due to 1999 crisis, (Frenkel, Rapetti, 2010). In Mexico, the shift resulted from the Mexican crisis in 1994, (National Bank of Mexico, 2009). In Germany and Switzerland the move was caused by the end of Brettonwood's system. In 1997 the Czech Republic was the first Central European country to adopt a floating exchange rate regime as the consequence of a speculative attack, (Valachy, Kočenda, 2003). In Australia and Indonesia after the 1997 crisis the fixed regime was blamed for not being able to tackle the problem of large capital outflows, (Frankel, 2003).

Table 2 and Table 3 present results of ADF unit root test of the exchange rate changes, inflation differential, interest rate differential and International Fisher effect. Firstly, we tested level stationarity around the zero (Table 2), subsequently around the constant (Table 3). The results rejected a unit root in all cases of exchange rate changes. The inflation differential around zero was rejected in the Czech Republic and Mexico (sample II.). Nevertheless purchasing power parity was proved in the Czech Republic via stationary inflation differential around the constant. Interest rate differential around the constant was not rejected at the 1% significance level only in the case of the Czech Republic, Switzerland and Australia.

Table 2: Unit root ADF test

	No deterministic terms			
	e_{ft}	$\frac{1+I_{lt}}{1+I_{ft}}-1$	$\frac{1+i_{lt}}{1+i_{ft}}-1$	$\left(\frac{1+I_{lt}}{1+I_{ft}}-1\right)+\left(\frac{1+i_{lt}}{1+i_{ft}}-1\right)-e_{ft}$
Germany	-6.4490 ***	-5.9926 ***	-0.9864	-4.6603 ***
Czech Republic	-6.7043 ***	-0.9789	-2.6075 **	-1.7260 ***
Chile	-5.1968 ***	-5.5066 ***	-0.6807	-1.8172 *
Switzerland	-4.8326 ***	-2.4444 **	-0.6185	-2.5426 ***
Australia	-9.0974 ***	-7.8049 ***	-1.8669 *	-4.0352 ***
Brasil	-3.1894 ***	-4.1162 ***	-0.8218	-0.8205
Indonesia	-8.9319 ***	-6.9480 ***	-1.7420 *	-2.6534 ***
Korea	-7.9342 ***	-7.3315 ***	-1.4099	-1.4788
Mexico I.	-8.0800 ***	-2.6302 ***	-1.2961	-2.0869 **
Mexico II.	-9.6186 ***	0.5921	2.8113	1.6191

Notes: *, ** and *** denote significance at the 10, 5 and 1% level.

Table 3: Unit root ADF test

	Constant			
	e_{ft}	$\frac{1+I_{lt}}{1+I_{ft}}-1$	$\frac{1+i_{lt}}{1+i_{ft}}-1$	$\left(\frac{1+I_{lt}}{1+I_{ft}}-1\right)+\left(\frac{1+i_{lt}}{1+i_{ft}}-1\right)-e_{ft}$
Germany	-6.6622 ***	-6.8915 ***	-1.1169	-4.6280 ***
Czech Republic	-6.6570 ***	-8.3512 ***	-3.6302 ***	-4.4134 ***
Chile	-5.7808 ***	-6.7277 ***	1.5017	-2.8994 *
Switzerland	-5.0263 ***	-4.8315 ***	-3.7409 ***	-4.0855 ***
Australia	-9.1435 ***	-8.8891 ***	0.1540 ***	-4.6473 ***
Brasil	-6.8774 ***	-5.2144 ***	-2.1282	-2.0681
Indonesia	-9.0745 ***	-7.2318 ***	-2.8324 *	-4.7826 ***
Korea	-8.0189 ***	-7.7878 ***	-1.9476	-4.5756 ***
Mexico I.	-8.3348 ***	-3.4200 **	-2.2835	-3.5386 **
Mexico II.	10.6031 ***	-0.5321	1.9119	0.6044

Notes: *, ** and *** denote significance at the 10, 5 and 1% level.

In most of analysed countries inflation and interest rates differentials were balanced by exchange rate changes. The hypothesis of the International Fisher effect was not accepted in the case of Mexico (sample II.) and Brasil, (at the 10% significance level), in Chile (at the 5% significance level), and in Mexico (sample I.), (at the 1% significance level). In the case of Korea, we did not reject unit root process with no deterministic trend but we reject unit root with constant at 1% significance level. This result can indicate a long-term difference in risk premium between the assets or existence of a structural break within the time series. The existence of the structural break is very important limitation of employed ADF tests. Therefore we continue with cointegrated vectors and error correction terms estimation. Table 4 and Table 5 present results of unit root ADF tests of all analysed time series. As we described in the methodology, exchange rate and price indices were transformed by natural logarithm. According to the ADF unit root tests we conclude that most of the time series are first-order integrated. Stationary or higher order integrated time series were excluded from the cointegration analysis. In the case of the Czech Republic, Indonesia, Korea and Mexico (sample I.) we identified the rank of the cointegrated vectors involving first order integrated time series at the 1% and 5% significance level separately.

Table 4: Unit root ADF test, levels

	e_f	I_f	I_l	i_f	i_l
Germany	-0.9464	-0.2011	-4.2048 ***	-1.9963	-1.5293
Czech Republic	-2.3294	-2.8786 *	-1.0425	-3.8936 ***	-2.2969
Chile	-0.1514	-0.7688	-4.1289 ***	0.3644	-0.5611
Switzerland	-1.0681	1.7381	-1.2388	-1.8433	-1.7444
Australia	-1.3953	-2.8178 *	-1.7586	-2.1105	-2.5813
Brasil	-0.6397	-0.2950	1.0748	-0.0784	-1.7332
Indonesia	-0.5458	-3.3943 **	0.0763	-2.3409	-2.8204 *
Korea	-1.1280	-1.5542	-1.7821	-1.8373	-1.8948
Mexico I.	-1.2811	-1.7906	-0.8141	-1.2669	-2.9341 *
Mexico II.	2.4208	-2.9749 **	4.4548	-2.0206	2.1171

Notes: *, ** and *** denote significance at the 10, 5 and 1% level.

Table 5: Unit root ADF test, first differences

	e_f	l_f	l_l	i_f	i_l
Germany	-6.6553 ***	-3.4938 **	-6.9693 ***	-4.9407 ***	-4.9696 ***
Czech Republic	-6.6950 ***	-6.5102 ***	-7.7403 ***	-6.2144 ***	-8.4547 ***
Chile	-5.7487 ***	-6.6066 ***	-6.2814 ***	-4.1431 ***	-8.7390 ***
Switzerland	-5.0044 ***	-4.9091 ***	-2.1852	-3.5101 **	-10.6312 ***
Australia	-9.1110 ***	-4.4819 ***	-7.7980 ***	-8.8295 ***	-14.0619 ***
Brasil	-7.0156 ***	-5.7283 ***	-4.6340 ***	-3.1312 **	-6.3785 ***
Indonesia	-9.1290 ***	-8.6062 ***	-7.1558 ***	-2.9085 *	-6.4578 ***
Korea	-8.2533 ***	-8.8795 ***	-7.5564 ***	-2.7828 *	-8.5453 ***
Mexico I.	-8.3839 ***	-8.4641 ***	-3.2100 **	-4.0044 ***	-7.4158 ***
Mexico II.	-10.1477 ***	-4.1220 ***	-0.5297	-8.2595 ***	-6.3765 ***

Notes: *, ** and *** denote significance at the 10, 5 and 1% level.

Table 6 presents results of the Johansen tests for the cointegration rank, especially trace test and maximum eigenvalue test. We assessed null hypothesis of cointegration rank less than or equal to r. Except Korea, where the additional model was estimated at the 5% significance level of first order integrated time series, we reject the hypothesis that there is no long-term cointegrated relation between the variables.

Finally, we employed Johansen constraint test to identify driving forces in the system (Table 7). We focused on the exchange rate and its adjustment speed to disequilibrium in each of the cointegrating relations. Table 7 shows p-values and indicates that exchange rate is weakly exogenous with respect to the other variables. We found, that in the case of Brasil, Korea and Mexico exchange rate changes might affect other variables, but it does not adjust to disequilibrium in the cointegrating relations. Most of other results confirm the economic theory that the positive interest rate differential affects the exchange rate appreciation and positive inflation differential effect the exchange rate depreciation. The results which do not support these both assumptions can be identified in the case of Germany, Czech Republic, Switzerland and Indonesia. The first models estimated for Australia and Indonesia are arguable because the impact of foreign prices and interest rates seems to be overestimated. In the case of Mexico (sample I.), we tend to conclude that the exchange rate is an exogenous variable in the system.

Table 6: Johansen rank tests for cointegration

		Trace test				Maximum eigenvalue test		
	lag	*r=0*	*r=1*	*r=2*	lag	*r=0*	*r=1*	*r=2*
Germany	0	62.0283 ***	17.8292	5.0091	0	44.1991 ***	12.8201	4.7476
Czech Republic	0	31.4095 **	8.5584	1.0761	0	22.8511 **	7.4822	1.0761
Czech Republic [1)]	0	59.6569 ***	29.6653 *	14.5526 *	0	29.9916 **	15.1127	11.8179
Chile	0	68.6646 ***	29.8047 **	11.4815	0	38.8598 ***	18.3233	6.6118
Switzerland	0	62.8370 ***	32.2513 **	10.9873	0	30.5856 **	21.2640 **	8.3603
Australia	1	48.4738 **	17.8637	5.3122	1	30.6101 ***	12.5515	4.6860
Australia[1)]	0	185.2936 ***	49.5142 **	27.1829 *	0	135.7795 ***	22.3312	16.3206
Brasil	0	106.6465 ***	47.1887 *	25.5356	0	59.4579 ***	21.6531	12.3965
Indonesia	0	61.7343 ***	2.3309	0.3279	0	59.4034 ***	2.0030	0.3279
Indonesia [1)]	0	94.3980 ***	17.9871 **	0.1277	0	76.4109 ***	17.8594 **	0.1277
Korea	0	86.0780 ***	38.9644	22.1361	0	47.1136 ***	16.8283	13.4544
Korea [1)]	0	43.0300	20.9392	10.2757	0	22.0909	10.6635	8.0000
Mexico I.	0	196.8767 ***	34.2110 **	8.1138	0	162.6657 ***	26.0971 ***	7.5676
Mexico I.[1)]	0	288.5199 ***	98.6766 ***	29.6367 **	0	189.8433 ***	69.0399 ***	25.8754 **
Mexico II.	0	34.6845 **	7.2988	0.6210	0	27.3857 ***	6.6779	0.6210

Notes: *, ** and *** denote significance at the 10, 5 and 1% level.

[1)] additional model includes *I(1)* time series, identified at the 5% significance level

Table 7: Johansen constraint test

	Weak exogeneity test*	Adjustment Speeds			
		l_f	l_l	i_f	i_l
Germany	0.7891	-0.0019	-	0.0364	0.0846
Czech Republic	0.8623	-	0.0031	-	-1.0790
Czech Republic **	0.1892	-0.0005	-0.0033	-	1.1571
Chile	0.3750	0.0009	-	0.0987	-0.0338
Switzerland	0.8429	0.0024	-	-0.1231	-0.2854
Australia	0.1356	-	0.0001	0.2981	-0.3978
Australia**	0.3089	-0.0009	0.0003	0.3167	-0.3457
Brasil	0.0030	-	-	-	-
Indonesia	0.9892	0.0096	-	-0.0168	-
Indonesia**	0.4791	-	-0.0093	-	-1.4099
Korea	0.0975	-	-	-	-
Mexico I.	0.0773	-	-	-	-
Mexico I.**	0.7640	0.0002	0.0091	0.0093	-0.1714
Mexico II.	0.0039	-	-	-	-

* p-value (we test null hypothesis of the exchange rate adjustment with respect to other variables)

** additional model includes *I(1)* time series, identified at the 5% significance level

To summarize, there is evidence of significant adjustment of the exchange rate to changes in local interest rates. However, in the second subgroup of ountries (specific by jump depreciation of the exchange rate after leaving the peg) the exchange rate tend to be weakly exogenous.

4 Parallels with current Eurozone problems

Since we consider a monetary union a form of fixed exchange rate arrangement, the results of the research also have several policy implications for current Eurozone problems. PIIGS countries, but mainly Greece, represent Euro Area members whose costs of participation in the monetary union may have exceeded the benefits, (Eichengreen, 2007). The situation about the exit of Greece from the Eurozone is calming at the moment, but during the financial and debt crisis, several authors argued that the Union should accept a different design, (e.g. Cooper, 2012, studies the exit from the monetary union by modelling two scenarios of future design of monetary arrangement). So what might we expect to happen in the monetary sector of a country which decides to leave a monetary union and introduce a new currency? Since the deposits would stay honored in the former currency of the monetary union, basically, a parallel currency market of two currencies would be created. And in which exchange rate regime would the newly introduced currency operate? The purpose of leaving the monetary union and introducing a new currency is supposed be to to regain the exchange rate policy right and devalue the currency, (as Berger, 2012; Butler, 2011 and Koráb, Burešová, 2012, suggest). As the country leaving the monetary union is highly probably externally imbalanced, the new currency should be left to float to restore the balance and then, again, be fixed to a global currency employing a more flexible exchange rate regime, (e.g. crawling peg). We can draw from the research presented in this paper in in a way that the country leaving monetary union should expect sharp depreciation, without long trend, and the exchange rate adjustment would be weakly exogenous to interest and inflation rate changes, (based on the arguments provided in previous section related to countries with sharp depreciation). Since Mexico and Brasil are two unofficially dollarized countries where the US dollar and the national currency circulate altogether, further research should deeply investigate the conditions when the national currency ceased to be fixed to the US dollar and was allowed to float.

Conclusions

In this paper we have studied the behaviour of the exchange rate and its short-term adjustment to the inflation and interest rate differential on the sample of countries which decided to shift the exchange rate regime from a form of fixed arrangement to floating. The results suggest that the adjustment depends on the rate of flexibility of the fixed arrangement before the shift to floating.

Two subgroups of countries in the sample are therefore made, the first with no sharp depreciation and the second with sudden depreciation after leaving the peg. Countries which adjusted the central parity frequently and whose band was set wider did not experience sudden depreciation after leaving the peg, compared to countries where the band was narrow and the central parity was rigid. In the group of countries with more rigid peg arrangement we identified that the exchange rate adjustment is mostly weakly exogenous to inflation and interest rates changes and it is only temporary without longer trend.

Since we compare a monetary union to a peg arrangement with a narrow band and rigidly adjusted central parity, we argue that in the case of the exit of a member state from a monetary union, the depreciation would only be temporary and the exchange rate adjustment would be weakly exogenous to inflation and interest rate changes. After the exit from a monetary union, there would be created a parallel currency market in the monetary sector of a country leaving the union. Since the deposits would probably stay honored in the former common currency, two currencies would circulate in the economy. Two countries in our sample experienced such situation, as they were unofficially dollarized, fixed the national currencies to the US dollar and then allowed it to float. Further deep investigation of historical examples of Mexico and Brasil may help understand the currently discussed problems.

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