How Much Can the Monetary Policies of Small Open Economies Neighbouring the Eurozone Be Independent?

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Abstract

This paper examines the argument that a small open economy with goods and service markets integrated into a major currency block has decreased autonomy over its monetary policy. The idea is derived from Optimum Currency Area theory (OCA), which tries to answer the question of what economic area is supposed to share one common currency. The main cost of joining a common currency area is a loss of independent monetary policy of the economy. Independence of monetary policy can be interpreted as the ability to set interest rates autonomously of the international interest rates. The de facto independence of an economy is strongly influenced by its size and market integration as R. McKinnon famously noted. Therefore, the paper's question is: do the countries abstaining from joining the Eurozone have a truly independent monetary policy? If the independence of their monetary policy is low, then the cost of joining the Eurozone is also low. The topic is highly relevant for the examined countries as five of them are legally bound to accept Euro. Therefore, the costs of losing "not so independent" monetary policy should not be so high. We analyze the data if the European countries with sovereign currency follow the monetary policy of the Eurozone and the United States. As previous literature stated, the independent monetary policy sets the interest rates to impact the economy's internal balance. On the other hand, if the central bank uses its interest rate tool to affect the exchange rate, then the monetary policy is not so independent. The results show that the monetary authorities of the United Kingdom, Sweden, and Denmark follow the lead of the European Central Bank much more evidently than the Czech Republic, Hungary, Poland, and Romania.

Keywords: monetary policy; OCA; common currency; market integration;

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1. Introduction

This paper strives to analyze whether the monetary policy of EU non-Eurozone countries is independent or not.

Why is this important?

The advantage of joining a common currency area is a debated topic, especially in the European Union (EU) countries that are not yet members of the Eurozone (EZ). The United Kingdom secured a permanent opt-out of the Eurozone and is already out of the EU. Denmark also obtained an opt-out in the Maastricht treaty but is a member of the ERM2

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system that pegs the Danish Krona to the Euro in a narrow fluctuation band of 2.25%. The rest of the non-Eurozone EU countries are legally obliged under the Maastricht treaty to join the Euro. However, there is no deadline or penalty for not joining the currency union. Sweden is a specific case as the country has already held a referendum on Euro acceptance in 2003, where more than 55% voted against joining the Eurozone (EZ). As a consequence, the Swedish government postponed the euro adoption indefinitely. The rest of the non-EZ EU countries are the three largest economies of the 2004 enlargement – Poland, the Czech Republic, and Hungary, even though institutionally harmonized (as confirmed by Jasova and Kaderabkova, 2021; Čermáková *et al.*, 2020; Čermáková and Filho, 2021), also hesitate about the adoption of the new currency as well as the latest members of the EU – Bulgaria, Croatia, and Romania. Apart from Bulgaria and the case of Denmark, all of them have some type of floating exchange rate regime. This paper assesses the data on all of them apart from Croatia and Bulgaria, as their data are insufficient.

What do we know?

The Eurozone is a very intriguing concept for economists in relation to optimum currency area theory (OCA), because this is the first time that so many developed countries with plentiful and reliable statistics have joined a common currency. Finally, even the theories starting in the 1960s can be empirically tested. OCA tries to answer the question of which economic areas are supposed to share one common currency. OCA is usually based on cost-benefit analysis where the costs are associated with macroeconomics, that is, the loss of monetary policy independence and benefits are related to microeconomics concepts, i.e., lower transaction costs and less money illusion. R. Mundell is considered to be a pioneer of the theory and the godfather of the Eurozone. Over time numerous conditions for OCA have been suggested, many of them contradictory to each other. The most famous criteria are Mundell's factor mobility and R. McKinnon's degree of economic openness.

The main cost of joining a common currency area is the dissolution of a self-determined monetary policy of the economy. The Czech National Bank states: *"After the loss of independent monetary policy, flexibility and the ability to adjust quickly to economic shocks will be crucial for maintaining the good performance of the Czech economy."* (The Czech Republic's Updated Euro-area Accession Strategy, 2019).

What can we do about it?

This paper examines the argument that a small open economy with goods and service markets integrated to a major currency block has decreased autonomy over its monetary policy. The argument is derived from R. McKinnon’s contribution to OCA. The de facto autonomy of monetary policy is strongly influenced by its size and markets integration as R. McKinnon (1963) famously noted. Therefore, the paper’s question is: do the countries abstaining from joining the Eurozone enjoy unconstrained monetary policy from the policies of the Eurozone? The less independence of their monetary policy, the lower the cost of joining a common currency. We interpret the independence of monetary policy as the ability to set interest rates autonomously of the international interest rates (Bednar, 2021). Hence, benchmark interest rates of 7 European countries are empirically tested for dependence on the analogical interest rates in the Eurozone and the United States. The aim of the paper is to contribute to a discussion on the cost side of joining the Eurozone for the assessed countries.

How is it done?

Several specifications of regressions are run to establish whether there is an association in movements of the countries’ real interest rates with Eurozone and United States interest

rates. The data on interest rates usually suffers from so-called conditional heteroscedasticity. That is, the variance is dependent on the time. Periods of 'lull and storms' exist, that is, low variance and high variance. This fact makes common OLS inference harder as Gauss Markov assumptions are broken. It means that standard errors may be biased and therefore the significance might be spurious. In order to overcome the problem, we set up dummy variables that should account for different periods of volatility. The conjecture suggested by Plümper and Troeger (2006) that due to the creation of the Eurozone as a large currency block neighbouring the assessed countries, their monetary independence is lowered even more is also tested by adding a Eurozone dummy to the regressions.

The results show a significant association of the first difference between the real interest rate of all countries with the EZ real interest rate. However, the explained variance of the newer EU countries' real interest rates is substantially smaller than that of the older members – the United Kingdom, Denmark, and Sweden. The explanation is likely due to the stronger financial market integration of the older members with the EZ. The non-EZ EU countries seem to have lowered the independence of their monetary policies to different extents. The Eastern European countries deviate their real interest rate more (Venhoda, 2022); hence we can deduce that their monetary policy is more sovereign than that of the older EU members.

2. Literature review

The vastly influential Mundell-Flemming model implies that a country cannot maintain at the same time a fixed foreign exchange rate, free capital movement, and independent monetary policy. According to the so-called impossible trinity concept, a country can maintain a fully working independent monetary policy only if it surrenders its fixed exchange rate or free float of capital. (Fleming, 1962; Mundell, 1963). Obstfeld *et al.* (2004), who examined data on countries between world wars, confirmed the concept empirically. They showed that the Golden standard countries that allowed unrestricted movement of capital followed the base interest rate, while free-float countries do not chase the common base interest rate.

Nevertheless, McKinnon (1963) showed that this concept might be misleading as independent monetary policy depends on the volume of the economy or the currency area. Small open economies have limited power over their monetary policy, even with floating exchange rates. During an adverse economic shock to an open economy, its central bank is motivated to decrease the key interest rates to offset the shock. This usually causes a capital outflow from the country. This results in the weakening of the country's currency. Depreciation of domestic currency leads to an increase in inflation. The more open the economy, the more substantial effect on the country's inflation (McKinnon,1963)

Hausmann *et al.* (2001) finds that interest rates in countries with a floating exchange rate regime respond to the US monetary policy shocks in similar fashion as the fixed exchange rate countries. Also, one of the conclusions of Frankel (1999), who examines a broad range of countries, shows that interest rates in Latin American countries are more sensitive to the US monetary policy shocks if the country has a loose Dollar peg rather than a tight Dollar peg. But, overall, he does not detect any strong connection between currency regimes and interest rate autonomy.

Calvo and Reinhard (2002) show that, especially in smaller economies that claim to have a floating exchange rate regime, it is widespread to use the interest rate to stabilize external shocks and the country's exchange rate. They call it 'fear of floating'. These countries that fear the float thus restrict their monetary independence because they use an interest rate tool to offset external shocks that the shifting of exchange rate should theoretically handle.

Moreover, countries that neighbour a key currency area (such as the Eurozone or the United States) are subjects to so-called 'size bias '. Various studies confirm that investors prefer to hold assets in large currency areas than small ones (Kliber and Rutkowska-Ziarko, 2021; Altinbas, 2020; Čermáková, 2021). This is visible in investors holding more Euro-denominated assets than they held assets denominated in currencies of countries that are now part of the Eurozone. Capital owners perceive major currencies as more stable or as a 'safe haven' (Plümper and Troeger, 2006; Andelinovic *et al.*, 2020; Srivastava, 2022). For example, if the United Kingdom had decreased its interest rates before the formation of the Eurozone, some of the domestic capital would have moved abroad and the US Dollar would have become the most attractive 'safe haven' destination. Consequently, the US dollar would have appreciated not only against the GB Pound but to a smaller extent against all other currencies as well. The UK was mainly importing from the European Union countries; therefore, the depreciation did not cause as much import inflation. While now that the Eurozone exists, it is likely that some portion of the capital that would have moved to the US would be allocated to Eurozone capital markets. Thus, appreciating the UK's largest importer currency and therefore increasing inflation pressures. To sum up the hypothesis, the existence of 'size bias' makes major currencies, such as the Euro or the US Dollar more attractive for foreign investors. This fact makes small economies with a large share of imports from the major currency area even more prone to import inflation in the case of decreasing their interest rates. This fact negatively affects the effectivity and independence of the monetary policy tools. These conclusions were confirmed by key studies on national data sets conducted by Cecrdlova (2020 and 2021), Khan *et al.* (2019), or Bednar (2018).

The research is partially inspired by the above-mentioned paper by Plümper and Troegel (2006) who use similar reasoning but test only data from the United Kingdom, Denmark, and Sweden. Moreover, they use data from 1980 to 2005, which are only 5 years after the advent of Eurozone.

Among other relevant papers are Reade and Voltz (2011) who apply cointegration techniques to daily three-month EURIBOR and Swedish STIBOR to find out whether the Swedish nominal interest rate follows the analogical nominal interest rate of the Eurozone. Their results turn out significant although low. They conclude that the Swedish Central Bank (Riksbank) follows the Eurozone EURIBOR. However, they remove the outliers that are related to the financial crisis. Fratzscher (2002) shows that a monetary authority under a flexible exchange rate loses its autonomy if it lacks credibility or if the economy is highly financially integrated with a larger monetary union such as the United States or the Eurozone. Frankel *et al.* (2004) shows, using an ARDL model, that interest rates spillovers are dependent on the exchange rate regime to a limited extent. In the long run, countries that are sufficiently integrated into the world economy and into world financial markets will have to follow international interest rates. In the short run, the countries with a flexible ER tend to follow the international lead more loosely. Woodford (2007) sets up a new Keynesian model of two countries with fully integrated financial markets to prove that there is no way globalization can substantially interfere with containing domestic inflation by national monetary policy.

Windberger *et al.* (2012) argue for using structural breaks in volatility estimates analysis. Each of the three countries in the researched time changed its exchange rate regime at least once. The authors tried to exploit the variety of ER regimes in time and space across similar economies. They find no significant evidence of foreign interest rates spillovers into the assessed countries. Based on the results, they claim that monetary independence of the Czech Republic, Hungary and Poland is in place. Căpraru and Ihnatov (2012) subset CEE countries by their exchange rate regime and then run a panel data regression of domestic nominal interest rates on the Eurozone one; they also add the inflation differentials as a second variable. The results show a strong association of the CEE interest rates across all the subsets of ER regimes and that is as for de jure so for de facto regimes.

Rey (2015) shows that *'cross-border flows and leverage of global institutions transmit monetary conditions globally, even under floating exchange-rate regimes*', hence she claims a Dilemma exists instead of Trilemma. She means that the only choice is between unrestricted capital flows or independent monetary policy. Moreover, in a situation of globalized capital' '*key countries monetary policies influence other countries*' monetary situations. Financial imbalances can occur, and impact periphery countries' products. Or due to international debt on periphery countries' companies, the so-called balance sheet effects change to the monetary policy adversely impacts the economy (Rey, 2016).

Disyatat and Rungcharoenkitkul (2016) argue that sensitivity of emerging market to global financial contagion is much lower than that of developed countries. They analyze co-movement of bond yields across countries by using asset pricing framework. An interesting insight is brought by Law *et al.* (2019) – the authors show that a sufficiently large amount of foreign exchange reserves can partially offset the negative effect of financial integration on monetary independence. A similar framework to Obstfeld *et al.* (2004) is used by Klein and Shambaugh (2015) to assess whether a middle way in a monetary policy trilemma is plausible. The authors try to find out if by partially controlling capital flows and partially floating the exchange rate, a country can gain more monetary independence. They conclude that the capital controls would have to be very extensive to improve monetary independence under a fixed exchange rate, but a moderate amount of exchange rate flexibility provides significant improvement in monetary independence.

Obstfeld (2015) claims a bigger problem for small open economies is the financial rather than a monetary trilemma. While his position lies between two 'extremes' in the opinions on the monetary trilemma – Rey's 'trilemma is dilemma' and Woodford's 'totally independent' monetary policy under a flexible exchange rate. Obstfeld says that due to the globalization the monetary authority' s decision making grew more difficult. The existence of financial trilemma causes the decision making ever more complex. The central banks must also consider the effect of their monetary moves on the stability of the financial system.

David Romer (1991) shows why inflation in small open economies are on average lower than in large countries. The explanation of this may be surprising – according to Romer, it lies in the fact that unexpected inflation causes real depreciation in a small open economy and therefore the authorities are more cautious about monetary expansion. Goczek and Mycielska (2013) research a similar hypothesis to Plümper and Troegel (2006) on the Polish WIBOR; they run the Vector Error Correction Model (based on a cointegration tests) with monthly data in order to exclude noise that arises from daily records. Their results show a rather high adjustment coefficient for the Polish WIBOR and the WIBOR's long-running coefficient is 0.855 which is high. In 2014, the authors conducted analogical panel computations for the Czech Republic, Hungary, Poland and Romania. However, this time

they used weekly three-month nominal interest rates. Their results show a strong dependency of the research interest rates on EURIBOR. They conclude, that since the nominal interest rate of researched countries closely follows the Eurozone interest rate, the central and eastern European countries' central banks have limited independence in setting their own monetary policy. Hence, joining the Eurozone would bring about relatively low cost in terms of losing monetary policy.

Gabrish (2017) uses a similar method to GARCH but he employs daily nominal market interest rates and he does not use panel specification of data but individual GARCH tests. He interprets the ARCH stability coefficient in relation to GARCH and then he compares the sum with unity. His results lead him to conclude that the Czech Republic, the United Kingdom and Romania have very low coefficients of co-movements between their money markets and Eurozone money markets, therefore the central banks of the respective countries are in fact independent. On the other hand, in Denmark the monetary independence is very low which is not so surprising given the fact that the country is a member of ERM2 system, the Danish central bank would likely profit from joining the Eurozone as it would at least participate in its decision making. Sweden, Hungary, and Poland also appear to follow the Eurozone money market and therefore their monetary independence is reduced

What is the contribution of this paper?

This research is mainly inspired by the methods of Obstfeld *et al.* (2004), thought provoking conclusions by (Rey, 2015)and the findings and approach of Plümper and Troegel (2006).

The paper differs from the above-mentioned papers in (a) the method is inspired by Obstfeld *et. al* (2004), but we devised a response to the remarks on the time-dependent variability by setting up dummy variables that control for it (b) inclusion of size bias- based on paper by Plümper and Troegel (c) the use of real interest, Obstfeld *et. al* (2004) and Gabrish (2017) use nominal interest rates (d) the data used are different. We run regression on 7 non-Eurozone countries over a period of 22 years.

3. Theoretical arguments

One of the implications of optimum currency area theory is that the costs of a country joining a currency union is the loss of own independent monetary policy. This paper tries to assess the independence of monetary policy in countries that may join the European Monetary Union. If the countries' monetary policy is de facto independent, then losing its own monetary policy is a cost. On the other hand, if the countries' monetary policy follows the lead of the ECB, then losing sovereign monetary policy implies low to zero cost.

The question: are the monetary policy of non-Eurozone EU countries independent?

To answer this question, we must define what independent monetary policy means. Obstfeld *et al.* (2004) provides a neat definition: independent monetary policy is '*the ability of the central bank to set interest rates independently of international rates.'* Also, another definition implied by Goczek and Mycielska (2013) can be used: an economy where real interest rates are set to adjust only the shocks from within the economy while a floating exchange rate takes care of external shocks has independent monetary policy.

Central banks' policies mainly influence short-term interest rates. Hence, the examination is conducted on the short-term interest rate. The real interest rate is used to account for the fact that different inflation across time and countries would distort the results.

Thus, the main variable of interest is the real interest change. As inferred from the theoretical discussion, the association of changes of a country's short-term real interest rate with the Eurozone's moves of real interest rate implies that the country's monetary policy follows the ECB's monetary policy, be it for 'fear of floating', synchronization of business cycles or both together. Any of these reasons suggest the decreased usefulness of sovereign monetary policy.

Figure 1. Time Series of Real Interest Rates of the Czech Republic, the United States and the Eurozone

We ran several specifications of regression to estimate the effect of real interest rate changes in the Eurozone on other EU countries and the UK.

Obstfeld *et al.* (2004) use differenced estimators (first difference) as they remove trends and unit roots in the data. The differenced real interest rates are stationary according to ADF test and KPSS. In the simplest specification, we ran simple OLS regression for each of the countries where the dependent variable is the differenced real interest rate (dRIR) and the only explanatory variables are the differenced real interest rate of Eurozone (dRIREZ) and differenced real interest rate of the US (dRIRUS). Yet, even after removing serial correlation, the time series contain time-dependent variability. This fact breaks one of Gauss Markov assumptions for linear models (Stock and Watson, 2015). The standard errors are time-dependent and therefore they are inefficient and unreliable. To overcome this assumption breach, we set up dummies for each country that switch on (value 1) in periods of high variability. The dummies eliminate the time conditional heteroscedasticity.

The data used are monthly one-month EURIBOR rates and national analogues compiled by Eurostat. One month is the shortest period for which is assigned monthly annual rate of change of all-items HICP.

The real interest rate is calculated according to Fisher's equation (Sun and Phillips, 2004):

$$r_{t+1} \approx i_t - \pi_{t+1}$$

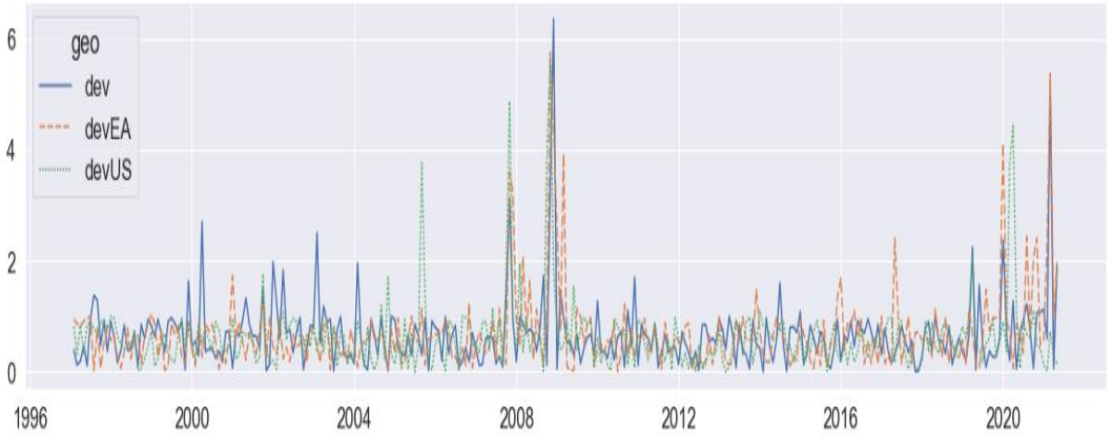
Where r stands for the real interest rate, $\underline{i}$ stands for nominal interest rate and π means inflation.

The high volatility dummies for every country were computed based on this arbitrary rule:

$2 < \frac{|dRIR| - \mu_{|dRIR|}}{\mu_{|dRIR|}}$ then the dummy is assigned value 1, otherwise 0.

The same rule applies for high volatility dummies of the Eurozone and the US.

Figure 2. Absolute Value of deviation of the first difference Real Interest Rate of Sweden, the United States, and the Eurozone



4. Analysis

The analysis was conducted on many different specifications of linear regressions for each country, where the dependent variable is always the first difference of the real interest rate of the country

Regressions 1 are specified accordingly:

$$dRIR = \alpha + \beta 1 dRIREZ + \beta 2 dRIRUS + \varepsilon \quad (1)$$

where dRIR stands for the first difference of the real interest rate of the researched country, dRIREZ stands for the first difference of the real interest rate of the Eurozone and dRIRUS stands for the first difference of the real interest rate of the United States

This is the most parsimonious specification of the regression. In this type of regression specification, we found strong heteroscedasticity and therefore low significance combined with low explained variance (R-squared).

Regressions 2 have Eurozone dummies. The dummy has a value of 1 for the period since January 1999 until present, otherwise a value of 0. It is specified:

$$dRIR = \alpha + \beta 1 dRIREZ + \beta 2 dRIRUS + \beta 3 EUROZONEDUMMY + \varepsilon \quad (2)$$

where EUROZONEDUMMY stands for the dummy representing the value of one since January 1999, for periods before the advent of the Euro the value is zero

Regressions 3 are specified accordingly:

$$dRIR = \alpha + \beta 1 dRIREZ + \beta 2 dRIRUS + \beta 3 EUROZONEDUMMY + \beta 4 HVDUMMY + \beta 5 HVDUMMYEZUS + \varepsilon \quad (3)$$

where HVDUMMY stands for the dummy representing the value of one for high volatility periods of the researched countries as explained in the chapter above and HVDUMMYEZUS is the high volatility dummy for the Eurozone and the United States combined, for periods before the advent of the Euro the value is zero.

Czech Republic

The Czech Republic shows to have one of the most independent monetary policies. Interestingly, the OLS standard error is biased up against the heteroscedasticity robust standard error. Thus, the heteroscedasticity robust set of regressions turn out an association with change in the EZ interest rate on change of the Czech IR on 95% of statistical significance. The Czech Republic real interest rate is moving in the same direction and for 1% change in EZ RIR, the Czech Republic RIR changed by 0.7%. However, the very low value of adjusted R^2 shows that the variation in RIR change is not explained by variation in its EZ counterpart. Therefore, the conclusion is that the Czech Republic's monetary policy is independent. The variation in the interest rate changes is not explained.

Table 1. Regression 3 with heteroscedasticity robust standard errors

CZ — OLS Regression Results

Dep. Variable:	dRIR	R-squared:	0.039
Model:	OLS	Adj. R-squared:	0.022
Method:	Least Squares	F-statistic:	8.038
Date:	Sun, 07 Aug 2022	Prob (F-statistic):	4.14e-07
Time:	10:29:03	Log-Likelihood:	-511.38
No. Observations:	292	AIC:	1035.
Df Residuals:	286	BIC:	1057.
Df Model:	5		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	0.4141	0.616	0.672	0.502	-0.794	1.622
dEA	0.6665	0.274	2.429	0.015	0.129	1.204
dUS	0.0612	0.141	0.435	0.664	-0.214	0.337
EZdummy	-0.4587	0.646	-0.710	0.478	-1.725	0.808
volD	-0.4731	1.606	-0.295	0.768	-3.621	2.675
volbig	1.0390	1.046	0.994	0.320	-1.010	3.088

Denmark

Denmark is a special case. The country's exchange rate has been pegged since the early 1980's, initially to the German Mark and then to the Euro. As a member of the ERM2 system it has been obliged to keep the currency trading in a narrow fluctuation band of 2.25% on either side of the specified rate. The central bank's main goal, to keep the inflation low, is de facto transferred to the ECB. The main objective of the Danish central bank, apart

from guarding financial stability, is to defend the exchange rate in the fluctuation band. Denmark does not have an independent monetary policy – its interest rate either follows the EZ interest rate or is used to defend the exchange rate. The central bank cannot use the instrument to impact its economy.

Also, the regression shows significant dependence on the EZ interest rate with a relatively high adj. R^2.

Table 2. Regression 3 with heteroscedasticity robust standard errors

DK OLS Regression Results

Dep. Variable:	dRIR	R-squared:	0.365
Model:	OLS	Adj. R-squared:	0.354
Method:	Least Squares	F-statistic:	23.17
Date:	Sun, 07 Aug 2022	Prob (F-statistic):	1.56e-19
Time:	10:29:03	Log-Likelihood:	-62.676
No. Observations:	292	AIC:	137.4
Df Residuals:	286	BIC:	159.4
Df Model:	5		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	0.0212	0.069	0.307	0.759	-0.114	0.157
dEA	0.4830	0.081	5.964	0.000	0.324	0.642
dUS	0.1484	0.054	2.746	0.006	0.042	0.254
EZdummy	-0.0237	0.071	-0.335	0.738	-0.163	0.115
volD	-0.5337	0.425	-1.256	0.209	-1.366	0.299
volbig	0.8551	0.431	1.983	0.047	0.010	1.700

Hungary

Hungary's regression shows that once accounted for heteroscedasticity, the association of the country's RIR with the EZ RIR becomes lower. Otherwise, the results resemble those of the Czech Republic, that is, with 1% change in the EZ RIR the Hungarian RIR changes by 0.57% on a 99% statistical significance level. However, the adj. R^2 value is very low which shows that most of the variation is not explained by this model. Therefore, we conclude that the Hungarian monetary policy from this point of view is independent.

Table 3. Regression 3 with heteroscedasticity robust standard errors

HU OLS Regression Results

Dep. Variable:	dRIR	R-squared:	0.073
Model:	OLS	Adj. R-squared:	0.056
Method:	Least Squares	F-statistic:	11.22
Date:	Sun, 07 Aug 2022	Prob (F-statistic):	7.40e-10
Time:	10:29:03	Log-Likelihood:	-306.10
No. Observations:	282	AIC:	624.2
Df Residuals:	276	BIC:	646.1
Df Model:	5		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	0.1206	0.183	0.658	0.510	-0.238	0.480
dEA	0.5709	0.187	3.053	0.002	0.204	0.937
dUS	0.0119	0.195	0.061	0.951	-0.370	0.394
EZdummy	-0.1518	0.190	-0.799	0.424	-0.524	0.220
volD	0.1314	0.905	0.145	0.885	-1.642	1.905
volbig	0.4377	0.070	6.256	0.000	0.301	0.575

Poland

The Polish RIR shows a stronger association with the EZ RIR and to the US RIR. The value of adj. R^2 is 12% which is also substantially larger than the explanatory power of the same model for the Czech Republic and Hungary. The result is contradictory to the theory, as Poland is not so much a small open economy like the two countries. One possible explanation is that Poland appears to fear floating as shown in the paper by Goczek and Mycielska (2013).

Table 4. Regression 3 with heteroscedasticity robust standard errors

PL OLS Regression Results

Dep. Variable:	dRIR	R-squared:	0.134
Model:	OLS	Adj. R-squared:	0.119
Method:	Least Squares	F-statistic:	3.164
Date:	Sun, 07 Aug 2022	Prob (F-statistic):	0.00850
Time:	10:29:03	Log-Likelihood:	-296.10
No. Observations:	292	AIC:	604.2
Df Residuals:	286	BIC:	626.3
Df Model:	5		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	-0.0777	0.261	-0.298	0.766	-0.589	0.433
dEA	0.5367	0.181	2.959	0.003	0.181	0.892
dUS	0.2395	0.129	1.854	0.064	-0.014	0.493
EZdummy	0.0363	0.272	0.133	0.894	-0.498	0.570
volD	0.0444	0.669	0.066	0.947	-1.267	1.355
volbig	0.3968	1.657	0.239	0.811	-2.851	3.645

Romania

Romania appears to have the most independent monetary policy. Although, the heteroscedasticity robust results provide a high significance level for the association of the EZ RIR with the Romanian RIR However, the magnitude of change is much larger. Looking at adj. R^2, it can be concluded that the Romanian monetary policy is independent.

Table 5. Regression 3 with heteroscedasticity robust standard errors

RO OLS Regression Results

Dep. Variable:	dRIR	R-squared:	0.015
Model:	OLS	Adj. R-squared:	-0.003
Method:	Least Squares	F-statistic:	1.399
Date:	Sun, 07 Aug 2022	Prob (F-statistic):	0.224
Time:	10:29:03	Log-Likelihood:	-1139.6
No. Observations:	292	AIC:	2291.
Df Residuals:	286	BIC:	2313.
Df Model:	5		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	3.6125	5.870	0.615	0.538	-7.892	15.117
dEA	3.0366	1.466	2.071	0.038	0.163	5.910
dUS	-0.5305	1.040	-0.510	0.610	-2.570	1.509
EZdummy	-3.6633	6.037	-0.607	0.544	-15.495	8.168
volD	1.0963	7.350	0.149	0.881	-13.309	15.502
volbig	-0.4894	0.964	-0.508	0.612	-2.379	1.401

Sweden

Sweden's results show that changes in real interest rate are associated as with the EZ RIR changes so with the US RIR changes. Also, the regression has a substantial adj. R^2 value. It appears that Swedish changes in real interest rates significantly follow those of the EZ and to a lesser extent also the changes in the US RIR. The results make us conclude that Swedish monetary independence is seriously limited.

Table 6. Regression 3 with heteroscedasticity robust standard errors

SE OLS Regression Results

Dep. Variable:	dRIR	R-squared:	0.344
Model:	OLS	Adj. R-squared:	0.332
Method:	Least Squares	F-statistic:	13.42
Date:	Sun, 07 Aug 2022	Prob (F-statistic):	9.28e-12
Time:	10:29:03	Log-Likelihood:	-98.081
No. Observations:	292	AIC:	208.2
Df Residuals:	286	BIC:	230.2
Df Model:	5		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	0.0763	0.066	1.153	0.249	-0.053	0.206
dEA	0.5446	0.108	5.037	0.000	0.333	0.756
dUS	0.1495	0.056	2.680	0.007	0.040	0.259
EZdummy	-0.0807	0.069	-1.170	0.242	-0.216	0.054
volD	-0.3569	0.465	-0.767	0.443	-1.269	0.555
volbig	0.4923	0.576	0.855	0.393	-0.636	1.621

UK

The UK's results suggest strong association with the EZ RIR and a weaker association with the US RIR. Interestingly, the dummy for high volatility of Eurozone and the US is negative and significant. Our interpretation is that in normal times the UK follows the real interest rate of its largest trade partners, but if she needs it, the Bank of England can deviate from what the ECB or the FED does. The model also provides the largest part of explained variations – the adj. R^2 is 44%.

Table 7. Regression 3 with heteroscedasticity robust standard errors

UK OLS Regression Results

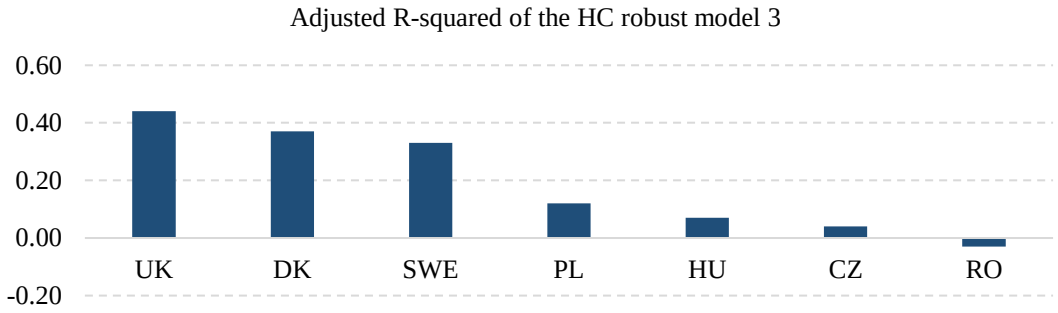
Dep. Variable:	dRIR	R-squared:	0.448
Model:	OLS	Adj. R-squared:	0.438
Method:	Least Squares	F-statistic:	11.16
Date:	Sun, 07 Aug 2022	Prob (F-statistic):	8.73e-10
Time:	10:29:03	Log-Likelihood:	-30.116
No. Observations:	274	AIC:	72.23
Df Residuals:	268	BIC:	93.91
Df Model:	5		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	0.0879	0.045	1.965	0.049	0.000	0.176
dEA	0.6399	0.137	4.673	0.000	0.371	0.908
dUS	0.0989	0.059	1.690	0.091	-0.016	0.214
EZdummy	-0.0935	0.048	-1.967	0.049	-0.187	-0.000
volD	-0.1432	0.483	-0.297	0.767	-1.090	0.803
volbig	-0.7765	0.432	-1.796	0.073	-1.624	0.071

5. Overall Interpretation of the Results

The results of all researched countries show a significant statistical association of the first difference of their interest rates for almost all specifications of the regressions. This might be explained by all the researched countries facing similar or the same phase of the business cycle for most of the time. This is the case especially when accounted for the extreme changes in real interest rates. However, the countries differ in the level of explained variations by the model.

Figure 3. Countries' adjusted R^2 for specification 3 regressions



The regressions show the ECB's large impact on monetary policy of the older EU members and a former one – the UK. The models have very low explanatory power for the researched central and eastern European countries except for Poland.

Table 8. All countries' regression results tabulated, ran with heteroscedasticity robust standard errors

RIR of	Czech R.	Denmark	Hungary	Poland	Romania	Sweden	UK
(Intercept)	0.40	0.02	0.12	-0.07	3.60	0.08	0.09**
dEZ	0.67**	0.48***	0.57***	0.54***	3.03**	0.54***	0.64***
dUS	0.06	0.15***	0.01	0.24*	-0.50	0.15***	0.1*
EZ_Dummy	-0.45	-0.02	-0.15	0.03	-3.70	-0.08	-0.09**
vol_dummy	-0.47	0.43	0.13	0.04	1.09	-0.40	-0.14
volatility_EZUS_Dummy	1.04	0.43**	0.43***	0.40	-0.49	0.52	-0.77
Adj. R squared	0.02	0.35	0.03	0.12	-0.03	0.33	0.44
F-statistic p-value	0.00	0.00	0.00	0.00	0.22	0.00	0.00

What might be the reasons that older EU countries follow the ECB interest rate changes more closely than newer members?

It can be a result of closer financial market integration that makes the older EU members more cautious at deviating significantly from the EZ interest rate.

The countries of the 'Non-Euro Area Core', that is, the UK, Sweden and Denmark have much more integrated financial (including capital) markets to those in the Eurozone than so-called 'non-Euro Area East' i.e., Czechia, Poland Hungary, Romania and Poland (Nardo *et al.*, 2017). As Goczek and Mycielska (2019) as well as Vukson (2017) argue, for small open economies, highly financially integrated with a larger monetary area, an interest rate deviation can result in significantly increased volume of financial flows and exchange rate volatility that can destabilize the economy. The central bank must include these factors into its loss function and therefore is more likely to follow the lead of the larger monetary area.

We cannot confirm the hypothesis that formation of large currency block, i.e., the Eurozone will deteriorate the neighboring country's monetary independence. The coefficient of the dummy variable for the Eurozone existence was only significant in the case of the UK but the value of the coefficient is negative and low. Hence, we cannot support the conclusion by Plümper and Troegel (2006).

6. Conclusion

The paper analyses monetary policy independence in the EU countries that are not members of the Eurozone. The real-world motivation of the paper is an ongoing debate on whether to adopt the Euro in these EU countries. The theoretical motivation and inspiration lie in the paper by Obstfeld *et al.* (2004) where the authors define independent monetary policy as an ability to set domestic interest rates independently from international rates. We used a similar approach to examine the association (dependence) between the Eurozone and other EU countries.

The instrument to judge the sovereignty of monetary policy is the real interest rate of the countries and whether its changes follow the real interest rate changes in the EU and the US. The data used spans more than 22 years across seven countries with monthly frequency. The results show that all the countries follow the lead of the ECB to some extent. Denmark, Sweden, and the UK appear to be more dependent on the Eurozone than the Czech Republic, Hungary, and Romania.

Denmark's dependence on Eurozone monetary policy does not come as a surprise because Denmark is a member of ERM2 system and has thus effectively surrendered its own monetary policy. Sweden and the United Kingdom do not have their currencies pegged. According to the impossible trinity concept, a country can possess only two of the three possible policy positions: independent monetary policy, fixed exchange rate and free capital flow. The results of our research strongly contradict this concept as they show the diminished monetary independence of Sweden and the UK This means that they only enjoy fully free capital flow out of the trilemma. This conclusion is in line with the paper by Rey (2015) where she dismisses the Trilemma notion and claim that open economies face only dilemma. Countries can only choose between unrestricted capital flow or independent monetary policy.

The Czech Republic, Hungary, Poland, and Romania prove to have somewhat more independent policies than the older EU members. Although, their real interest rate changes are also significantly associated with those of the Eurozone. Their explained variance is very low and therefore it can be concluded that the driver of the real interest rate changes is something other than international interest rates. These results are more supportive to Woodford's conclusion of fully independent monetary policies under free float exchange rate regime.

It appears to us that the capital market integration of these countries with the Eurozone is probably the culprit of the older EU members stronger dependence on ECB policies than the newer members. We cannot confirm the hypothesis stipulated by Plümper and Troegel (2006), our regression analysis did not confirm impact of the Eurozone inception on the neighboring countries monetary sovereignty.

These days, it seems, that the central banks of the Czech Republic or Hungary would most likely wish for much higher responsiveness of their respective currencies to the change of

interest rates. At the time of finishing this paper, high inflation troubles most European countries. In the Czech Republic, Hungary, Poland and Romania, we can speak about galloping inflations and in spite of restrictive monetary policies of the countries' authorities, inflation is hard to curb. The Czech monetary authorities unprecedently increased benchmark interest rates. Yet, the currency did not appreciate significantly. Therefore, the central bank supports the Czech Koruna by open market operations, thus depleting its foreign reserves.

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Data

Nominal Short-Term Interest Rate of EU countries series[2]	Eurostat
Annual change of HICP monthly data in as the inflation measure[3]	Eurostat
FED. Funds Rate and US Inflation rate	Federal Reserve Bank of St. Louis

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[2] https://ec.europa.eu/eurostat/cache/metadata/en/irt_st_esms.htm#stat_pres1563785273137
[3] https://ec.europa.eu/eurostat/cache/metadata/en/prc_hicp_esms.htm

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Appendix 1

Stationarity tests where:

- Type 1 means: no drift, no trend
- Type 2 means: with drift, no trend
- Type 3 means: with drift, with trend
- P value *0.1* means p-value>0.1 and p-value 0.01 means p-value<0.01

Czech republic	**lag**	**kpss**	**p.value**
type 1	12	0.07	0.1
type 2	12	0.03	0.1
type 3	12	0.03	0.1

Denmark	**lag**	**kpss**	**p.value**
type 1	12	0.08	0.1
type 2	12	0.03	0.1
type 3	12	0.02	0.1

Hungary	**lag**	**kpss**	**p.value**
type 1	12	0.10	0.1
type 2	12	0.03	0.1
type 3	12	0.03	0.1

Poland	**lag**	**kpss**	**p.value**
type 1	12	0.05	0.1
type 2	12	0.04	0.1
type 3	12	0.04	0.1

Romania	**lag**	**kpss**	**p.value**
type 1	12	0.16	0.1
type 2	12	0.08	0.1
type 3	12	0.04	0.1

Sweden	**lag**	**kpss**	**p.value**
type 1	12	0.61	0.1
type 2	12	0.10	0.1
type 3	12	0.05	0.1

United Kingdom	**lag**	**kpss**	**p.value**
type 1	12	0.28	0.1
type 2	12	0.05	0.1
type 3	12	0.05	0.1

Stationarity tests

- Type 1 means: no drift, no trend
- Type 2 means: with drift, no trend
- Type 3 means: with drift, with trend
- P value *0.1* means p-value>0.1 and p-value 0.01 means p-value<0.01

Czechia	type1.lag	type1.ADF	type1.p.value	type2.lag	type2.ADF	type2.p.value	type3.lag	type3.ADF	type3.p.value
1	0	-14.37	0.01	0	-14.35	0.01	0	-14.32	0.01
2	1	-16.07	0.01	1	-16.05	0.01	1	-16.02	0.01
3	2	-10.76	0.01	2	-10.75	0.01	2	-10.73	0.01
4	3	-12.07	0.01	3	-12.06	0.01	3	-12.04	0.01
5	4	-8.44	0.01	4	-8.44	0.01	4	-8.42	0.01
6	5	-8.03	0.01	5	-8.02	0.01	5	-8.01	0.01
7	6	-6.12	0.01	6	-6.12	0.01	6	-6.10	0.01
8	7	-5.77	0.01	7	-5.76	0.01	7	-5.75	0.01
9	8	-5.04	0.01	8	-5.04	0.01	8	-5.03	0.01
10	9	-5.07	0.01	9	-5.06	0.01	9	-5.05	0.01
11	10	-4.71	0.01	10	-4.71	0.01	10	-4.70	0.01
12	11	-4.74	0.01	11	-4.73	0.01	11	-4.72	0.01

Denmark	type1.lag	type1.ADF	type1.p.value	type2.lag	type2.ADF	type2.p.value	type3.lag	type3.ADF	type3.p.value
1	0	-14.33	0.01	0	-14.31	0.01	0	-14.29	0.01
2	1	-9.86	0.01	1	-9.85	0.01	1	-9.84	0.01
3	2	-7.89	0.01	2	-7.88	0.01	2	-7.87	0.01
4	3	-6.93	0.01	3	-6.92	0.01	3	-6.91	0.01
5	4	-6.67	0.01	4	-6.65	0.01	4	-6.64	0.01
6	5	-5.63	0.01	5	-5.62	0.01	5	-5.61	0.01
7	6	-5.49	0.01	6	-5.48	0.01	6	-5.47	0.01
8	7	-5.14	0.01	7	-5.14	0.01	7	-5.13	0.01
9	8	-4.79	0.01	8	-4.79	0.01	8	-4.78	0.01
10	9	-4.48	0.01	9	-4.47	0.01	9	-4.47	0.01
11	10	-4.34	0.01	10	-4.33	0.01	10	-4.33	0.01
12	11	-5.97	0.01	11	-5.96	0.01	11	-5.95	0.01

Hungary	type1.lag	type1.ADF	type1.p.value	type2.lag	type2.ADF	type2.p.value	type3.lag	type3.ADF	type3.p.value
1	0	-13.89	0.01	0	-13.89	0.01	0	-13.87	0.01
2	1	-10.08	0.01	1	-10.09	0.01	1	-10.07	0.01
3	2	-7.72	0.01	2	-7.72	0.01	2	-7.72	0.01
4	3	-6.54	0.01	3	-6.55	0.01	3	-6.54	0.01
5	4	-6.33	0.01	4	-6.33	0.01	4	-6.33	0.01
6	5	-6.14	0.01	5	-6.15	0.01	5	-6.14	0.01
7	6	-5.69	0.01	6	-5.70	0.01	6	-5.70	0.01
8	7	-5.42	0.01	7	-5.44	0.01	7	-5.44	0.01
9	8	-5.36	0.01	8	-5.38	0.01	8	-5.38	0.01
10	9	-5.35	0.01	9	-5.36	0.01	9	-5.37	0.01
11	10	-5.09	0.01	10	-5.10	0.01	10	-5.12	0.01
12	11	-5.55	0.01	11	-5.58	0.01	11	-5.59	0.01

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Poland	type1.lag	type1.ADF	type1.p.value	type2.lag	type2.ADF	type2.p.value	type3.lag	type3.ADF	type3.p.value
1	0	-12.01	0.01	0	-12.00	0.01	0	-11.99	0.01
2	1	-8.62	0.01	1	-8.62	0.01	1	-8.60	0.01
3	2	-6.32	0.01	2	-6.33	0.01	2	-6.31	0.01
4	3	-5.87	0.01	3	-5.87	0.01	3	-5.86	0.01
5	4	-5.38	0.01	4	-5.38	0.01	4	-5.38	0.01
6	5	-4.65	0.01	5	-4.64	0.01	5	-4.65	0.01
7	6	-4.12	0.01	6	-4.11	0.01	6	-4.12	0.01
8	7	-4.19	0.01	7	-4.19	0.01	7	-4.19	0.01
9	8	-4.26	0.01	8	-4.27	0.01	8	-4.27	0.01
10	9	-4.49	0.01	9	-4.50	0.01	9	-4.49	0.01
11	10	-4.60	0.01	10	-4.63	0.01	10	-4.60	0.01
12	11	-5.57	0.01	11	-5.59	0.01	11	-5.58	0.01

Romania	type1.lag	type1.ADF	type1.p.value	type2.lag	type2.ADF	type2.p.value	type3.lag	type3.ADF	type3.p.value
1	0	-11.94	0.01	0	-11.92	0.01	0	-11.91	0.01
2	1	-11.38	0.01	1	-11.37	0.01	1	-11.38	0.01
3	2	-11.26	0.01	2	-11.25	0.01	2	-11.28	0.01
4	3	-10.52	0.01	3	-10.52	0.01	3	-10.56	0.01
5	4	-10.59	0.01	4	-10.59	0.01	4	-10.68	0.01
6	5	-9.48	0.01	5	-9.49	0.01	5	-9.59	0.01
7	6	-9.08	0.01	6	-9.10	0.01	6	-9.26	0.01
8	7	-7.22	0.01	7	-7.26	0.01	7	-7.46	0.01
9	8	-7.57	0.01	8	-7.62	0.01	8	-7.89	0.01
10	9	-6.39	0.01	9	-6.45	0.01	9	-6.71	0.01
11	10	-6.25	0.01	10	-6.30	0.01	10	-6.56	0.01
12	11	-7.08	0.01	11	-7.12	0.01	11	-7.39	0.01

Sweden	type1.lag	type1.ADF	type1.p.value	type2.lag	type2.ADF	type2.p.value	type3.lag	type3.ADF	type3.p.value
1	0	-13.93	0.01	0	-13.98	0.01	0	-14.01	0.01
2	1	-9.37	0.01	1	-9.40	0.01	1	-9.42	0.01
3	2	-8.73	0.01	2	-8.76	0.01	2	-8.77	0.01
4	3	-7.09	0.01	3	-7.11	0.01	3	-7.11	0.01
5	4	-6.63	0.01	4	-6.64	0.01	4	-6.63	0.01
6	5	-6.37	0.01	5	-6.39	0.01	5	-6.37	0.01
7	6	-6.31	0.01	6	-6.32	0.01	6	-6.29	0.01
8	7	-6.71	0.01	7	-6.71	0.01	7	-6.68	0.01
9	8	-6.21	0.01	8	-6.21	0.01	8	-6.18	0.01
10	9	-5.62	0.01	9	-5.62	0.01	9	-5.59	0.01
11	10	-5.35	0.01	10	-5.34	0.01	10	-5.31	0.01
12	11	-7.00	0.01	11	-7.06	0.01	11	-7.04	0.01

United Kingdom	type1.lag	type1.ADF	type1.p.value	type2.lag	type2.ADF	type2.p.value	type3.lag	type3.ADF	type3.p.value
1	0	-11.68	0.01	0	-11.69	0.01	0	-11.67	0.01
2	1	-9.42	0.01	1	-9.44	0.01	1	-9.42	0.01
3	2	-8.14	0.01	2	-8.17	0.01	2	-8.15	0.01
4	3	-6.67	0.01	3	-6.69	0.01	3	-6.68	0.01
5	4	-6.71	0.01	4	-6.74	0.01	4	-6.72	0.01
6	5	-6.58	0.01	5	-6.60	0.01	5	-6.59	0.01
7	6	-5.76	0.01	6	-5.79	0.01	6	-5.78	0.01
8	7	-5.94	0.01	7	-5.98	0.01	7	-5.97	0.01
9	8	-4.95	0.01	8	-4.99	0.01	8	-4.98	0.01
10	9	-4.39	0.01	9	-4.44	0.01	9	-4.43	0.01
11	10	-4.59	0.01	10	-4.65	0.01	10	-4.64	0.01
12	11	-5.51	0.01	11	-5.59	0.01	11	-5.58	0.01