Iceland's Currency Options

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Abstract

This paper employs cointegration techniques to determine the degree of convergence of Iceland's nominal interest rates and inflation rates with that of Canada and the Euro area. Nominal interest rates are used here as an indicator of financial market integration and inflation rates, a measure of monetary policy integration. The degree of convergence of Iceland's inflation and nominal interest rates with the United States is also studied for comparison. The result of the test provides evidence in support of inflation rate convergence between Iceland and the Euro area. It also shows nominal interest rate convergence among all four countries. This result would contribute to the discussion on whether Iceland should join the European Union and European Monetary Union or adopt the Canadian dollar in a formal currency union, if it chooses to abandon its currency.

Key words: Cointegration, inflation, interest rate, monetary union, currency union

JEL Classification: C22, C32, F33, F36

I Introduction

As a small country with a freely floating low-volume world currency that has historically been volatile, the question of an appropriate currency arrangement is an important one for Iceland, more so following the financial crises and the near collapse of the Icelandic krona in October 2008.

Much of the recent political debate in Iceland has been about a possible European Union (EU) and European Monetary Union (EMU) membership; there has also been a growing debate about adopting a major currency such as the Canadian dollar. Many Icelanders who oppose EMU membership point to the relatively weak correlation of Iceland's business cycle with that of the Euro area compared with Canada, which is also a resource rich nation with a similar monetary policy. There are also Icelanders who want less integration with the EU or any other country and argue that the Iceland enjoyed an export driven recovery after the fall of the krona in 2008 because it had its own currency.

Iceland could hope that by joining the European Monetary Union (EMU), it would reduce the high cost of doing business associated with their small currency, attract foreign direct investment by reducing uncertainty due to currency fluctuations, and reduce borrowing costs. However, these benefits should be weighed against the potential high cost of giving up independent monetary policy; independent financial stability rules and may give in to formal limits on fiscal policy associated with formal currency unions.

Robert Mundell (1961) wrote about the criteria for an optimal currency area. He identified labour and capital mobility, and a fiscal transfer mechanism to compensate areas that are adversely affected by labour and capital mobility, as important ingredients for a successful currency union. Countries in a currency union, he argued, should also have similar business cycles so that a shared central bank can promote growth in recessions and contain inflation in booms.

Convergence of economic indicators such as inflation and interest rates between countries and among regions has important policy implications as to whether countries have similar business cycles. Understanding the behaviour of these economic indicators across countries also provides clues about the extent to which countries conduct independent monetary policies.

Inflation trends have converged globally in the last three decades. Cavallero (2011) found that inflation cycles in Europe converged in the long-run. He argued that labour market institutions may represent one source of divergence in the short-run, given that they may influence wages and therefore influence inflation. Hence, to the extent to which structural reforms in the Euro area countries reduce wage rigidities, inflation differentials should tend to fade away in the long-run. Therefore, more coordinated labour market policies across Euro area countries could enhance synchronization among inflation rates.

Since the 1970's the degree of financial market integration has increased due to relaxed capital controls. Testing for convergence of nominal interest rates in the past reflected the fact that capital market integration was thought to be a fairly recent phenomenon; it may be that a common stochastic trend across countries was not a feature across different periods. Siklos and Wohar (1997) first tested for cointegration over a base sample and repeated all the tests by adding a year at a time until the full sample was reached. This approach allowed them to analyze the evolution of any cointegrating relationship. A second set of tests for cointegration considered combinations of countries chosen according to institutional or geographical similarities. For these reasons, they considered Germany, Belgium, Italy, The Netherlands, and France together, and the United States and Canada together as well. They also looked at groups consisting of the United States, Germany, and Japan, and the United States, United Kingdom, and Germany.

When they tested all countries together the results indicated that although interest rates didn't converge, they were moving more closely with each other in the 1990s than they did in the early 1980s. When they tested convergence of nominal interest rates among the sub-groupings of countries, they found evidence that convergence of nominal interest rates was not a feature of the European Monetary System countries (Germany, Belgium, Italy, the Netherlands, and France),

but a long-run equilibrium relationship among these interest rates does exists[1]. One possible reason for this finding was that member countries practice short-run monetary policy independence. None of the other sub-groupings of countries, except for the Canada-United States combination, revealed any evidence of interest rate convergence either over the full sample or across subsamples.

This paper employs cointegration techniques to determine the degree of convergence of Iceland's nominal interest rates and inflation rates with that of Canada, the Euro area and the United States. Nominal interest rates are used here as an indicator of financial market integration and inflation rates are used as a measure of monetary policy integration to determine the degree of similarity in business cycles.

Using monthly data from 2002M1 to 2012M12, the paper concludes that there a cointegrating structure for nominal interest rates that is consistent with convergence between Iceland and Canada, Iceland and the Euro area and Iceland and the United States. However, with respect to inflation a cointegrating vector confirmed convergence between Iceland and the Euro area, with no evidence of convergence in the others.

The paper is organised as follows: Section II reviews relevant literature on inflation and interest rate convergence. Section III discusses the data and the cointegration methodology employed in the analysis. The empirical results, discussion and conclusion are in Sections IV and V respectively.

[1] European Monetary System is a former European monetary arrangement.

II Review of Literature

Most industrialized countries may have converging inflation rates if their monetary policies are integrated and reflect similar views on inflation among policymakers. Siklos and Wohar (1997) found convergence in inflation for European Monetary System countries, the United States and Canada, and the United States, Germany, and Japan. They argued that inflation rates are often used to indirectly measure the degree of integration in monetary policies and that industrialized countries' central banks developed common views about levels of inflation during the 1980s. These countries have shared beliefs concerning the advantages of low and stable inflation rates.

Crowder (1996) concluded that inflation rates among the seven largest industrialized countries (G-7) shared one common stochastic trend in the post-war era, over both the fixed and floating exchange rate regimes. Crowder and Phengpis (2007) confirmed this view with more precise results, and they found that complete economic convergence exhibited a weak form rather than a strong form for the G-7 countries. According to the monetarist view, the results may be due to central bank policy coordination, currency substitution, the relative purchasing power parity, domestic output adjustments and common stochastic shocks, as they are all causes of the global inflation convergence.

Furthermore, Rogers (2007) pointed out that European price dispersions are similar to the price dispersions of United States cities. He found in the case of the European cities there was a striking decline in dispersion for traded goods prices, most of which took place prior to the launch of the euro.

Overall, these papers show that price and inflation convergence has been a global phenomenon among the largest industrialized countries, with similar views on monetary policy and inflation being a key driving force. Cavallero (2011) argued that being in a currency union may increase convergence, when he found that the inflation cycles lack synchronization over short time horizons and converged in the long-run. He said the launch of the European Monetary Union and the introduction of the single currency have boosted trend convergence. Since inflation cycles prove to have converged in the long-run it confirms the theory that the monetary union has

boosted trade patterns among Euro area countries and therefore improved the synchronization of inflation cycles in the long run.

Like inflation rates, a monetary union can also lead to convergence of interest rates. Interest rate convergence reflects behaviour in financial markets and the increasing degree of international integration of financial markets would lead to equalization of real interest rates across national boundaries.

Fountas and Wu (1999) confirmed the existence of real interest rate convergence in the European Union using data from 1979-1993. They observed that since the 1970s there has been a growing degree of integration as constraints to the movement of financial capital have been gradually relaxed. Most of the Exchange Rate Mechanism members started abolishing capital controls during the 1980s and the capital controls were gone by July 1st, 1990.

In an environment of fixed exchange rates, the increasing degree of international integration of financial markets would lead to a tendency for equalization of real interest rates across national boundaries. A finding of real interest rate convergence would then have important policy implications for the effectiveness of domestic stabilization policy. With real interest rates set in international markets, domestic monetary policy would have no influence on savings or consumption decisions (Feldstein, 1980).

Holtemoller (2005) found varying degrees of monetary convergence of potential European Monetary Union accession countries. Other studies that concluded there were varying degrees of interest rate convergence among countries using the euro includes Camarero *et al* (2002); Jenkins and Madzharova (2008).

Overall the majority of the research done on the Euro area looks at inflation convergence. But, these few studies show that nominal and real interest rate convergence is also a feature of European and industrialised countries in the long run, showing that the financial markets of these countries have become integrated over the years, and this integration could hinder domestic stabilization policies.

III Data and Methodology

The degree of convergence was estimated using monthly data from 2002:M1 to 2012:M12[2]. This study used monthly lending prime rates as nominal interest rates and inflation rates were calculated using consumer price index (CPI) data from Iceland, the European Union and the United States, drawn from the International Monetary Fund's international financial statistics database.

Testing for unit-roots with the Augmented Dickey-Fuller (ADF) test and Monte Carlo Simulations are among the most common tests by researchers. Lopez and Papell, (2007) and Bussetti et al. (2006) used the above methods to study the convergence of inflation in the Euro area, studied the effects of the pre Maastricht Treaty era, the effect of the Maastricht Treaty in 1991, the single market in 1993, and the launch of the euro in 1999. Lopez and Papell (2012) later used a restricted version Seemingly Unrelated Regressions (SUR) known as the ADF-SUR test which accounted for serial and contemporaneous correlation and allowed them to test shorter time periods and got a more precise view on when convergence began and when it was achieved.

Apart from these prominent methods, researchers have also made use of other techniques. Pelinescu and Caraiani (2006) used stationarity tests along with various statistical methods such as variances, and variation coefficients to test the impact of inflation targeting on the convergence of inflation rates in Romania and the EU. Fountas and Wu (1999) found that results differed depending on the type of tests used: traditional cointegration tests did not support the hypothesis of real interest rate convergence, but recently developed tests that endogenously determined potential structural breaks showed that real interest rate convergence had taken place in several European countries, particularly for long-term real interest rates.

Cavallero (2011) used a mixed time series/cross-section approach and distinguished between structural and cyclical components in his study of inflation rate convergence in the EU-12 area.

[2] The Icelandic Central Bank Act of 2001 states that the main objective of monetary policy is price stability, which is also the main monetary policy objective of the Bank of Canada and the European Central Bank. Euro coins and banknotes entered circulation on January 1, 2002.

He used a thick modeling approach to obtain the trend-cycle decomposition, and a distribution dynamics approach was used for the cross-sectional analysis. Then transition probability matrices and stochastic kernels were used to analyze trend and cyclical dynamics. Rogers (2007) used standard deviations across cities to test for inflation convergence in Euro area cities and to investigate how close their convergence was to that of US cities. Honohan (1992) used time trend and intercept shift dummy variables to test the impact of currency unions in the rand and franc zones of Africa, on inflation convergence.

Other important methods that have been used for testing convergence include the Johansen Cointegration tests. Siklos and Wohar (1997) used the ADF unit root tests as well as Johansen Cointegration tests to test convergence in inflation and interest rates for the European Monetary System (EMS) countries, the US and Canada, and the US, Germany, and Japan; Crowder and Phengpis (2007) used them to test inflation rates and convergence among the seven largest industrialized economies and; Kendall (2000) used Johansen cointegration, ADF tests and Perron tests to test for exchange rate convergence in CARICOM.

Johansen tests are used for testing cointegration of several time series which permits more than one cointegrating relationship. It is generally more applicable to use Johansen tests and ADF tests together than just using an ADF test for testing convergence. Busetti et al. (2006) pointed out that the joint use of unit-root tests and stationarity tests can allow a researcher to determine if regions have already converged or in the process of converging. This shows how important these tests are because there is a big difference between converging rates and already converged rates, and not knowing which is actually taking place could lead to policy makers choosing the wrong policy for the situation.

A standard unit root process as shown below is used in the analysis in this paper;

$$y_t = \delta + \rho y_{t-1} + \varepsilon_t \quad (1)$$

$\{\varepsilon_t\}$ is assumed to be independent and identically distributed random variable with zero mean, and is independent of the observed initial value y_0 . $\{y_t\}$ has a unit root if, $\rho = 1$. Therefore, the

null hypothesis is that $\{y_t\}$ has a unit root against a one-sided alternative of $\rho < 1$, and it is strictly -1 and 1.

For n series with unit roots and n-1 cointegrating vectors, convergence implies the series share a common stochastic trend. Since fewer cointegration vectors mean fewer factors driving the variables towards equilibrium, one cointegrating vector (n-1 cointegrating vectors) implies a very stable relationship. Linear combination $y_t^{Ice} - y_t*$ is stationary, where $\{ y_t^{Ice} \}$ is Iceland's vector and

$\{ y_t* \}$ is the corresponding vector for comparison countries in the study. These linear relationship also imply that the vectors are strongly cointegrated and have converged with a cointegrating vector of $[1, -1]$, a weaker and more general version is given below;

$$y_t^{Ice} - \alpha - \beta y_t* \tag{2}$$

Stationarity is a necessary condition for cointegration and convergence, but it is not sufficient as convergence also requires that $\beta > 0$. A strong version requires that $\alpha = 0$ and $\beta = 1$.

This paper seeks to determine the degree of convergence of Iceland's nominal interest rates and inflation rates with that of Canada, the Euro area and the United States using stationarity and cointegration tests. Nominal interest rates are used here as an indicator of financial market integration and inflation rates, a measure of monetary policy integration.

IV Empirical Results

Stationarity tests in autoregressive time series models continue to receive considerable attention in econometric analysis. This paper uses the Augmented Dickey Fuller (ADF) and the Ng-Perron tests for unit roots, since a necessary condition for cointegration is that individual time series are non-stationary. The Ng and Perron (2001) test statistic avoids the power problems usually associated with traditional methods for testing unit roots by putting together modified versions of Phillips and Perron (1988), Bhargava (1986) and the point optimal statistic by Elliot et al. (1996).

Tables 1 and 2 in the appendix show detailed results of the unit roots tests for Iceland, Canada, the Euro area and the United States. The null hypothesis in the ADF test is that the time series is non-stationary but in the Ng-Perron test, the null is that of stationarity. The results are summarized below;

Table 1: Unit Root Test

	Country			
Variable	Iceland	Canada	Euro area	United States
Inflation rate	Unit root	Stationary	Unit root	Stationary
Nominal interest rate	Unit root	Unit root	Unit root	Unit root

The results of these tests show that variables are non-stationary in levels except inflation in Canada and the US. The variables are integrated of order 1 and have to be differenced once to obtain stationarity, suggesting that shocks to the variables only have transitory effects and they would move back to equilibrium in the long run. Having established that the variables have unit roots (except inflation in Canada and the United States), cointegration tests are used to examine the degree of convergence of Iceland's inflation rate with that of the Euro area and nominal interest rates with rates in Canada, the Euro area and the United States.

The results of a Johansen Cointegration Test to determine if the variables are cointegrated are summarized below; see Appendix Table 3 for details.

Table 2: Johansen Cointegration Test

Number of Cointegrating Vectors for Inflation Rates		
Canada	Euro area	United States
-	1	-
Number of Cointegrating Vectors for Nominal Interest Rates		
Canada	Euro area	United States
1	1	1

The results in the table above show that nominal interest rates in Iceland are cointegrated with rates in Canada, the Euro area and with the United States. This result is consistent with earlier findings, following decades of financial market integration, in Europe, Canada and the United States, and in some other Organisation for Economic Cooperation and Development (OECD) countries.

Also, inflation rates in Iceland are cointegrated with inflation rates in the Euro area. One cointegrating vector (n-1 cointegrating vectors) in the test above implies a very stable relationship and the cointegration of both Iceland's nominal interest rates and inflation rates with the Euro area confirms the convergence of real interest rates.

V Discussion and Conclusion

This study employs cointegration techniques to determine the degree of convergence of Iceland's nominal interest rates and inflation rates with that of Canada, the Euro area and the United States. Nominal interest rates are used here as an indicator of financial market integration and inflation rates, a measure of monetary policy integration.

Using monthly data from 2002M1 to 2012M12, tests show that variables are non-stationary in levels except inflation in Canada and the United States. In Iceland and the Euro area where both nominal interest rates and inflation rates have unit roots, the Fisher equation would imply that real interest rates in these countries are stationary or that cointegration exists between nominal interest rates and inflation rates.

The paper concludes that there is a cointegrating structure for nominal interest rates that is consistent with convergence between Iceland and Canada, Iceland and the Euro area and Iceland and the United States. A single common stochastic trend observed in the study among a vector of *n* variables represents a condition of convergence and implies a very stable relationship. However, with respect to inflation a cointegrating vector confirmed convergence between Iceland and the Euro area, with no evidence of convergence in the others.

Canada's nominal interest rates may converge with rates in Iceland and may have a similar monetary policy goal as Iceland, but as a major oil exporter, its currency is likely to follow the price of oil. A formal currency union between the two countries would imply that if the price of oil is high, the currency would rise in value, raising the price of goods and services in Iceland. This has the effect of encouraging cheap imports instead of domestically produced goods and services and dampen exports especially tourism, which is an important industry in Iceland.

Nominal interest rate convergence indicates financial market integration among these countries and inflation convergence between Iceland and the EU indicates integration in monetary policies.

The results imply that monetary policy in Iceland may have lost some of its effectiveness as a stabilisation policy tool and if Iceland should abandon its currency, the natural choice is the euro.

Appendix

Appendix Table 1: Unit root tests for variables in levels

		Ng-Perron (Exogenous: Constant)			
Countries	ADF(Exogenous: Constant)	MZ_α	MZ_t	MSB	MPT
Iceland					
Inflation	-2.215	-8.409	-2.049	0.244	10.843
Interest rate	-1.229	-0.434	-0.219	0.506	17.955
Canada					
Inflation	-3.473*	-17.826*	-2.979*	0.167*	1.398*
Interest rate	-0.923	-2.128	-0.983	0.462	11.093
Euro area					
Inflation	-2.243	-8.557	-2.068	0.242	2.863
Interest rate	-1.266	-2.118	-0.781	0.369	9.605
United States					
Inflation	-3.681*	-18.499*	-3.041*	0.164*	1.326*
Interest rate	-1.042	-2.775	-1.109	0.399	8.617

*Rejects the null hypothesis of non-stationarity (unit root) in levels at 5%.

Appendix Table 2: Unit root tests for variables in First difference

Countries	ADF(Exogenous: Constant)	Ng-Perron (Exogenous: Constant) MZ_α	MZ_t	MSB	MPT
Iceland					
Inflation	-6.076	-43.189	-4.615	0.107	2.281
Interest rate	-8.735	-56.030	-5.293	0.095	0.437
Canada					
Interest rate	-7.545	-53.386	-5.167	0.097	0.459
Euro area					
Inflation	-8.897	-57.155	-5.344	0.094	0.434
Interest rate	-5.322	-37.695	-4.341	0.115	0.650
United States					
Interest rate	-4.694	-31.986	-3.999	0.125	0.766

The table above confirms stationarity in first difference for all tests @ 5%.

Values are compared with critical values for the ADF tests from Dickey and Fuller (1981) and for the Ng-Perron tests from Ng and Perron (2001). Table 1 shows that variables are non stationary in levels except inflation in Canada and the US. The variables have to be differenced once in Table 2 to obtain stationarity; they are integrated of order 1.

Appendix Table 3: Johansen cointegration test

		Canada		Euro area		United States	
	Test Type	$\alpha = 0; \beta = 1$	$\beta > 0$	$\alpha = 0; \beta = 1$	$\beta > 0$	$\alpha = 0; \beta = 1$	$\beta > 0$
Iceland *Inflation*	Trace	-	-	0	1	-	-
	Max-Eig	-	-	0	1	-	-
Iceland *Interest rate*	Trace	1	0	1	0	1	0
	Max-Eig	1	1	1	0	1	1

Number of cointegrating relations based on MacKinnon-Haug-Michelis (1999) at 5%.

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