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Ágúst Arnórsson and Gylfi Zoega*

Department of Economics
University of Iceland, 101 Reykjavik
Iceland

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Abstract

We find that both actual changes and unexpected changes in interest rates affect the average exchange rate in Iceland when the year 2009 is included in the sample that ends in August of this year but not when it is excluded. This early period was characterized by lax capital controls until the autumn of 2009. It follows that, given the moderate changes of interest rates observed in the data, using interest rates to stabilise the exchange rate may work when the capital controls are not effectively enforced but is not as useful when they are enforced. However, it should be noted that large changes in interest rates may have an effect on exchange rates when capital controls are enforced, although such changes never occurred during our sample period.

JEL: G01, E42, E52, E58.
Keywords: Financial crises, capital controls, policy rates, exchange rates.

*Corresponding author: Gylfi Zoega, Department of Economics, University of Iceland, 101 Reykjavik, Iceland. Email: gz@hi.is, Tel. +354 525 5239. This work was supported by the Icelandic Research Fund (IRF – grant number 130551-052) and the University of Iceland Research Fund.

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1. Introduction

The Icelandic parliament introduced capital controls on 29 November 2008 after the massive blow the country's financial system endured in October the same year. Before and after the financial crisis the Icelandic economy had suffered severe liquid funds and assets outflows that followed years of strong inflows in the form of local banks borrowing in international capital markets and speculators taking long positions in the krona, a form of the carry trade. In order to curb the outflow of capital the Central bank of Iceland raised its policy rate to 15.5% in the spring of 2008 hoping that a higher return on domestic assets might dissuade foreign owners from withdrawing their domestic investment and converting kronur into foreign currency. Raising nominal interest rates to such high levels, on the other hand, might be taken as a sign of desperation by foreign investors, not to mention the adverse effect high interest rate have on the liquidity position and even solvency position of domestic enterprises. The alternative of allowing the exchange rate to fall would, however, have had even greater adverse effects on these balance sheets due to the prevalence of foreign-currency loans. But the interest rate increases did not stem the outflow of capital, as the carry trade unraveled and the exchange rate fell and eventually collapsed in September. Due to heavy borrowing in foreign currencies by the Icelandic business sector, the fall in the exchange rate lead the sector into technical bankruptcy, while a modern bank run the inability of banks to borrow from other banks – marked the downfall of the renowned commercial banks who could no longer roll over their foreign debt. Thus Iceland resorted to capital controls, as Malaysia had previously done in 1998 under similar circumstances.[1,2]

Icelandic authorities reached an agreement with the IMF on a comprehensive financial stabilization program that included the introduction of the capital controls. The Fund lent the government considerable amounts of foreign currency – a multitude of the country's quota at the IMF – and oversaw the process of resurrection. The Fund recommended that capital controls would be upheld while keeping the current account open and at the same time allowing the conversion of interest income on domestic assets by foreign investors

[1] See Kaplan and Rodrik (2001) on the use of capital controls in Malaysia.
[2] For a recent survey of the macroeconomic consequences of financial crises, see Reinhart and Rogoff (2009). On sudden stops, see Calvo *et al*. (2006). For an account of the turmoil in Iceland, see Benediktsdottir, Danielsson, and Zoega (2011).

into foreign currency. The central bank was to support the capital controls by maintaining high policy interest rate and it responded by raising the policy rate to 18%. Thus the combination of high interest rates and capital controls was used to stabilize the exchange rate. Meanwhile, the automatic stabilizers of fiscal policy were allowed to have an effect and the ensuing large fiscal deficit maintained aggregate demand internally while the capital controls and monetary policy were used to affect the exchange rate.

The approach by the IMF was justified by stating that the high interest rate will provide a generous rate of return on financial assets held in domestic-currency and holders of those assets would therefore be less likely to bypass the controls. But critics pointed out that high interest rates may also create a flow of interest payments through the current account, thus lowering the exchange rate. Allowing investors to take their interest income out of the currency was meant to prevent the excessive accumulation of domestic currency assets by foreign creditors as well as maintaining credibility in international capital markets.

The argument that high interest rates may defend the value of currencies during financial crises has some but often a rather weak empirical backing. Carporale *et al*. (2005) came to the conclusion that tight monetary policy boosts the exchange rate in normal periods while during crises, as in Asia in the late 1990s, the exchange rate weakened. Goldfajn and Gupta (2003) explored whether high interest rates can reverse currency valuation following financial crises. They examined data for eighty countries that went through financial crises during the period 1980-1998. The results indicate that the interest rate had the intended effect except when the economy was dealing with banking crises on top of a financial crisis. Finally Flood and Jeanne (2005) developed a model that demonstrates the difficulty of using interest rate policy to affect exchange rates in a fixed exchange rate regime and fiscal deficits because high interest rates have a negative effect on the public finances and consequently weaken the currency.

2. Interest parity condition

The problem Icelandic authorities faced in the years following the collapse of 2008 is that investors holding assets in domestic currency could find it in their best interest to convert their assets into foreign currency before the capital controls are lifted by circumventing the capital controls. The policy interest rate should therefore be aimed at making them indifferent between holding their assets in the domestic currency rather than the alternative.

The interest rate parity condition describes this in more detail. The theory represents an equilibrium, which leads to the indifference mentioned above when the expected rate of return from holding domestic currency and foreign currency assets are equalized adjusting for a risk premium on domestic assets. In this equilibrium, the expected return from keeping the assets in domestic currency is equal to the expected return of converting those assets in to foreign currency offshore, buying bonds in the foreign currency and then later return to the domestic currency on the on-shore market. This equilibrium is attained by the following equation

$$i_t = i_t^* + \log(E_{t+1}^e) - \log(e_t) + p_t \quad (1)$$

where the returns on assets remaining in the domestic currency are represented by the interest rate *i* which is equal to the returns on exiting the currency offshore at exchange rate e_t – defined as the price of foreign currency – and invest in foreign assets, which yield the interest rate i^* and then entering the domestic currency again in the future at expected onshore exchange rate E^e_{t+1}. When investors lack trust in domestic assets the rate of return to holding domestic bonds – the left-hand side of the equation above – has to increase the expected rate of return from leaving the domestic currency and then returning with the foreign rate of interest – the right-hand side of the equation by a risk premium *p* on holding assets in domestic currency.

Raising domestic interest rates *i* increases the expected return of domestic currency assets and should have the effect of raising both the onshore and the offshore exchange rate until the expected return from exiting the currency offshore equals the domestic currency interest rates, adjusted for the risk premium. In effect, higher domestic interest rates will reduce the supply of ISK in the offshore market, raising the offshore exchange rate, which then induces exporters to sell their foreign currency on the onshore market, raising that exchange rate too. Raising the foreign interest rate i^* would have the opposite effect by lowering both exchange rates.

According to the theory of efficient markets any deviation from the interest parity condition would allow for riskless arbitrage opportunity and thus the condition should hold invariably. When the economy is however partly disconnected from the outside world prices can hardly reflect all information available and agents in the market might therefore be lacking sufficient information to utilize possible favorable circumstances. That being said the Icelandic economy won't be surrounded by capital controls forever and foresighted

investors might therefore be willing to invest in Iceland despite the capital controls on the promise that they will be able to withdraw their investment in the future and exchange it in to foreign currency.[3]

3. Event study of interest rate changes

The experiment we wish to carry out is to explore if changes in the Central Bank's policy interests rate affects the exchange rate of the Icelandic krona by conducting an event study where the average level of the exchange rate before and after an interest rate decision is compared.

Equation (1) implies that an unexpected increase in interest rates makes the exchange rate appreciate. We ran multiple least-squares regressions with the relative change of the average exchange rate – from before the interest rate decision to after – as the dependent variable and either actual changes in interest rate or the unexpected changes in interests as the independent variable. The exchange rate is measured by the general exchange rate index reported by Landsbanki Islands. Data on policy interest rates comes from the Central Bank of Iceland and the unexpected change is measured by difference in actual policy interest rate and the forecasts carried out by the research departments of two local commercial banks: Islandsbanki and Landsbanki Islands.

In our study we report estimates for three sample periods. The first ranges from January 2009 to August 2015. This is our whole sample and we have observations on interest rates, exchange rates and expected interest rate changes by one of the commercial banks, the Islandsbanki, for this period. The second sample starts in November in 2010 and ends in August 2015, it starts later because the second commercial bank, the Landsbanki, did not publish its forecast of interest rate changes until November 2010.

Two structural breaks may have occurred in the data since beginning of 2009. First, there was the strengthening of the controls in November 2009, until then the capital controls had not been effectively enforced. Secondly, the central bank started to use currency market interventions as a policy tool in the spring of 2013 and has reduced fluctuations in the rate ever since. An unexpected interest rate increase would then be expected to make the central bank buy more foreign currency instead of seeing the

[3] In fact, since the autumn of 2009 foreign investors have been allowed to invest in Iceland with the promise of being able to repatriate the investment in the future.

exchange rate appreciate. Our second sample does not include the year 2009 and hence can be used to test for the effect of the strengthening of capital controls. But in order to account for the change in the use of the policy instruments in 2013 we add one more sample period, from January 2010 to December 2012, which ends before the period of currency interventions started.

Figure 1 provides linear graphs of the raw data for the whole sample. As the reader may note the level of policy interest rate has become more stable in recent years and the forecasts have improved ad interim. Fluctuations in the rate of change of the exchange rate have also decreased. One explanation might be that the central bank tightened the capital controls in November of 2009 in order to encumber those trying to withdraw domestic monetary assets from doing so. Another, and more plausible reason, is that the central bank managed to stabilize the exchange rate through its currency interventions.

In Tables 1 and 2 below we present the results of the regressions mentioned above. The tables differ in how the average exchange rate is calculated; it is either an average on a weekly- or a monthly basis. The estimated equation in the first three columns of both tables is:

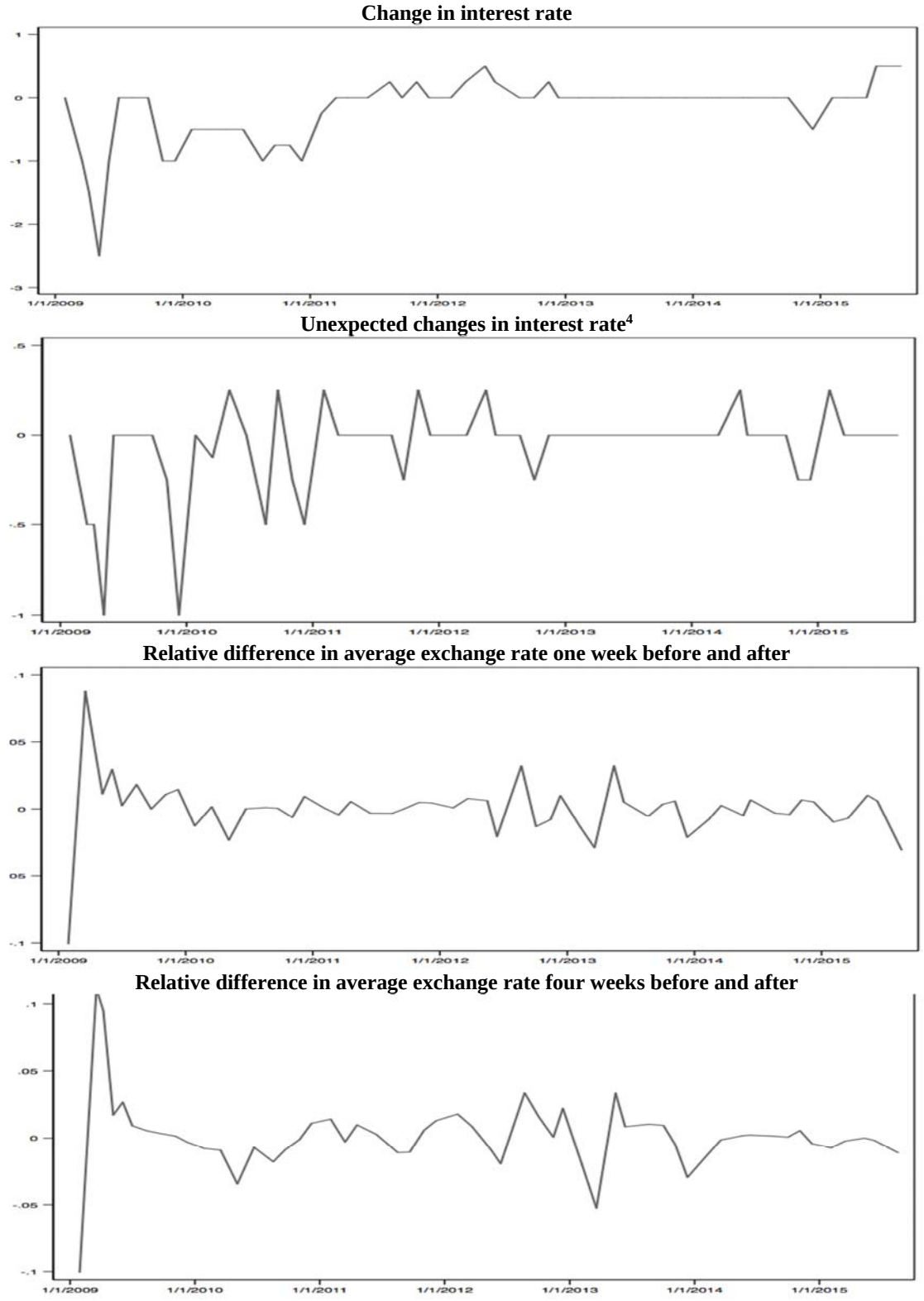
$$\frac{\bar{E}_a - \bar{E}_b}{\bar{E}_b} = a_o - a_1(i_a - i_b) \tag{2}$$

where $\bar{E}_a$ represents the average exchange rate after the change in policy interest rate and $\bar{E}_b$ the average exchange rate before the change. The policy interest rate after and before the announced day of adjustment are written as i_a and i_b respectively. We also use the unexpected rather than actual changes in interest rate. Here the estimated equation is

$$\frac{\bar{E}_a - \bar{E}_b}{\bar{E}_b} = a_o - a_1[(i_a - i_b) - (i_a^e - i_b)] \tag{3}$$

where i_a^e stands for the forecast carried out by either Islandsbanki or Landsbanki Islands. We provide the scatter plots in an appendix.

Figure 1. Difference in policy interest rate and relative difference in exchange rates



[4] Measured by Islandsbanki's research division.

Looking at the first column in both Tables 1 and 2, that uses the sample starting in January 2009, we note that if the Central Bank raises the policy rate by 1% it strengthens the average exchange rate of the krona by 1,5% in Table 1 and 1,7% in Table 2 – Table 1 using the one week before and after numbers and Table 2 using the four week before and after averages – since the exchange rate measures the price of foreign currency. The effect is smaller and statistically insignificant when the shorter samples, starting in 2010 are used. The estimated effect of unexpected changes in interest rate using the forecast by Islandsbanki is shown in the second column in the tables. The pair indicates that if Islandsbanki's research department is off by 1% it results in an increase in the average exchange rate by 2.9% and 3.2%, almost a doubling of the effect of the effects of the unadjusted interest rate changes in column (1). The effect remains statistically significant. In contrast, the effect of the unadjusted interest rate increase using the reported expectations by Landsbanki is statistically insignificant in column (4) of Table 1 due to the year 2009 being omitted from the sample. Using four weeks' averages does not change the results significantly.

The statistical significance of the effect of changes in interest rates on exchange rates appears to depend on the inclusion of the period from January 2009 until November 2009 in the sample. This was a period when the exchange rate depreciated significantly in the spring and summer of 2009, mainly due to lax supervision of the capital controls, until November 2009 when stronger supervision made the exchange rate appreciate.[5] The lowering of the policy interest rates in the spring of 2009 coincided with the depreciation of the currency, hence making the estimated coefficients in columns (1) and (2) statistically significant from zero. These results suggest that using interest rates to stabilize a currency is more effective when capital controls are not being strongly implemented but that the need to maintain high interest rates diminishes when the capital controls are more strongly reinforced. At least, moderate changes in interest rates do not appear to affect the exchange rate with effectively enforced capital controls. However, we cannot conclude anything about what would have happened to exchange rates if the interest rates had been changed more or brought down to very low levels based on this evidence.

[5] The more effective enforcement of the capital controls stabilised the exchange rate, which then led to lower inflation, allowing the central bank to continue to lower nominal rates in 2010.

Finally, in columns (5) and (6) we exclude the years 2013-2015 when the central bank was intervening directly in the currency market, hence masking any effect of interest rate changes on the exchange rate. However, the coefficient of the interest rate variable remains insignificant in these regressions also, which shows that the moderate changes in the interest rate observed after 2009 did not have a significant effect on the exchange rate independent of whether they were anticipated or not.

Table 1. Estimations in averages for **the one-week period** before and after

Dependent variable:	Relative difference in average exchange rate one-week before and after					
Sample period	01.01.09 to 31.08.15	01.01.09 to 31.08.15	01.11.10 to 31.08.15	01.11.10 to 31.08.15	01.01.10 to 31.12.12	01.01.10 to 31.12.12
	Change in interests	Unanticipated by Islandsbanki	Change in interests	Unanticipated by Landsbanki	Change in interests	Unanticipated by Islandsbanki
Coefficient estimate	-0,015	-0,029	-0,007	-0,74	0,002	-0,004
Std. Error	0,005	0,012	0,007	1,13	0,006	0,011
t-value	-2,85(**)	-2,51(**)	-1,05	-0,66	0,33	-0,31
R-squared	0,133	0,106	0,028	0,015	0,005	0,004
Adj. R-squared	0,117	0,089	-0,002	-0,015	-0,04	-0,041
Observations	55	55	39	39	24	24

99% confidence interval is denoted by (***) while the: 95% confidence interval is denoted by (**). The null hypothesis for heteroskedasticity can be rejected for the starred sample by 95% confidence interval but skewness testing for normality reports ambiguous result. However, a non-parametric alternative to the paired Student's t test - Wilcoxon signed-rank test- rejects the null hypothesis that the expectations had no effect on the exchange rate by 90% confidence interval.

Table 2. Estimations in averages for **the four-week period** before and after

Dependent variable:	Relative difference in average exchange rate four-weeks before and after					
Sample period	01.01.09 to 31.08.15	01.01.09 to 31.08.15	01.11.10 to 31.08.15	01.11.10 to 31.08.15	01.01.10 to 31.12.12	01.01.10 to 31.12.12
	Change in interests	Unanticipated by Islandsbanki	Change in interests	Unanticipated by Landsbanki	Change in interests	Unanticipated by Islandsbanki
Coefficient estimate	-0,017	-0,032	-0,009	-0,584	0,008	-0,004
Std. Error	0,006	0,014	0,009	1,394	0,007	0,011
t-value	-2,55(**)	-2,24(**)	-1,01	-0,42	1,12	-0,31
R-squared	0,109	0,086	0,026	0,005	0,541	0,004
Adj. R-squared	0,092	0,069	0	-0,022	0,111	-0,041
Observations	55	55	39	39	24	24

99% confidence interval is denoted by (***) while the: 95% confidence interval is denoted by (**). The null hypothesis for heteroskedasticity can be rejected for the starred sample by 95% confidence interval but skewness testing for normality reports ambiguous result. However, a non-parametric alternative to the paired Student's t test - Wilcoxon signed-rank test- rejects the null hypothesis that the expectations had no effect on the exchange rate by 90% confidence interval.

4. Conclusions

The historical financial crisis in Iceland provides excellent testing grounds for the effect of high interest rates accompanied by capital controls. Starting from a policy rate of 18% in February 2009, a sequence of interest rate reductions brought interest rates down to 4.25% at the end of 2011.

Overall, the experience suggests a weak effect of moderate changes in interest rates on the exchange rate when capital controls are enforced. It follows that cutting interest rates from a very high level is not likely to make a currency depreciate in an effective capital control regime, highlighting the importance of the effective enforcement of the controls. However, when capital controls are not effectively being monitored, lowering interest rates may make the exchange rate depreciate.

This paper ends with the caveat that even if small changes in the central bank policy rate do not affect the exchange rate notably in a capital controls regime, interest rate policy can be used to affect aggregate demand, the incentives to save and invest in a balance of payments crisis and the incentive to deleverage. Therefore, maintaining non-zero interest rates in a capital control regime may be justified by other factors. Besides, we do not know what would have happened to exchange rates in Iceland if interest rates had been brought down to very low levels in large steps, only that the small changes in interest rates that we see in the data did not affect the exchange rate in a statistically significant way once capital controls were more strongly reinforced.

References

Agnieszka, S., 2008. International parity relations between Poland and Germany: A cointegrated VAR approach. MPRA Paper 24057.

Ariyoshi, A., Habermeier, K., Laurens, B., Otker-Robe, I., Canales-Kriijenki, J.I., Kirilenko, A., 2000. Capital controls: Country experiences with their use and liberalization. IMF Occasional Paper 190.

Benediktsdottir, S., Danielsson, J., Zoega, G., 2011. Lessons from a collapse of a financial system. Economic Policy. 26 (66), 183-235.

Calvo, G., Izquierdo, A., Loo-Kung, R., 2006. Relative price volatility under sudden stops: The relevance of balance sheet effects. Journal of International Economics. 9 (1), 231-254.

Caporale, G.M., Cipollini, A., Demetriades, P.O., 2005. Monetary policy and the exchange rate during the Asian crisis: Identification through heteroscedasticity. Journal of International Money and Finance. 24, 39-53.

Danielsson, J., Zoega, G., 2009. The Collapse of a Country, second edition, www.RiskResearch.org.

Flood, R.P., Jeanne, O., 2001. An interest rate defense of a fixed exchange rate? Journal of International Economics. 66, 471-484.

Goldfajn, I., Gupta, P., 2003. Does monetary policy stabilize the exchange rate following a currency crisis?. IMF Staff Papers.50 (1), 90-114.

Gosh, A.R., Chamon, M., Crowe, C., Kim, J.I., Ostry, J.D., 2009. Coping with the crisis: Policy options for emerging market countries. IMF Staff Position Note 23, SPN/09/08.

Kaplan, E., Rodrik , D., 2001. Did the Malaysian capital controls work? NBER Working Paper 8142.

Keynes, J.M., 1929. The German transfer problem. The Economic Journal. 39 (153), 1-7.

Lacerda, M., Fedderke, J.W., Haines, L.M. 2010. Testing for purchasing power parity and uncovered interest parity in the presence of monetary and exchange rate regime shifts. South African Journal of Economics. 78 (4), 363-382.

Reinhart, C.M., Rogoff, K.S., 2009. The Aftermath of financial crises. NBER Working Paper 14656.

Taylor, M. P. (1989). Covered interest arbitrage and market turbulence. *The Economic Journal*, 376-391.

Data

Data on central bank interest rate are taken from the Central Bank of Iceland‘s website: www.sedlabanki.is.

Data on exchange rates were taken from the website of the Landsbanki: https://www.landsbankinn.is/markadir/gjaldmidlar/gengisthroun/#/A/01-12-2012/18-09-2015/GVT-ISK/

Predicted interest rate changes were provided by the research divisions of the two commercial banks:

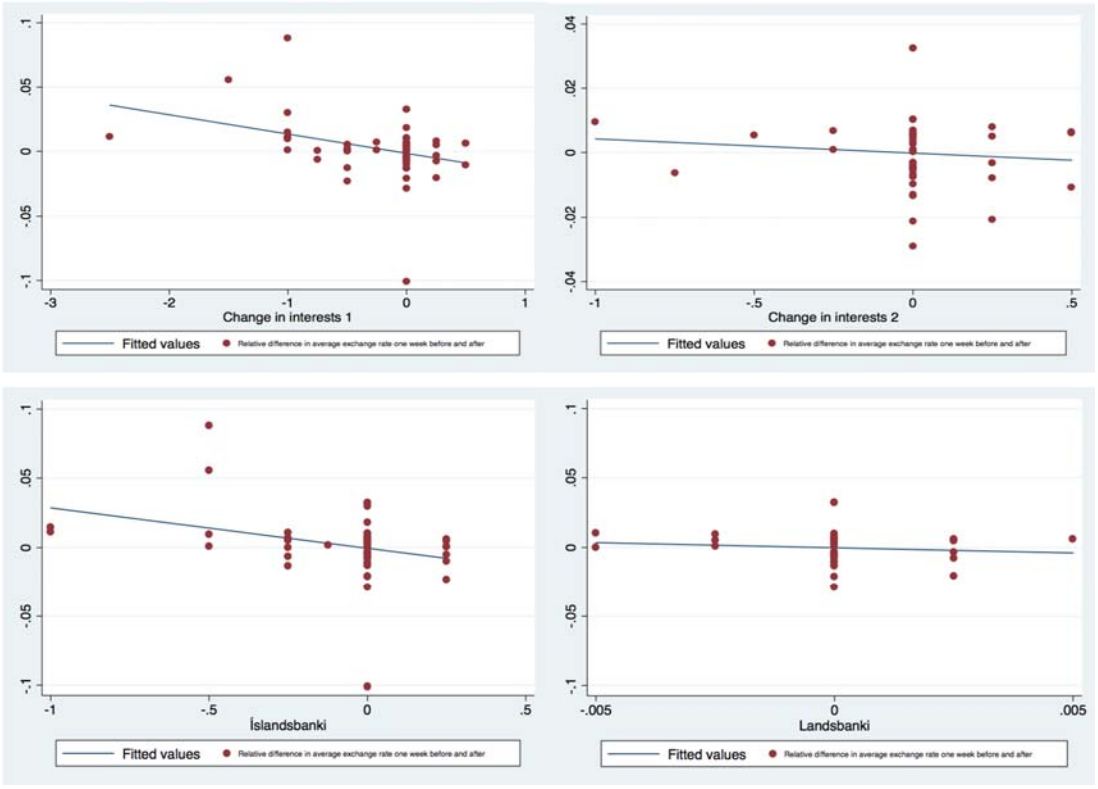
Islandsbanki – Department of analysis (2015)

Landsbanki Islands – Department of analysis (2015)

Appendix

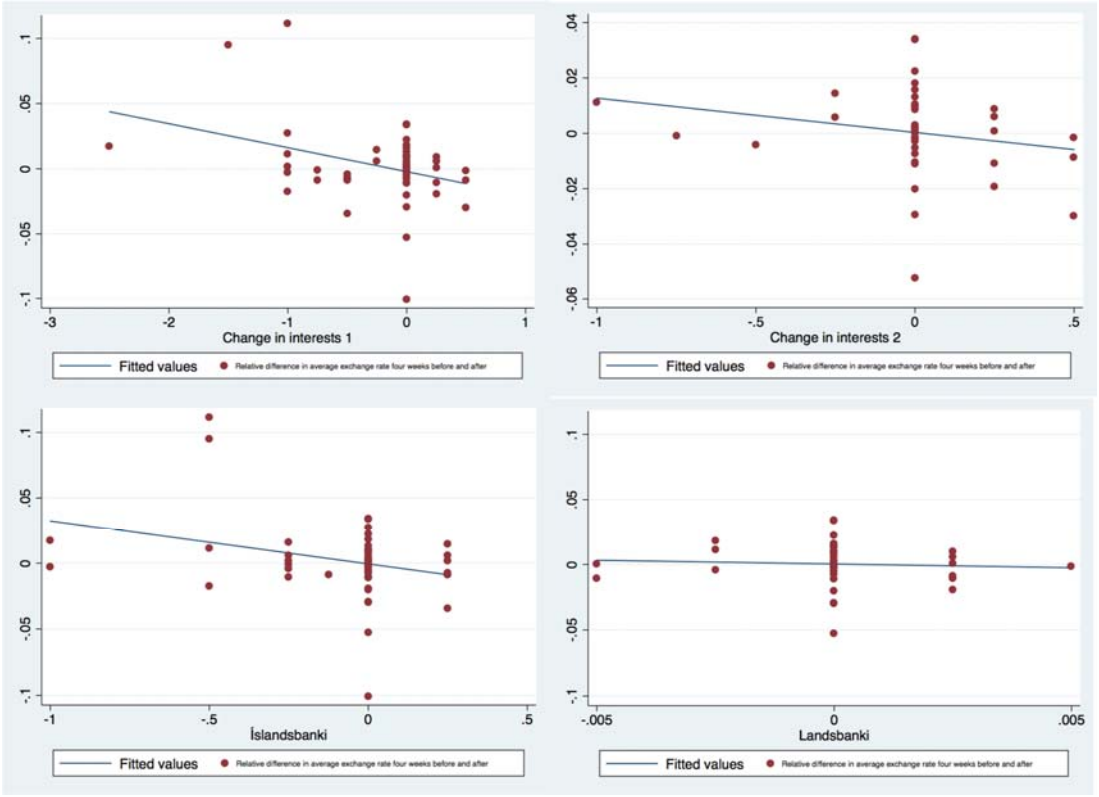
Figures A1 and A2 show the relationship between the relative change of the exchange rate (vertical axis) and the change in interest rates (horizontal axis) using one-week average in Figure A1 and four week averages in Figure A2.

Figure A1. Relative difference in average exchange rate <u>one</u> week before and after



The panel in the top-left corner shows the relationship between relative changes in average exchange rates using **one-week** averages and changes in interests for the period 1. January 2009 to 31. August 2015. The one in the top-right corner uses data from the period 1. November 2010 to 31. August 2015. The graphs below replace actual with unexpected interest rate changes for the same periods.

Figure A2. Relative difference in average exchange rate <u>four</u> weeks before and after



The panel in the top-left corner shows the relationship between relative changes in average exchange rates using **four-week** averages and changes in interests for the period 1. January 2009 to 31. August 2015. The one in the top-right corner uses data from the period 1. November 2010 to 31. August 2015. The graphs below replace actual with unexpected interest rate changes for the same periods.