WORKING PAPER
CENTRAL BANK OF ICELAND
No. 47

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November 2009

Central Bank of Iceland Working Papers are published by the Economics Departments of the Central Bank of Iceland. The views expressed in them are those of their authors and not necessarily the views of the Central Bank of Icleand.

Also available on the Central Bank of Iceland World Wide Web site (http://www.sedlabanki.is)

ISSN 1028-9445

A double-edged sword:
High interest rates in capital-control regimes[a]

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Abstract

This paper derives the relationship between central bank interest rates and exchange rates under a capital control regime. Higher interest rate may strengthen the currency by reducing consumption and imports and by inducing foreign owners of local currency assets not to sell local currency off shore. There is also an effect that goes in the opposite direction: Higher interest rates increase the flow of interest income to foreigners through the current account which makes the exchange rate fall. The historical financial crisis now under way in Iceland provides excellent testing grounds for the analysis. Overall, the experience does not suggest that cutting interest rates moderately from a very high level is likely to make a currency depreciate in a capital control regime but highlights the importance of effective enforcing of the controls.

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

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In recent years many countries have experienced an inflow of foreign capital driven by the carry trade. Examples include Australia, Iceland and Turkey. A rapid unwinding of the carry trade can have disastrous consequences, as experienced by Iceland in the fall of 2008 where the unwinding of the carry trade led to a collapse of the currency and a financial crisis when the country's banking system collapsed and a large fraction of the business sector became insolvent.[1] One possible response to the unwinding is to impose capital controls that keep the current account open and allow the flow of interest income to be converted into foreign currency.[2] This was the measure recommended by the IMF in Iceland following the collapse of its financial system in October 2008. More controversially, the Fund recommended that the capital controls be supported by high central bank interest rates, which were raised to 18% before the programme was commenced. The question addressed in this short note is to what extent the policy of high interest rates really helps support the exchange rate when capital controls are in place.

The rationale for keeping interest rates high alongside the capital controls rests mainly on the premise that a high rate of return on domestic-currency financial assets will discourage investors from exploring ways of getting around the controls, i.e. by finding local exporters willing to buy the local currency for foreign exchange in the off-shore currency market. There are, of course, also the prospects of relaxing the controls. However, it is clear that this is only the case if higher domestic interest rates translate into higher interest income measured in foreign currency. This can be demonstrated not to be always the case. Interestingly, high interest rates also have the effect of weakening the exchange rate by creating a flow of interest payments through the current account.

The empirical work on the effect of high interest rates on exchange rates during financial crisis does not lend strong support to the argument that high interest rates defend the value of the currency. Caporale et al. (2005), amongst others, find that while tight monetary policy boosts the exchange rate during normal periods, it weakened it during the Asian crisis in the later 1990s. Goldfajn and Gupta (2003) analyse a large dataset of currency crises in eighty countries for the period 1980-1998 in order to explore

[1] 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 Danielsson and Zoega (2009).

[2] See Ariyoshi (2000) for a review of different countries' experience with capital controls, including those in East Asia in the late 1990s.

whether high interest rates are successful in reversing currency undervaluation in the aftermath of a currency crisis. They find that this is so except when the economy also faces a banking crisis, in which case the results are not robust. Flood and Jeanne (2005) derive a model that shows that an interest rate defence of a fixed exchange rate regime can prove ineffective if accompanied by an unsound fiscal policy because the high interest rates will be perceived to have a detrimental effect on the public finances which weakens the currency. There are few studies of the effect of high interest rates under a regime of capital controls.

The demonstration will first be carried out under the assumption of no leakages. Thereafter the role of leakages will be explored before incorporating the effects into a simple macroeconomic model, which captures the different links between the policy rate and the exchange rate. The final section describes the effect of recent interest rate reductions in Iceland on the on-shore and the off-shore exchange rate in light of the earlier discussion.

1. The case of no leakages

Assume that the foreign owners of domestic currency assets are concerned about their interest income measured in foreign currency, *iED* where *i* is the rate of interest, *E* is the nominal exchange rate measured as the foreign-currency price of one unit of local currency, so that an increase in *E* means appreciation, and *D* is the stock of foreign-owned assets measured in domestic currency. Prices at home and abroad are fixed and assumed to equal one so that *E* is also the real exchange rate. These investors will benefit from both higher interest rates *i* as well as a higher exchange rate *E*. They will not benefit from an interest rate rise if this is offset by a large depreciation of the domestic currency. It follows that one can derive an *iso-interest* curve that gives all combinations of *i* and *E* that the foreign investor is indifferent between. Taking the total differential of *iED* gives the slope of the curve as

$$\frac{dE}{di} = -\frac{E}{i} < 0 \qquad (1)$$

The equation defines a downward-sloping, strictly convex iso-interest curve in the exchange rate/interest rate space.

The feasible combinations of exchange rates and interest rates under a capital control regime are given by the current account balance,

$$iED = EX\left(E\right) - M\left(E\right) \tag{2}$$

The interest payments measured in foreign exchange have to equal the excess of foreign-exchange export earnings and the cost of imports. An appreciation of the currency gives lower export volumes, $X_E(E)<0$, and higher import volumes, $M_E(E)>0$.[3]

Assume that imports become more sensitive to changes in exchange rates as their volumes increase: that is when the exchange rate rises, $M_{EE}(E)>0$, while the sensitivity of exports with respect to exchange rates in a resource-based economy does not depend on the volume of exports, $X_{EE}(E)=0$. Conversely, when the currency depreciates, imports fall, but consecutive depreciations have a smaller effect on imports because initially consumers reduce their consumption of the more price-elastic imports – cars, consumer durables and so forth – making their consumption basket gradually more price-inelastic. Even a very large depreciation will not dissuade consumers from using some imported food, oil and medication; the elasticity of imports becomes very small.

Taking the total differential of equation (2) gives a *current-account constraint* that reflects all the combinations of *E* and *i* that make the current account balanced. The slope of the curve in the E-I space is equal to the marginal rate of transformation between *E* and *i*

$$\frac{dE}{di} = \frac{ED}{X + EX_E - M_E - iD} \tag{3}$$

which is negatively sloped as long as

$$e_X + e_M > 1 \tag{4}$$

where $e_X = -EX_E\left(E\right)/X\left(E\right)$ and $e_M = E\left(M_E\left(E\right)+iD\right)/\left(M\left(E\right)+iED\right)$ are the elasticities of exports and imports (plus interest payments on domestic-currency assets to

[3] Note that leakages do not occur, by assumption, so that the appreciation does not have the effect of increasing leaks by making it more tempting for exporters to sell their foreign currency at the lower off-shore rate nor does it reduce leaks by making it less tempting for the foreign investors to find these exporters in the off-shore market.

foreigners) with respect to the exchange rate. The Marshall-Lerner condition is thus necessary and sufficient for $dE/di<0$.

Clearly, a depreciation will raise exports and lower imports to enable the transfer of resources to pay the interest on the debt but the depreciation will also reduce the foreign currency income from exports – and lower the foreign currency value of interest payments – requiring the elasticities to be large enough to offset this effect. This effect is decreasing in the stock of debt so that lower elasticities suffice when debt D is very high.[4]

The tangency between the iso-interest curve and the current-account constraint – given by the equality of the slopes of the two shown in equations (1) and (3) – gives $X+EX_E-M_E=0$. Dividing by X yields

$$-EX_E(E)/X(E)+EM_E(E)/\left(M(E)+iED\right)=1 \tag{5}$$

which is the condition;

$$e_X+e_M-\frac{iD}{M(E)+iED}=1 \tag{6}$$

Equation (6) defines a maximum if, as assumed, $X_{EE}=0$ and $M_{EE}>0$, since the second-order condition is: $2X_E-M_{EE}<0$. The optimum for the foreign investor is shown in Figure 1 as point F. The current account is balanced and the interest income in foreign currencies is maximized.

The maximization of interest income of foreign investors is not desirable from the viewpoint of local authorities. These may want to maximize the foreign-currency value of domestic output net of interest payments to foreigners; $EY-iED$. This gives upward-sloping *iso-income* curves, higher interest payments have to be met by a higher exchange rate to make the local economy indifferent to the change:

$$\frac{dE}{di}=\frac{ED}{Y-iD}>0 \tag{7}$$

[4] The current-account constraint is concave if

$$\frac{d^2(iED)}{di^2}=\frac{ED^2}{(X+EX_E-M_E-iD)^2}\left(2-\frac{E(2X_E-M_{EE})}{X+EX_E-M_E-iD}\right)<0$$

which translates into $X-M_E+\frac{1}{2}EM_{EE}>iD$. Since $M_E>0$ and $M_{EE}>0$ it follows that as i gets large, the M_E term becomes small.

The local authorities may hence prefer point *L* since in the absence of leakages, there is no reason for them to offer positive interest rates.[5] However, the prospects of the relaxation of capital controls calls for higher interest rates as does a concern for maintaining credibility in international financial markets. In addition, lowering rates may weaken the capital controls by inducing foreign investors to buy foreign currency off shore.

2. Leakages introduced

Allowing for leakages, the flow of export revenue into the on-shore foreign exchange market depends on the difference between the on-shore and the off-shore exchange rates. The typical exporting firm maximizes its domestic currency profits, defined as the sum of domestic currency revenue on shore and off shore net of the expected cost of being caught evading the capital controls.

Assume that the expected costs of evasion depend on the volume of off-shore trade: $T(X\text{-}X^L) = t_0(X\text{-}X^L) + t_1(X\text{-}X^L)^2$, where X^L is the volume of exports appearing in the on-shore export market and $t_0 > 0$ and $t_1 > 0$. The expected profits in units of output are given by equation (8),

$$\pi = \frac{e}{E} X^L + \left(X - X^L\right) - \left[t_0\left(X - X^L\right) + t_1\left(X - X^L\right)^2\right] \qquad (8)$$

where *e* is the off-shore exchange rate and *E* the on-shore exchange rate as before. The volume X^L that shows up in the on-shore market generates less revenue – in terms of domestic output – than that which shows up in the off-shore market. Imagine that each unit of exports generates *e* units of foreign currency in the off-shore market but then this is bought back in using the on-shore market at a higher exchange rate so that the revenue coming from exports through the on-shore market is lower per unit of output sold than that coming from the off-shore market since $e<E$. It follows that exporting firms will lose from buying the domestic currency on-shore where it is more expensive. However, buying on shore will lower the expected costs of detection.

[5] The iso-income curves are convex since $\frac{d^2E}{di^2} = \frac{ED^2}{\left(Y - iD\right)^2} > 0$.

The first-order condition with respect to X^L gives exports traded in the off-shore market as a positive function of the difference between the on-shore and the off-shore exchange rate and a negative function of the intensity of monitoring of the capital controls, t_0 and t_1:

$$X - X^L = \frac{1}{2t_1}\left(\frac{E-e}{e}\right) - \frac{t_0}{2t_1} \tag{9}$$

The on-shore exchange rate is determined so as to generate a balanced current account, which, from equations (2) and (9), gives

$$iED = E\left(X - \frac{1}{2t_1}\left(\frac{E-e}{e}\right) + \frac{t_0}{2t_1}\right) - M\left(E\right) \tag{10}$$

An increase in the exchange rate differential – making the currency relatively more expensive on shore – will increase leakages and lower X^L while an increase in monitoring t_0 and t_1 will raise X^L by increasing the likelihood that violations of the capital controls will be detected. It follows that greater enforcing of the controls will strengthen the exchange rate while an off-shore depreciation will weaken it by encouraging local exporters to buy domestic currency off shore.

The next equation sets the returns to staying in the domestic-currency asset equal to that of exiting the currency off shore and investing in foreign assets that yield an interest rate of i^* plus a risk premium on domestic-currency assets p:

$$i_t + \frac{E^e_{t+1} - e_t}{e_t} = i^*_t + \frac{p_t}{e_t} \tag{11}$$

Solving for the domestic rate of interest gives;

$$i_t = i^*_t - \frac{E^e_{t+1} - e_t}{e_t} + \frac{p_t}{e_t} \tag{12}$$

This is the interest-parity condition. This equation determines the off-shore exchange rate given the domestic and the foreign interest rate and the risk premium: An increase in domestic interest rates will raise the expected return from holding domestic-currency assets and this will make the off-shore exchange rate increase until the expected return from exiting the currency off shore is raised to equal the higher domestic currency interest rates: an increase of the foreign interest rate i^* will have the converse effect of making the off-shore exchange rate fall in order to lower the return to exiting the

currency back to where it was before; an increase of the risk premium p will lower the off-shore exchange rate for the same reason; and finally, the higher is the expected future on-shore exchange rate E_{t+1}^{e}, the higher is the off-shore exchange rate.

Together, equations (9), (10) and (12) determine the on-shore exchange rate E, the off-shore rate e and the volume of exports that shows up in the on-shore market X^L. The equations reveal that cutting interest rates has both a *flow effect* – captured by equation (10) – as well as a *stock effect* – capture by equation (12). Lower interest rates strengthen the exchange rate by reducing the required trade balance. This is the flow effect. But they also lower the expected return from holding domestic-currency assets which makes the off-shore exchange rate fall – when leakages increase – which lowers the volume of exports that go to the on-shore market X^L, which makes the on-shore exchange rate fall. It follows that cutting interest rates below the level that maximises the foreign-exchange revenue in Figure 1 may either strengthen or weaken the exchange rate. Note that stronger enforcement of capital controls – a higher level of t_0 and t_1 – will weaken the stock effect and make it more likely that the exchange rate increases following an interest rate reduction.

Starting from a high rate of interest, beyond the one generating maximum interest income in foreign currency in Figure 2, a fall in the rate of interest initially makes domestic assets more lucrative and hence reduces the supply of local currency off shore – while the interest income in foreign currencies iE is rising because E rises disproportionately with lower i – but, eventually, a further interest rate reduction will result in a lower interest income measured in foreign currency and this would tend to lower the exchange rate if the stock effect dominates the flow effect. This is shown in Figure 2. A falling interest rate may now cause the on-shore exchange rate to fall – if the stock effect of increased leakages dominates the effect of smaller flows of interest income – which makes the current- account constraint upward-sloping from the origin at low rates of interest. In this case the optimum for the local economy would entail a non-zero rate of interest – since interest rates would be raised from a very low level to reduce the leakages and strengthen the exchange rate.

When we focus on the area where the Marshall-Lerner conditions are satisfied, raising interest rates will always make the off-shore exchange rate increase but will either

make the on-shore increase – if the stock effect dominates – or decrease – if the flow effect dominates. This is shown in Figure 3.

3. A macroeconomic model

We start by summarizing the equations that determine the on-shore exchange rate *E*, the off-shore exchange rate *e* and the volume of exports that show up on shore X^L. The only change made is to make imports *M* depend on output *Y*, in addition to the exchange rate *E*.

$$iED = E\left(X - \frac{1}{2t_1}\left(\frac{E-e}{e} \right) + \frac{t_0}{2t_1} \right) - M\left(E,Y\right) \qquad (10')$$

$$i_t = i_t^* - \frac{E_{t+1}^e - e_t}{e_t} + \frac{p_t}{e_t} \qquad (12')$$

The first equation describes the current-account constraint (CA) while the second one has the interest parity constraint (IP).

We can easily add the two equations to a traditional macroeconomic model. Assume that demand determines output and that demand depends on output *Y*, the domestic interest rate *i* and the real exchange rate *E*. Also assume a horizontal LM curve given by the policy rate

$$i = i^p \qquad \text{LM} \qquad (13)$$

Add an IS curve that has output *Y* as a function of demand which depends on the domestic rate of interest, output, the exchange rate *E* and a fiscal parameter *F*.

$$Y = D\left(i,Y,E,F\right) \qquad (14)$$

We now have a system of four equations in four endogenous variables; output, the domestic rate of interest, the on-shore exchange rate and the off-shore exchange rate. The general equilibrium is shown in Figure 4.

Changes in the central bank policy rate have a threefold effect on the on-shore exchange rate. A higher interest rate – represented by an upward shift of the horizontal LM curve – may reduce demand and make output contract which then makes the volume of imports fall which makes the currency appreciate since the current account will now be balanced at a higher exchange rate. This is *the income effect*. Second, the higher interest rate raises the return to holding domestic assets which makes the off-shore exchange rate

increase due to a reduction in the supply of the domestic currency in the off-shore market. This will tend to strengthen the on-shore exchange rate when exporters turn to the on shore market. This is *the stock effect*. Finally, the higher interest rate puts downward pressure on the on-shore exchange rate by raising the flow of interest income going through the current account since a lower exchange rate is necessary to create a larger trade surplus so as to accommodate the higher interest payments to foreigners. This is *the flow effect.*

Clearly, the size of the income effect depends on the slope of the IS curve and the elasticity of imports with respect to the exchange rate. With a steep IS curve and a low elasticity, the income effect becomes unimportant. The size of the stock effect depends on the effectiveness of the capital controls t_1. The effect is small when the controls are more effective because exporters will not be as willing to buy the local currency off shore. Finally, the flow effect depends on the elasticities of imports and exports with respect to the exchange rate.

4. Discussion

High interest rates help strengthen the exchange rate in a capita-control regime by lowering aggregate demand and inducing foreign investors – trapped by the capital controls – not to try too hard to evade the controls. However, they create a flow of interest income that when converted into foreign currency puts downward pressure on the exchange rate. This is the transfer problem discussed by Keynes in the 1920s.[6]

During a financial crisis when households are paying off their debt, the higher interest rates may not lower demand much and the effect of interest rates on leakages is uncertain and certainly declining in the intensity of monitoring of the capital controls. It is hence quite possible that high interest rates put downward pressure on the exchange rate.

Starting from very high interest rates, the lowering of rates will raise the interest income of foreign investors measured in foreign currency due to an appreciation of the domestic currency, caused by a smaller flow of interest income into the foreign-exchange market. In this case, the lowering of interest rates will benefit both the home country as well as the foreign investors. A further reduction of interest rates will harm the foreign

[6] See Keynes (1929).

investors, but may benefit the local economy. The reduction will benefit the local economy when there are no leakages – both because of lower interest payments in domestic currency but also because of smaller interest payments being converted into foreign exchange which will raise the exchange rate – but may hurt the local economy if leakages are increased by making the currency depreciate. In this case the effect of increased leakages on the exchange rate – making it depreciate – dominates the effect of a reduced flow of interest income – which generates an appreciation. It follows that raising rates at low levels may strengthen the exchange rate in the presence of leakages but will always weaken the exchange rate in the absence of leakages. There are two effects at work; the stock effect causes a currency appreciation while the flow effect causes a depreciation of the currency.

With leakages, the off-shore exchange rate is affected by changes on the supply side and the demand side. The off-shore exchange rate is increasing in the interest income on domestic assets measured in foreign currency; it is decreasing in the foreign rate of interest; and decreasing in the risk premium on domestic assets. It follows that a falling spread between the on-shore and the off-shore exchange rates can be caused by a reduced risk premium that reduces the supply of the local currency in the off-shore market or by exporters using the off-shore market to a greater extent by demanding more units of the local currency due to a less effective enforcement of the capital controls.

In conclusion, one must be careful when applying the policy of high interest rates in a capital-control regime and carefully monitor all stocks and flows to see if the high interest rates are operating to strengthen or weaken the exchange rate.

5. Iceland's experience with capital controls and high interest rates

Iceland was hit particularly severely by the global credit crunch. In the years preceding the crash, the country experienced one of the world's most rapid credit expansions when the balance sheets of the country's three largest banks grew from one year's GDP to nine year's GDP in just over four years. This expansion in banks' balance sheets was accompanied by an expansion of the balance sheets of businesses that became increasingly leveraged over the same period, usually in foreign-currency denominated loans (80% of total business debt to domestic depository institutions). Domestic asset

prices reflect this development; the stock market grew by a factor of nine over a period of four years, the currency appreciated and house prices more than doubled.

This development came to an end when the banks could no longer borrow wholesale in international credit markets starting in late 2007. Their situation became increasingly dire until Monday morning, the 29th of September, when the Central Bank explained that the smallest of the three large banks had approached the bank for help because of an anticipated liquidity problem in the middle of October. Lacking confidence in the collateral offered, the Central Bank decided to buy 75% of its shares at a very low price, leaving the bank few options but to accept. The part nationalization undermined confidence in the Icelandic banking system. The immediate effect was to cause credit lines to be withdrawn from the two remaining banks. One of them experienced a run on one of its foreign branch and collapsed while the other was brought down by the actions of the British government. The foreign exchange market collapsed on October 8th. The closing of the international part of the payment system immediately affected foreign trade, importers could not pay suppliers and exporters could not transfer funds to Iceland to meet domestic costs. The crisis spread quickly to the nonfinancial sector of the economy. Between 33-60% of non-financial firms became technically bankrupt; and a large swath of industries and employment – based on an abundance of borrowed money and a high exchange rate – became obsolete overnight, setting in motion a sudden rise of structural unemployment.

The Icelandic authorities eventually requested assistance from the International Monetary Fund. The IMF published in November 2008 their analysis of the crisis and the only published official plan on how to respond to it.[7] The plan lays out the objectives of monetary policy, fiscal policy and the restructuring process for the banking sector. The IMF program aims at stabilizing the exchange rate by a combination of high interest rates and severe capital controls that are planned to be gradually dismantled; to foster a banking system and protect relations with foreign financial institutions by the adoption of a strategy that is nondiscriminatory and collaborative; and, finally, to organize fiscal consolidation in light of the much greater anticipated level of public indebtedness. With

[7] International Monetary Fund, Iceland, *Request for Stand-By Arrangement*, November 25, 2008 (see http://www.sedlabanki.is/lisalib/getfile.aspx?itemid=6606).

the program came a rescue package worth around $5.2 billion from the IMF and several countries.[8]

One problem preventing a return to a floating exchange rate is the substantial amount of foreign speculative capital remaining in Iceland. If the exchange rate were to float, the expectation is that a substantial amount of funds would flow out, causing a large and sustained fall in the exchange rate, which would have further damaging effects on firms' balance sheets. In accordance with the IMF program, the Icelandic authorities imposed extensive capital controls in November 2008. Capital controls undoubtedly help solve the immediate problems facing the currency. Policy rates were raised before the IMF program was implemented on 24 October from 12% to 18%. This is perhaps the most controversial part of the program and the topic of this paper. The subsequent cautious lowering of the policy rate constitutes a natural experiment of the role of high interest rates in defending a currency under a capital control regime.

The Central bank started monetary easing in March, which was justified by the rapidly declining inflation. It reduced its policy rate by 1% from 18% to 17% on 3 March, then by 1.5% to 15.5% on 7 April and finally to 13% on 6 May. Figure 4 shows the policy rate, the on-shore exchange rate and the off-shore exchange rate between 1 September 2008 and 2 June 2009. Note that the euro/ISK exchange rate is fairly stable at around 0.60 euros in 100 kronur. However, the on-shore rate increased in February – March before a monetary easing was started. Figure 6 shows the same variables for the period 1 March to 2 June 2009. Several observations can be made about the pattern of interest rate and exchange rate developments:

- The on-shore exchange rate started a gradual decline before the first interest rate reduction.
- The on-shore exchange rate has continued a very gradual decline following the three interest-rate reductions.
- The off-shore exchange rate has increased during the period of monetary easing.

[8] See *Letter of Intent*, 15 November 2008 (http://www.imf.org/external/np/loi/2008/isl/111508.pdf) and the Stand-By Agreement (http://www.sedlabanki.is/lisalib/getfile.aspx?itemid=6606). Of this, $2.1 billion comes from the IMF, which is much more than its country quota of $173.6 million. The stand-by arrangement amounts to 1,190 percent of Iceland's quota.

The Central Bank engaged in substantial interventions in January and February, it then scaled back the interventions in March but resumed them in April and, especially, May. The extensive interventions in May suggest that the exchange rate would have ended up lower had the Bank not intervened.

The pattern of changes in the policy rate, the on-shore exchange rate and the off-shore exchange rate can be used to discriminate between the different channels from interest rates to exchange rates, discussed in Section 3 above; the income effect, the stock effect and the flow effect. We get the income effect when a fall in interest rates makes consumption and imports increase which lowers the on-shore exchange rate. This makes exporters turn to the on-shore markets which then makes the off-shore exchange rate fall. This is clearly not what has happened, imports have fallen by 50% year-on-year, there has been no reversal in this decline in recent months, and the off-shore exchange rate has not fallen. The stock effect is generated when a fall in domestic interest rates makes foreign owners of local assets attempt to sell the local currency off shore. However, this would make the off-shore exchange rate fall, which has not happened. Finally, lower interest payments to foreigners will make the on-shore exchange rate increase, which makes exporters turn to the off shore market which makes the off-shore exchange rate rise. This will happen gradually. However, the foreign owners choose when to convert the interest payments into foreign currency and this is not instantaneous. Moreover, cuts in the policy rate only affect the payments to foreign owners of local-currency assets gradually because some of the assets are long-term government bonds. For both reasons, it would be unrealistic to expect the exchange rate to strengthen soon after the policy rate is cut. However, this effect must eventually show up in the data. One can conclude that the evolution of the on-shore and the off-shore exchange rate does not suggest that the interest rate cuts have lowered the on-shore exchange rate.

Turning to other causal factors, lower foreign interest rates would reduce the supply of the domestic currency off shore which would make the off-shore rate increase, which would induce exporters to turn to the on-shore market so that the on-share exchange rate would also increase. This has clearly not happened. Expectations of currency depreciation on shore would have led to increased leakages and a fall in the off-shore rate

as well as a fall of the on-shore rate. This explanation can be discounted because the off-shore rate has not decreased.

This leaves us with one remaining possibility, which is that lax enforcing of the capital controls has resulted in a rising level of evasions. These circumventions or leakages show up in rising demand for local currency off shore and falling demand on shore which explains why the currency has depreciated on shore and appreciated off shore. The circumventions may be caused by a lack of trust in the domestic economy, especially the banking system.

6. Conclusion

This paper has derived the relationship between central bank interest rates and exchange rates under a capital control regime. The on-shore exchange rate is determined by the requirement of a balance on the current account.

Higher interest rate may strengthen the currency on shore by reducing consumption and imports. They may also induce foreign owners of local currency assets not to sell local currency off shore which will make the off-shore exchange rate rise which then discourages exporters from buying local currency off shore which raises the supply of foreign currency on shore and strengthens the exchange rate. There is also an effect that goes in the opposite direction: Higher interest rates increase the flow of interest income to foreigners through the current account which makes the on-shore exchange rate fall which then makes exporters turn to the on-shore market lowering the off-shore rate.

The historical financial crisis now under way 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 in the past three months have been accompanied by a reduction of the on-shore exchange rate and an increase of the off-shore exchange rate – the difference between the on-shore and the off-shore exchange rate has shrunk. These observations are inconsistent with the income effect and the stock effect which would predict that lower interest rates put downward pressure on the off-shore exchange rate. The flow effect must however be at work and will show up in a stronger exchange rate in the future.

The current pattern of on-shore and off-shore exchange rates is consistent with increased leakages brought about by lax enforcing of capital controls and learning about ways of circumventing the controls. This suggests a strong reason to increase the level of monitoring and enforcing of the capital controls. Overall, the experience does not suggest that cutting interest rates moderately from a very high level is likely to make a currency depreciate in a capital control regime but highlights the importance of effective enforcing of the controls.

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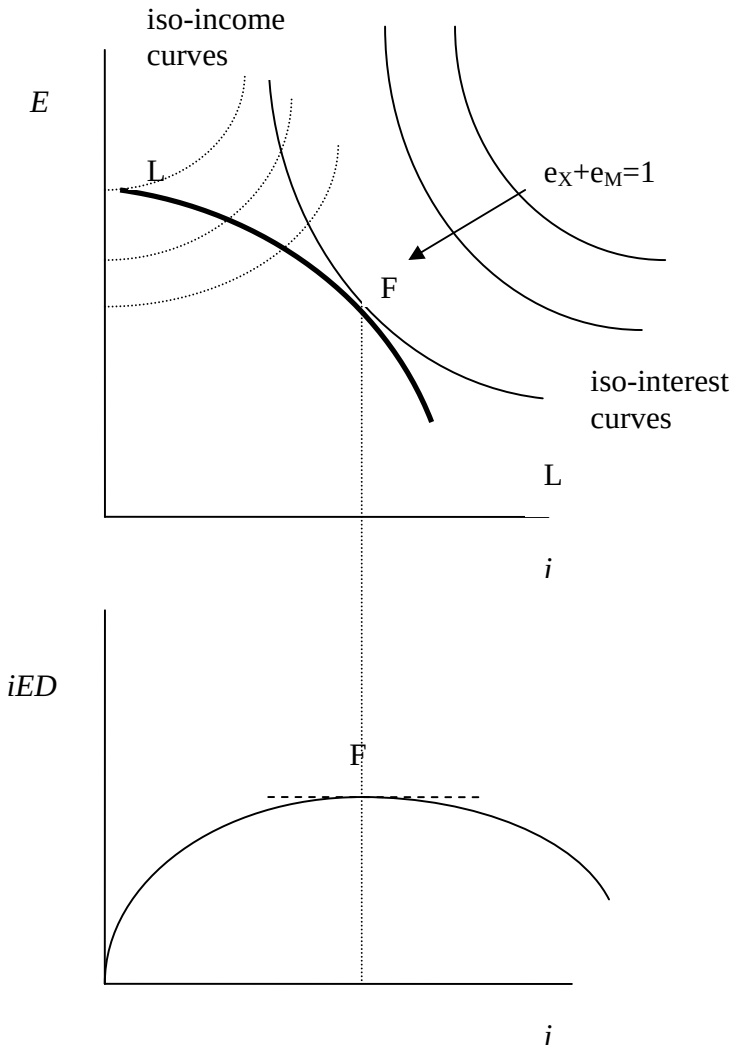
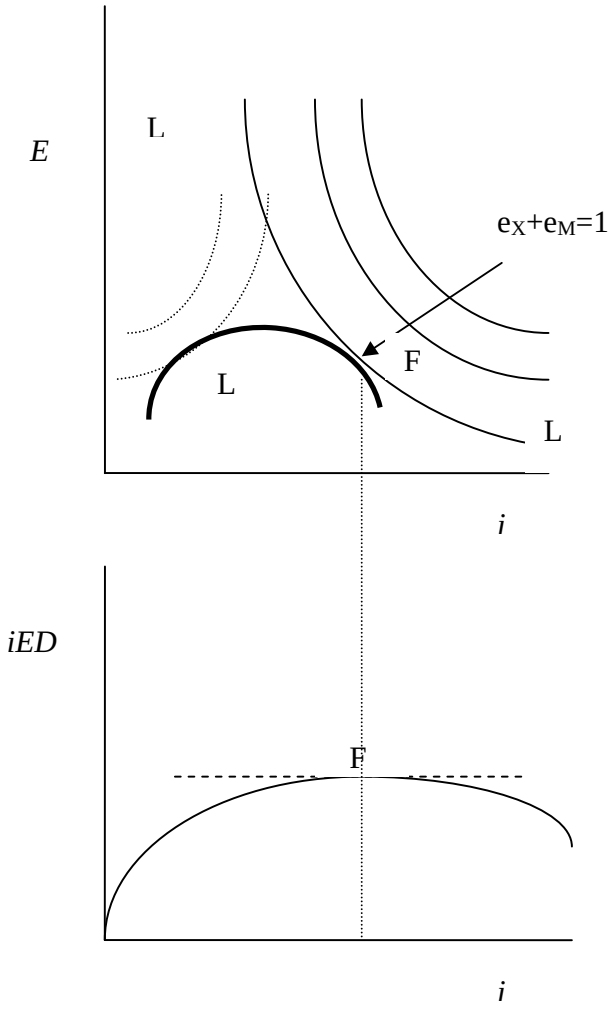
Figure 1. The interest income of foreign investors without leakages



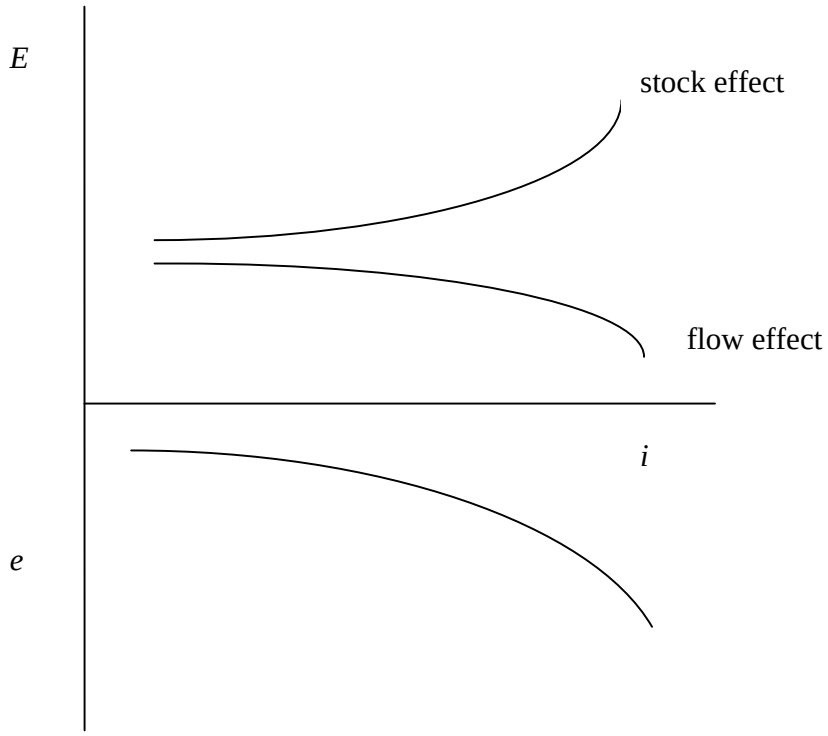
The bold current-account constraint shows all the combinations of *i* and *E* that give a balance on the current account. The iso-interest curves give all combinations of *i* and *E* that leave the foreign investor indifferent – give the same flow of interest income measured in foreign currency – and the iso-income curves give all combinations of *i* and *E* that leave the home country as well off in terms of the national income net of interest payments measured in foreign currency. At *F* the interest income of foreign investors, measured in foreign currency, is maximised, while the home country is best off at point *L* where the interest rate is equal to zero and the currency is appreciated to generate a current account balance.

Figure 2. The interest income of foreign investors with leakages



This figure differs from Figure 1 in that the bold current-account constraint is upward sloping to the left of F because raising interest rates at low rate of interest will make the currency appreciate by reducing the leaks.

Figure 3. Interest rates and the on-shore and off-shore exchange rates



This figure shows the relationship between domestic interest rates *i*, the on-shore exchange rate *E* and the off-shore exchange rate *e*. Raising the interest rate increases the rate of return to assets denominated in the local currency which makes the off-shore exchange rate increase so that the expected return on staying in the local currency or leaving via the off-shore market remain the same. The effect of the interest rate increase on the on-shore exchange rate is ambiguous. Higher interest rates cause a larger flow of interest payment going through the current account which makes the currency depreciate. This is the flow effect. However, the higher off-shore exchange rate may cause more exporters to convert their foreign currency on shore which would strengthen the on-shore exchange rate. This is the stock effect.

Figure 4. General equilibrium

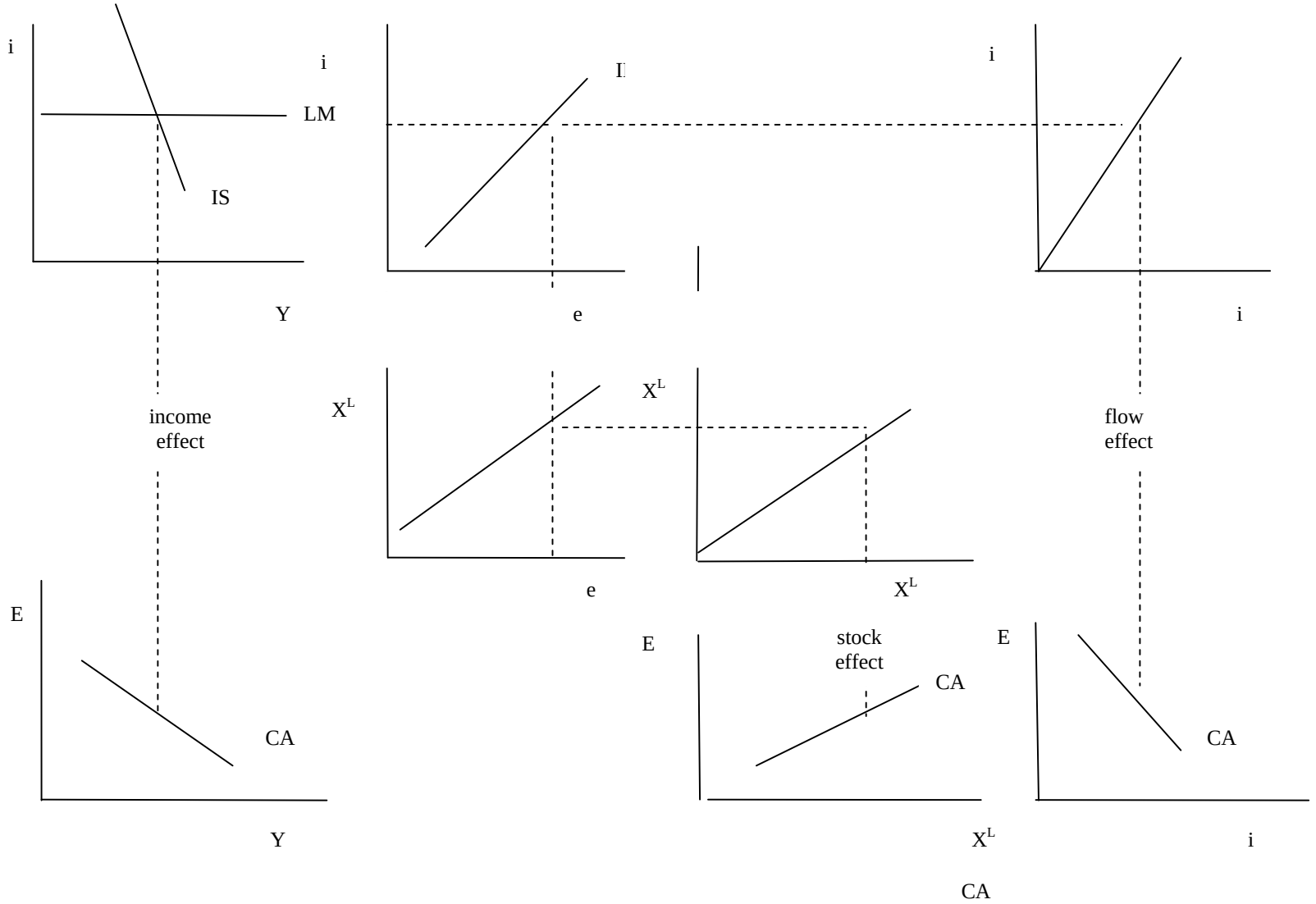


Figure 5. Interest rates and exchange rates

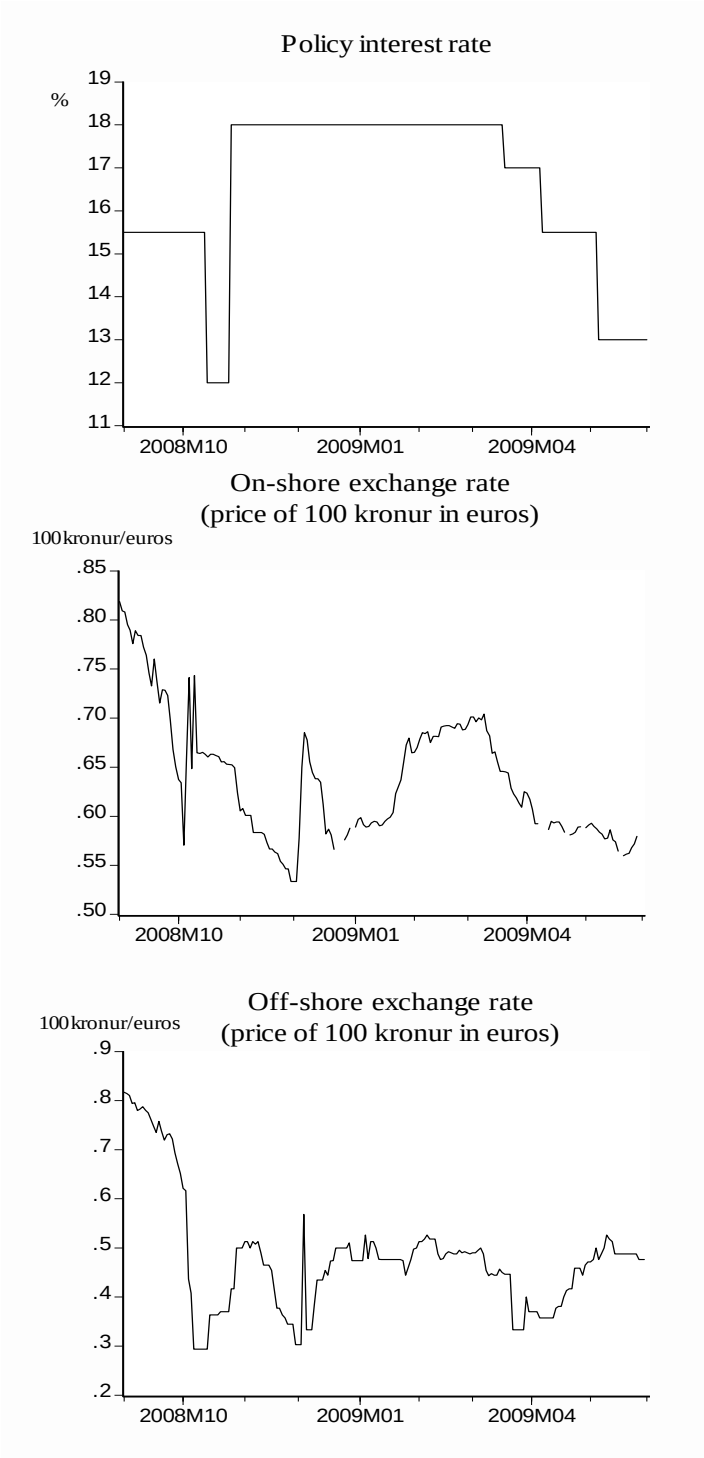


Figure 6. Monetary easing