Box 2

Impact of exchange rate movements on external trade and terms of trade

The real exchange rate has risen in the recent term and appears likely to continue doing so once the effects of recently concluded wage settlements have emerged in full. In terms of relative unit labour costs, the average rise in the real exchange rate could therefore be roughly 10% this year, largely because the increase in domestic wage costs is well above the average for Iceland's main trading partners. The Central Bank has repeatedly discussed the impact of such large pay rises on domestic inflation and the monetary policy response needed to ensure price stability over the medium term.

There has been less discussion, however, of the impact of such large cost increases on Iceland's competitive position and external trade. Other things being equal, the rise in the real exchange rate is likely to undermine Iceland's competitiveness and reduce exports. At the same time, it will lower import prices and erode the trade surplus, although terms of trade will improve. This Box attempts to estimate how strong the impact of the above-described increase in the real exchange rate could become, based on the historical relationship between external trade and exchange rate movements.

Theoretical background

In order to assess the impact of a higher real exchange rate on external trade, it is necessary to examine both how exchange rate movements affect import and export prices and how those price changes affect import and export volumes. A conventional theoretical trade model derived from Krugman (1987) is used to assess this effect. According to this model, exporters (both Icelandic exporters that sell abroad and foreign producers that sell to Iceland) can sell their products at different prices in different market areas. This is referred to as *pricing to market*. In pricing to market, exporters maximise their profit by choosing product prices subject to competitors' prices in the same market and to overall demand conditions in that market. Product prices in foreign currency relative to prices in trading partner countries are therefore determined by Iceland's real exchange rate vis-à-vis trading partners and domestic production costs, which can be described in their simplest form with the following equation (in this equation and those that follow, lower-case letters represent the natural logs of the variables concerned):

$$(1)\ (px + e - wp) = \beta(p + e - wp) + \eta(ulc - p)$$

where px is the export price in ISK, e is the exchange rate of the króna (measured as the price of one króna in foreign currency), wp is the general price level in trading partner countries, p is the general price level in Iceland, and ulc denotes unit labour costs in Iceland. Therefore, $px + e = pxf$ is export prices in foreign currency and $p + e - wp$ is the real exchange rate in terms of relative consumer prices. β therefore measures the exchange rate pass-through of export prices; i.e., the impact of changes in the exchange rate on export prices.

In the same manner, export volumes reflect the demand side of the export market, which is determined by the relative price of exports (i.e., the real exchange rate) and general demand in Iceland's trading partner countries:

$$(2)\ x = \phi(px + e - wp) + \sigma wd$$

where x denotes exports and wd is foreign demand. Therefore, ϕ measures the price elasticity of exports; i.e., the impact of changes in relative export prices in foreign currency on demand for Iceland's exported goods.

The imports side of external trade may be derived in exactly the same manner, as imports to Iceland are the mirror image of trad-

ing partners' exports to the country. Import prices relative to the domestic price level are therefore determined by the real exchange rate and domestic demand:

$$(3)\ (pm - p) = \alpha(p + e - wpx) + \delta d$$

where *pm* represents import prices in krónur, *wpx* is export prices in Iceland's trading partners, and *d* is domestic demand. Therefore, α measures the exchange rate pass-through of import prices. Finally, import volumes are determined by the relative price of imports and domestic demand:

$$(4)\ m = \gamma(pm - p) + \mu d$$

where *m* denotes imports. γ therefore measures the price elasticity of imports; that is, the impact of changes in relative import prices in krónur on demand for exported goods from Iceland's trading partners.

Estimating trade elasticities

The above-described trade elasticities are estimated using quarterly data from Q1/1990 through Q4/2014.[1] Because the data are non-stationary, it is not possible to use conventional regression analysis to estimate the parameters and their standard deviations. Instead, the fully modified least squares method (FM-OLS) developed by Phillips and Hansen (1990) is used. The estimation of the equation also contains constants and seasonal dummies. The results are summarised in Table 1.

Table 1 Estimation of trade elasticities

Variable	*Parameter estimation*	*Standard deviation*
Impact of exchange rate on export prices (β)	0.129	0.057
Impact of wage costs on export prices (η)	0.411	0.090
Impact of export prices on exports (ϕ)	-0.929	0.266
Impact of external demand on exports (σ)	0.912	0.041
Impact of exchange rate on import prices (α)	-1.103	0.040
Impact of domestic demand on import prices (δ)	0.621	0.019
Impact of import prices on imports (γ)	-0.442	0.089
Impact of domestic demand on imports (μ)	0.966	0.102

The parameters are all statistically significant from zero, and their signs and size are as expected. Here, however, the primary focus is on the impact of exchange rate movements on import and export prices and volumes. According to the parameter estimation in Table 1, a permanent 1% currency appreciation will cause import prices to fall by 1.1% (= $dpm/de = \alpha$). The appreciation therefore has a roughly one-to-one effect on import prices, and exchange rate

1. Using the database for the Central Bank's quarterly macroeconomic model, QMM (see Daníelsson *et al.*, 2015). For the export equations (Equations 1 and 2), *x* is measured with the volume of goods and services exports, *px* with the price deflator for goods and services exports, *e* with the trade-weighted exchange rate index (measured as the price in foreign currencies of one króna), *wp* with the trade-weighted consumer price index in Iceland's main trading partner countries, *wd* with trade-weighted GDP in Iceland's main trading partner countries, *p* with the Icelandic consumer price index, and *ulc* with wage costs over productivity. For the import equations (Equations 3 and 4), *m* is measured with goods and services imports, *pm* with the price deflator of goods and services imports, and *wpx* with trading partners' trade-weighted export prices. Finally, the best outcome was obtained by measuring *d* with domestic demand in Equation (3) and with GDP in Equation (4). This is also in line with what is done in the IMF study (2015). In the import equation, the ratio of world trade to global output is added as a proxy for the impact of increasing specialisation in world trade (see Daníelsson *et al.*, 2015).

pass-through to import prices is therefore nearly complete. The effect of a currency appreciation on export prices is smaller, however. Foreign currency prices of exports rise by 0.13% (= $dpxf/de = \beta$) whereas in krónur they fall by 0.87% (= $dpx/de = \beta - 1$). As a result, exporters are able to pass a portion of the currency appreciation on to foreign buyers, but for the most part, they must absorb it through reduced earnings. The exchange rate pass-through of domestic export prices is therefore less than complete.

Pricing decisions for imports therefore seem to be based on producer currency pricing; i.e., exporters to Iceland determine the price of the goods they sell to Iceland in their own currencies, and the price in krónur therefore reflects exchange rate movements in full. However, Icelandic export prices are more appropriately approximated by local currency pricing; i.e., Icelandic producers price their exported goods by and large in the currency of the importing economy, thereby absorbing changes in the exchange rate of the króna themselves. The parameter estimates suggest, though, that some export pricing is based on producer currency pricing.

These results are perhaps unsurprising in view of the small size of the Icelandic economy: it may be relatively costly for foreign exporters to analyse Icelandic market conditions; furthermore, imported goods often compete not with comparable domestic-made goods but with other imports that are similarly affected by exchange rate movements (see, for instance, Section 3 in Central Bank of Iceland, 2012). Because of the small size of the Icelandic economy, Icelandic exporters are often price-takers in foreign markets and have little scope to change their foreign currency prices in response to exchange rate movements.

The parameter estimates in Table 1 show that the impact of exchange rate movements on import and export prices differs; therefore, a currency appreciation affects terms of trade (i.e., relative import and export prices). According to the parameter estimates, a permanent 1% rise in the exchange rate causes Iceland's terms of trade to improve by 0.23% (= $\beta - 1 - \alpha$). On the other hand, a rise in the exchange rate cuts into exports and makes imports less expensive. The estimates in Table 1 suggest that a permanent 1% rise in the exchange rate causes a 0.12% contraction in exports (= $dx/de = \phi\beta$) and a 0.49% increase in imports (= $dm/de = \alpha\gamma$). These effects are broadly similar to the results obtained by the International Monetary Fund (IMF) (2015) in a recent analysis of trade elasticities for 60 countries over the period 1980-2014. According to the IMF's estimates, the price elasticity of imports is similar to that obtained for Iceland (γ is -0.30 instead of -0.44), whereas the price elasticity of exports is somewhat smaller (ϕ is -0.32 instead of -0.93). On the other hand, the IMF's results indicate somewhat more exchange rate pass-through, on average, to export prices (β is 0.55 instead of 0.13) and somewhat less pass-through to import prices (α is -0.61 instead of -1.10). The effect of a currency appreciation on terms of trade is therefore similar (0.16% instead of 0.23%). The empirical estimates are also similar to those obtained with the Central Bank's QMM for the trade components that are endogenous in the model (for instance, forecasts of marine product exports are based on information on total allowable catches, which are determined independently of the economic variables in Equation 2).

Impact of a 10% rise in the real exchange rate on external trade

The estimated trade elasticities from above can be used to assess the impact of the 10% rise in the real exchange rate expected to occur this year on import and export prices and volumes, and therefore on terms of trade and the trade balance. In the simulation, it is assumed

that the rise in the real exchange rate will consist of a 2.5% nominal appreciation of the króna and a 7.5% rise in domestic costs relative to foreign costs.[2] According to the parameter estimates in Table 1, this will lead to a 3.5% decline in import prices and a 1.3% rise in foreign currency prices of exports. In krónur terms, export prices will therefore fall by 1.2% and terms of trade will improve by 2.3%. However, the rise in the real exchange rate also causes exports to contract by 1.2% and imports to increase by 4.9%. Although terms of trade improve, external trade will therefore be somewhat less favourable, and the trade balance will deteriorate by 1.5 percentage points of nominal GDP. The impact on real net exports is greater, with net exports deteriorating by an equivalent of 2 percentage points of real GDP.[3]

These are the long-term effects of a change in the real exchange rate, however. In the short run, they could be greater or smaller. In order to assess the short-term effects and estimate the time it takes for the long-term effects to emerge, it is possible to estimate the trade equations using a so-called error correction form.[4] Chart 1 shows the effects of a rise in the real exchange rate over a fifteen-year period. As can be seen, the long-term effects have largely come to the fore two years after the shock. There are also indications of overshooting in the effect on volumes and foreign currency prices of exports, as well as in terms of trade.

Have exports developed as expected in the wake of the financial crisis?

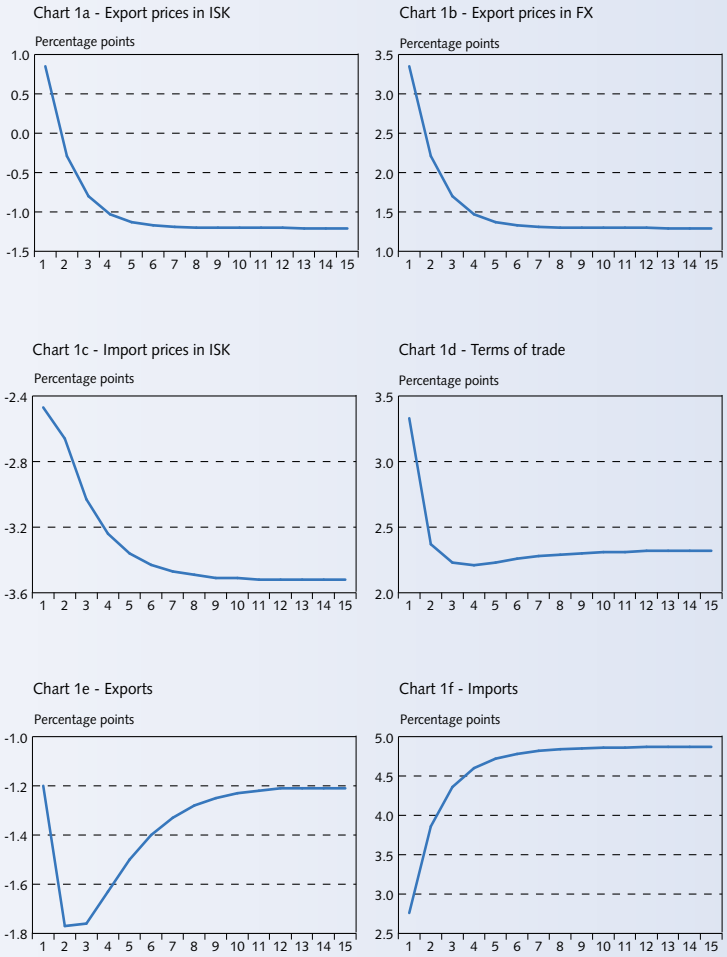
The global economy was thrown into turmoil by the global financial crisis that began in 2007 and struck Iceland with a vengeance a year later. World trade contracted sharply thereafter: trade-weighted demand among Iceland's main trading partners fell by 14% from mid-2008 to mid-2009, and relative prices of Iceland's exports fell more than 20% over the same period. The steep decline in the real exchange rate mitigated the negative impact of reduced global demand on Icelandic exporters by making domestic exports more competitive, thereby cushioning against the contractionary effects of the crisis, as well as supporting their earnings and offsetting the effects of the price declines in foreign markets.

2. Only the direct effects of exchange rate movements on external trade are discussed here; therefore, the potential indirect effects on domestic demand and revenues are not included.

3. It is possible to show that the impact of exchange rate movements on the trade balance is $[-1 + \beta(1 + \phi)]h_x - \alpha(1 + \gamma)h_m$ where h_x and h_m are the share of nominal exports and imports in nominal GDP (using the average for 1990-2014). The impact on net export volumes is correspondingly obtained using real instead of nominal trade shares. From this, it is also possible to derive the Marshall-Lerner condition, which describes the conditions under which the trade elasticities ensure that an exchange rate increase leads to a deteriorating trade balance; that is, that $\beta(1 + \phi) - \alpha(1 + \gamma) - 1 < 0$ which assumes that the trade shares are approximately equal in steady state). Using the parameter estimates in Table 1 gives a value of -0.38; therefore, the Marshall-Lerner condition is satisfied. If it is assumed that there is full exchange rate pass-through to import and export prices ($\beta = 1$ og $\alpha = -1$), the condition is obtained in its simple and better-known version: $\phi + \gamma + 1 < 0$.

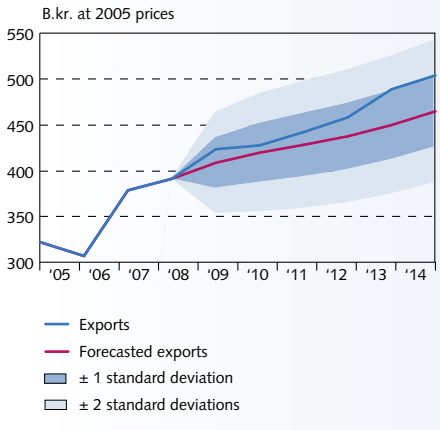
4. In its simplest form, the error correction model can be described as (Δ denotes the change in variables) $\Delta y_t = \rho_0 + \rho_1 \Delta y_{t-1} + \ldots + \rho_n \Delta y_{t-n} + \kappa_1 \Delta z_t + \ldots + \kappa_m \Delta z_{t-m} - \lambda(y_{t-1} - \pi z_{t-1})$, where y is the given endogenous variable (price or volume of imports or exports), and z represents the explanatory variables in Equations (1)-(4). The last component of the equation therefore contains the deviation from long-term equilibrium given by Equations (1)-(4), and λ describes how much of this deviation is "corrected" in each quarter. An equation in this form is estimated for the price and volume of imports and exports with the same variables as in the long-term relationships plus seasonal dummies. The equations for export prices and import volumes also contain a dummy variable that takes the value 1 in Q4/2008 but is otherwise zero. The import price equation contains a comparable dummy variable for Q1/2009. The explanatory power of the equations ranges from 65% (export prices) to 95% (import prices) for the price variables and from 75% (export volumes) to 83% (import volumes) for the volume variables.

Chart 1
Impact of a permanent 10% rise in the real exchange rate
The x-axis indicates the impact at the end of each year



Source: Central Bank of Iceland.

Chart 2
Goods and services exports 2005-2014



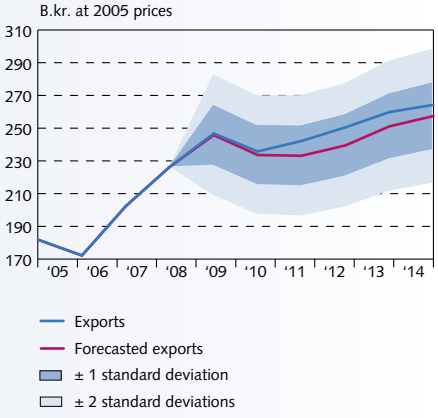
Sources: Statistics Iceland, Central Bank of Iceland.

In spite of the turbulence and the severe contraction in world trade, Iceland's exports continued to grow. It is interesting to examine, however, whether this growth was in line with what is implied by the historical relationship between exports and their determinants, or whether export growth was weaker than it would otherwise have been – for instance, because the banking crisis in Iceland and the associated disruption of cross-border payment intermediation undermined business relationships and made it harder for exporters to obtain trade credit (see, for example, IMF, 2015). In addition, it has often been asserted in domestic economic discourse that the capital controls imposed in Iceland in the wake of the crisis had caused similar problems and therefore reduced exports from the level that would otherwise have been achieved. In order to examine this more closely, the empirical model from above is used to forecast developments in goods and services exports from Q1/2009 through Q4/2014. Chart 2 shows the outcome and a comparison with actual developments. As can be seen, the exports equation underestimated post-crisis exports, although the difference is less than one standard deviation and is therefore not statistically significant.

Therefore, it cannot be seen that the banking crisis has undermined export growth in recent years. Neither is it possible to see

signs that the capital controls have done so, although it is impossible to project how export growth would have developed without them. This is not to say that the capital controls do no harm in the long run, but rather that the data do not suggest that they have reduced exports during the post-crisis period. This could be because the present discussion focuses on total exports, which are favourably affected by the surge in services exports stemming largely from Iceland's growing popularity as a travel destination. Chart 3 therefore shows the corresponding forecast for goods exports alone.[5] As the chart indicates, goods exports contracted somewhat in 2010 but have grown since then. The forecast from the beginning of 2009 has followed this trend well: developments in exports have actually been more favourable than the forecast indicates, although the difference is well within one standard deviation. Therefore, there is again no clear evidence that the banking crisis or the capital controls have undermined exports.

Chart 3
Goods exports 2005-2014



Sources: Statistics Iceland, Central Bank of Iceland.

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5. The equation for goods exports is estimated from 1997, but quarterly data prior to that time are not available in the QMM database. The estimation of the equation is very similar to what is obtained for total exports. A comparable result is obtained if only goods exports excluding aluminium, marine products, and ships and aircraft are considered.