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ICELAND

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ICELAND

SELECTED ISSUES

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Approved By
The European Department

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CONTENTS

ICELAND'S TOURISM ERUPTION ____ **4**
A. Introduction ____ 4
B. Driving Forces ____ 5
C. Outlook ____ 8
D. Conclusion ____ 10

BOX
1. Eyjafjallajökull and the "Inspired by Iceland" Campaign ____ 8

FIGURES
1. Tourists' Overnight Stays ____ 4
2. Tourist Arrivals ____ 4
3. Travel Receipts ____ 5
4. Total Export Receipts ____ 5
5. Real GDP Growth in Source Countries ____ 5
6. Tourism and Price Competitiveness ____ 6
7. Price Competitiveness ____ 6
8. Total Tourist Arrivals ____ 6
9. Tourism Overperformance ____ 6
10. Travel and Tourism Competitiveness Index Ranking ____ 7
11. Government Expenditure on Tourism ____ 7
12. Effectiveness of Tourism Marketing ____ 7
13. Post-Surge Travel to GDP Ratio ____ 9
14. What Improvements are Needed ____ 9
15. Direct Airlift Destinations, 2017 ____ 10
16. Likely to Return ____ 10

References ____ **11**

CREDIT GROWTH AND ECONOMIC RECOVERY IN EUROPE: THE CASE OF ICELAND ____ 12
A. Introduction ____ 12
B. The Post GFC Recovery in Iceland: Is It Different? ____ 13
C. GDP Growth and Credit Growth in Iceland and Europe ____ 15
D. GDP Growth Without Credit? ____ 17
E. Conclusion ____ 19

FIGURES
1. Europe and Iceland: GDP and Bank Credit to the Private Sector ____ 12
2. Iceland and European Countries: Performance Relative to Projection Paths ____ 16
3. Total Credit in Iceland ____ 20
4. Total Credit in European Countries ____ 21

TABLE
1. GDP Growth and Bank Credit Growth ____ 22
2. GDP Growth and Bank Credit to the Private Sector: Recession and Recovery ____ 23
3. GDP Growth and Total Credit to Private Sector Growth ____ 24

References ____ 25

APPENDIX
I. Country Groups ____ 26

THE "NEUTRAL" REAL INTEREST RATE: A USEFUL CONCEPT FOR ICELAND? ____ 27
A. Introduction ____ 27
B. Models and Methodologies ____ 28
C. Data Sources and Results ____ 31
D. Robustness Checks ____ 35
E. The Relationship between the NRIR Estimates and Future Inflation ____ 36
F. Conclusions ____ 36

FIGURES
1. Potential Driver of Natural Rate ____ 28
2. NRIR Estimate-HP Filter ____ 32
3. NRIR Estimate-ICST ____ 33
4. NRIR Estimate-LW ____ 35
5. NRIR Estimate-LWPRF ____ 35
6. Robustness of the NRIR-LWPRF Estimate ____ 36
7. RGap_HP ad Future Inflation ____ 38
8. RGap_ICST and Future Inflation ____ 38
9. RGap_LW and Future Inflation ____ 39
10. RGap_LWPRF and Future Inflation ____ 39

TABLES

1. Data Sources _____ 32
2. Priors and Posteriors of the LW and LWPRF models _____ 34
3. RGaps and Correlations with Future Inflation _____ 36

References _____ 40

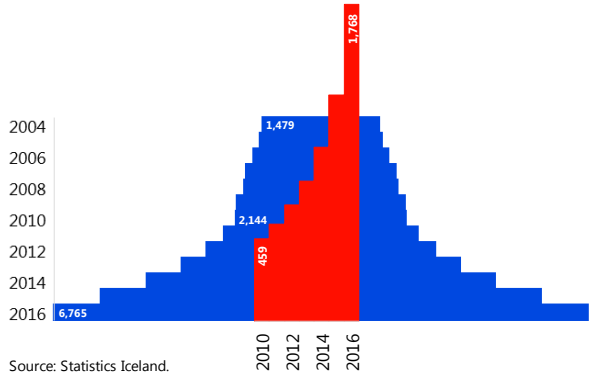
ICELAND'S TOURISM ERUPTION[1]

Tourism has surged above all expectations. The number of tourists has almost quadrupled since the Eyjafjallajökull eruptions in 2010, establishing tourism at the heart of the economy. Tourists do not seem to be mainly driven by rising incomes at home, nor have they been deterred by rising costs on the back of króna appreciation—which leaves Iceland's tourism boom largely unexplained by standard econometric models. Instead, Iceland's natural wonders, welcoming atmosphere, general safety, improving connectedness, and social media outreach have drawn in visitors. Going forward, tourism is likely to grow less rapidly than in recent years, yet remain at strong levels.

A. Introduction

1. Tourism has erupted like a volcano. The number of foreign visitors to Iceland has shot up like a pyroclastic flow in recent years, from a fairly stable level of around 470,000 per year during 2007–10 to 1.8 million in 2016. The annual growth rate in 2016 alone amounted to 40 percent. This year, Keflavík airport expects another 27 percent expansion, to 2.2 million foreign visitors. The number of foreigners' overnight stays has expanded in tandem, from 2.1 million in 2010 to 6.8 million in 2016. The ratio of tourists to inhabitants has increased almost exponentially, with accommodation seekers now outnumbering residents by more than 12:1.

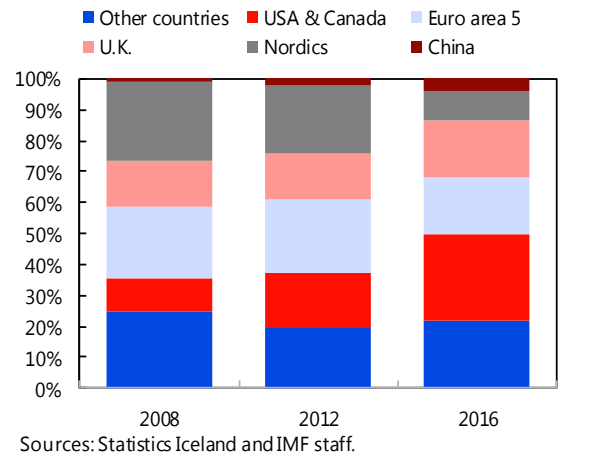
Figure 1. Tourists' Overnight Stays (Blue) and Airport Arrivals (Red)
(Thousands)



Source: Statistics Iceland.

2. Visitors come increasingly from North America, the United Kingdom and, most recently, China. The relative share of U.S., Canadian, and U.K. nationals has increased significantly while that of tourists from the Nordic countries and the five largest euro area countries has shrunk. Although still small with a share of only 4 percent, Chinese visitors are among the most rapidly growing groups by nationality.

Figure 2. Tourist Arrivals
(Percent of total)



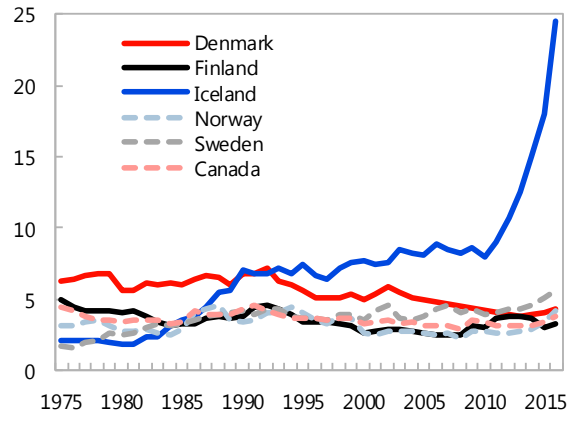
Sources: Statistics Iceland and IMF staff.

3. Tourism has established itself at the heart of the economy. The share of tourism receipts in total exports of goods and services rose from around 8 percent in the late 2000s to a

[1] Prepared by Uwe Böwer (EUR).

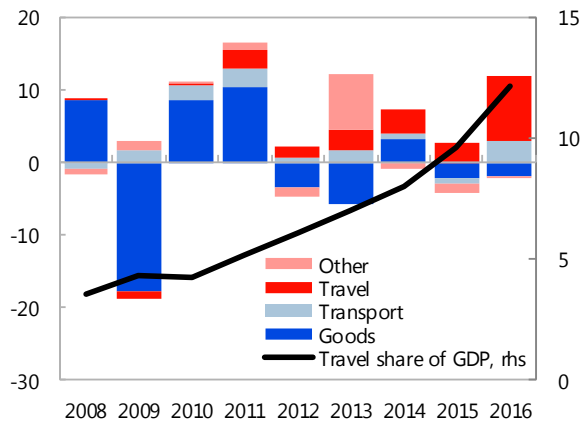
record 25 percent in 2016—far ahead of competitors such as the Nordics and Canada where the share increased only very moderately. Applying a wider definition of tourism receipts which includes also airline transport, tourism now makes up about 39 percent of Iceland's total exports, exceeding the combined receipts of fisheries, aluminum, and silicon. Tourism now drives Iceland's export growth. In 2016, the share of travel in GDP reached 12.1 percent. Including indirect contributions, the World Travel & Tourism Council (WTTC) estimates the total share of travel and tourism in GDP and employment at around 34 percent, vs. 7–8 percent in the rest of Europe (WTTC, 2017).

Figure 3. Travel Receipts
(Percent of total export receipts)



Source: IMF's Balance of Payments database.

Figure 4. Total Export Receipts
(Percentage point contribution to growth y/y)

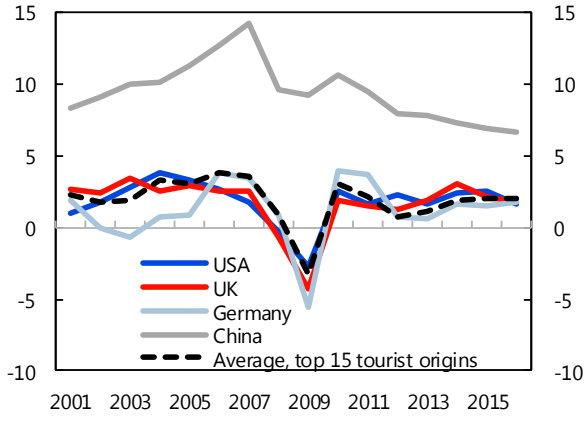


Source: IMF's Balance of Payments database.

B. Driving Forces

4. Push factors seem to have played a limited role in explaining Iceland's tourism boom. Economic growth in visitors' countries of origin, typically regarded as a fundamental determinant of tourism flows (Culiuc, 2014), does not appear strongly aligned with tourism arrivals in Iceland. Growth in Iceland's major tourist source countries slowed sharply just as Iceland's tourism boom took off. Although the source countries' real GDP growth rates have recovered more recently, this recovery appears insufficient to explain the exponential growth in the number of their nationals traveling to Iceland.

Figure 5. Real GDP Growth in Source Countries
(Percent)

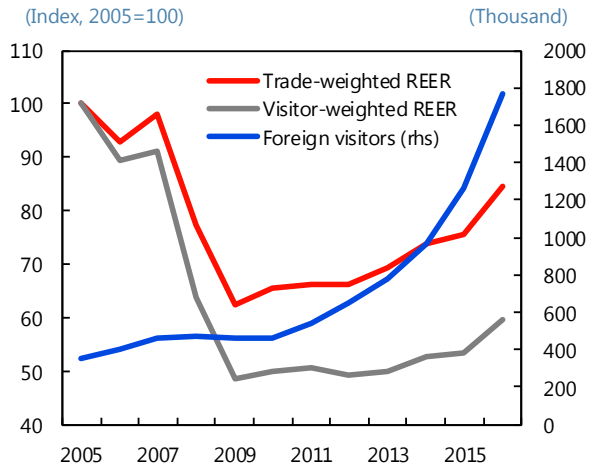


Source: IMF *World Economic Outlook*.

5. Cost competitiveness has suffered but tourists remain undaunted thus far. Cross country studies suggest a significant role for relative prices (e.g., Culiuc, 2014). Heavy króna depreciation in the wake of Iceland's banking crisis might have helped promote the initial pick up in

tourism. However, subsequent appreciation has not deterred the sharply rising number of arrivals. Interestingly, real appreciation was more modest when using a visitor weighted real effective exchange rate (REER) instead of the traditional trade weighted REER. Nonetheless, Iceland's price competitiveness in the travel and tourism industry lags behind competitors such as the Nordic countries and Canada, and has deteriorated over time while those countries have improved theirs.

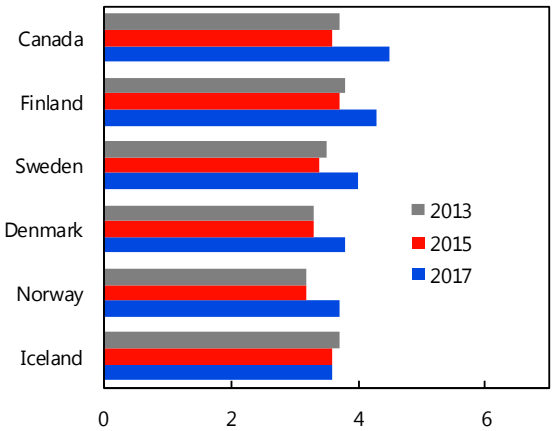
Figure 6. Tourism and Price Competitiveness



Sources: IMF's INS database; WTTC; Statistics Iceland.

Figure 7. Price Competitiveness

(1 = least competitive, 7 = most competitive)

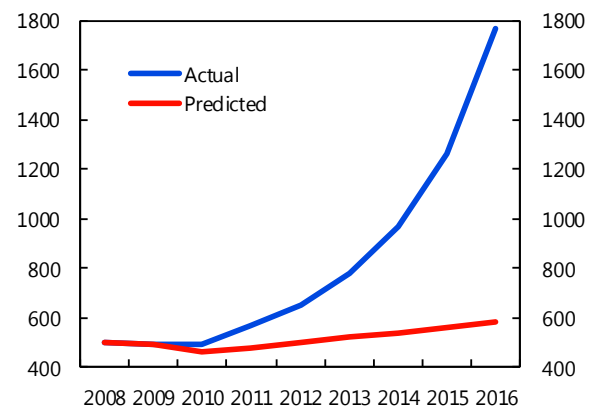


Source: WEF Travel & Tourism Competitiveness Reports.

6. Empirical models do not capture the determinants of Iceland's tourism boom. Although the gravity model by Culiuc (2014) generally performs well in explaining global bilateral tourism flows on the basis of relative GDP and bilateral real exchange rates, its explanatory power for Iceland is poor. The model tracks actual tourism flows to Iceland quite closely until 2010, but dramatically fails to predict the exponential growth thereafter. Broken down by source country, the model particularly underestimates rapidly growing arrivals from the United States and China.

Figure 8. Total Tourist Arrivals

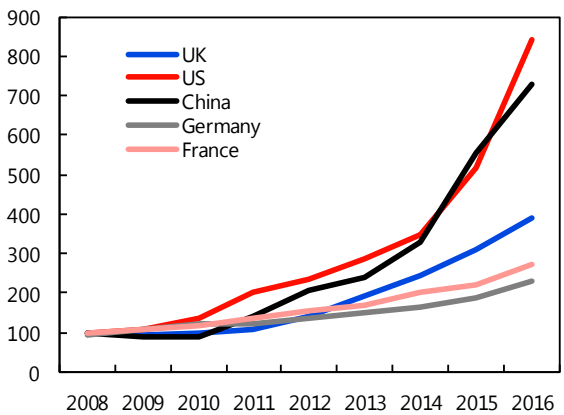
(Thousand)



Sources: UNWTO; Culiuc (2014); and IMF staff.

Figure 9. Tourism Overperformance

(Actual as percent of predicted arrivals)

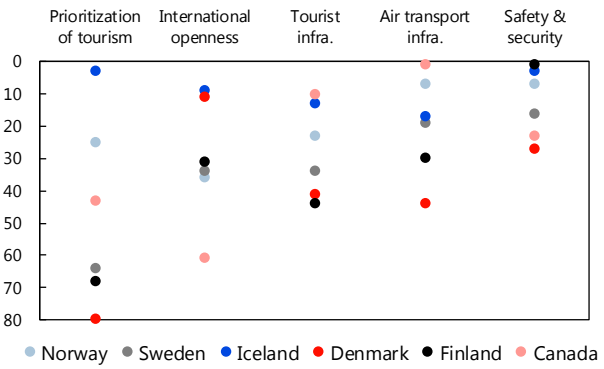


Sources: Statistics Iceland; Culiuc (2014); and IMF staff.

7. Soft factors seem to play a bigger role than prices. Non-cost competitiveness appears to matter more than costs. Iceland scores highly relative to its Nordic peers and Canada on qualitative factors valued by visitors:

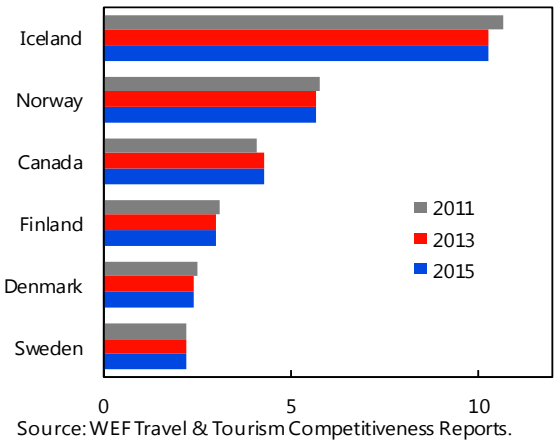
- **Prioritization and openness to tourism**. Iceland's effort to make tourism a priority is paying off. The government spends a far larger share of its expenditure on tourism related items such as cultural and recreational support than its peers. Openness to tourism is promoted by favorable visa procedures and regional trade agreements.
- **Tourist and air transport infrastructure**. In relation to its small population, Iceland's accommodation facilities and air transport infrastructure are rated as outstanding. Strong air transport infrastructure is of particular importance for small island countries (Acevedo *et al.*, 2016; Culiuc, 2014). The number of airlines operating from Keflavík airport has increased from seven in 2009 to 26 in 2017, and the number of direct connections has grown to more than 80. Moreover, the expansion of the baggage system at Keflavík in 2016 solved a crucial bottleneck and facilitated the handling of larger aircraft.
- **Safety and security**. Iceland benefits from its perception as extremely safe destination—a feature that is gaining importance in light of recent terror attacks in various European holiday destinations. Iceland's remote location and extremely low homicide rate bolster its reputation as a safe place to go.
- **Tourism marketing**. Iceland's tourism marketing has been extremely effective. In the eyes of experts consulted by the World Economic Forum, the

Figure 10. Travel and Tourism Competitiveness Index Ranking



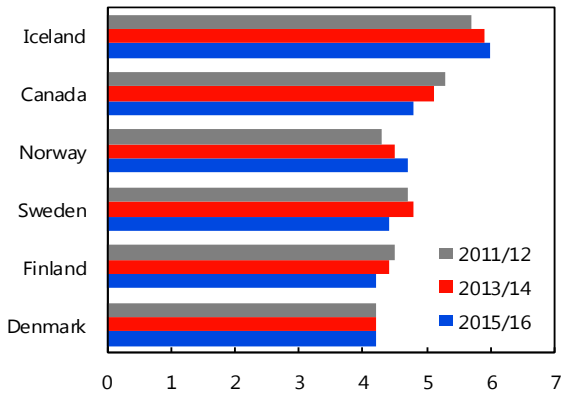
Source: World Economic Forum Travel and Tourism Competitiveness Report, 2017. Numbers represent the rank out of 136 countries.

Figure 11. Government Expenditure on Tourism
(Percent of total expenditure)



Source: WEF Travel & Tourism Competitiveness Reports.

Figure 12. Effectiveness of Tourism Marketing
(1 = very ineffective, 7 = very effective)



Source: WEF Travel & Tourism Competitiveness Reports.

effectiveness of Iceland's travel and tourism marketing exceeds that of its Nordic and Canadian competitors, and has increased over time.

Box 1. Eyjafjallajökull and the "Inspired by Iceland" Campaign

The Eyjafjallajökull volcanic eruptions of 2010 marked the beginning of Iceland's tourism marketing success. The ash clouds brought air traffic to a standstill across Europe. At the time, the authorities feared that, once more after the financial meltdown of 2008, Iceland's international image would be tarred by bad headlines. To reverse the expected negative perception and save the 2010 tourism season, the Icelandic government and the entire tourism industry joined forces in a concerted effort for the first time. The resulting "Inspired by Iceland" campaign and its successors became a roaring success. In hindsight, however, Eyjafjallajökull itself may have been the ultimate advertising for Iceland's natural wonders.

Iceland's social media marketing campaigns have been highly effective. Ordinary Icelanders and enthusiastic tourists became brand ambassadors for Iceland in a testimonial campaign on social media. It turned around the previously overwhelmingly negative connotation of Google hits on Iceland related to financial crisis and natural disaster. The success continued with the "Honorary Icelander" campaign which awarded honorary citizenship to every visitor and motivated more than 1,000 Icelanders, including the president, to open their homes and lives. Another online campaign invited the online community to "give Iceland a new distinctive name" to best characterize Iceland. The winner was announced by the mayor of Reykjavík as "The Isle the Awe Land," further enhancing Iceland's profile as a unique destination offering adventure and magical experiences. Again relying on volunteers, the "Ask Guðmundur" platform was set up as a human competitor to Google in which real Icelanders, all called Guðmundur, would answer questions for interested travelers. As tourism in Iceland began to weigh on the country's treasures, the "Iceland Academy" video series was launched to promote responsible tourism, attracting around 3 million views.

Experts praise the marketing effort as one of a kind. Its authenticity and the force of the public-private endeavor are identified as essential factors, building on a positive sense of national pride and willingness to share the national story (American Marketing Academy 2017; Best Marketing International 2017).

C. Outlook

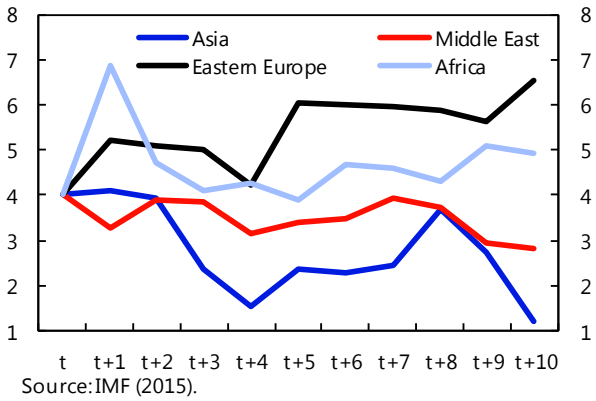
8. Is the tourism boom here to stay? The steep increase in tourist arrivals begs the question of whether the extraordinary growth rates can be sustained, whether growth will ease, or whether tourism in Iceland will fall off a cliff if prices exceed some pain threshold. Model projections appear of little value, given their poor record of explaining past patterns. There are, however, some indications that the tourism boom will most likely experience a soft landing.

9. The flexible exchange rate should help tourism adjust smoothly. Appreciation is both a result of and a dampening mechanism for tourism. To the extent appreciation has been driven by tourism, the currency must find a new and higher equilibrium level consistent with tourism demand. If at some point appreciation starts deterring tourists, the demand response will, in turn, limit the potential for further appreciation and help keep tourism at a sustainable level.

10. Experience from elsewhere suggests tourism surges tend to last. Reviewing experience from relevant other countries, IMF (2015) found that surges in tourism tend to be durable. Most countries that experienced an increase in travel exports of 4 percent of GDP or more over a period of ten years saw that ratio remain above its pre-surge levels ten years later. Where declines in tourism occurred, they were associated with political turmoil, crumbling infrastructure,

overcrowding in tourist sites, environment degradation, or losses in price competitiveness.

Figure 13. Post-Surge Travel to GDP Ratio 1/
(Percentage point of GDP)

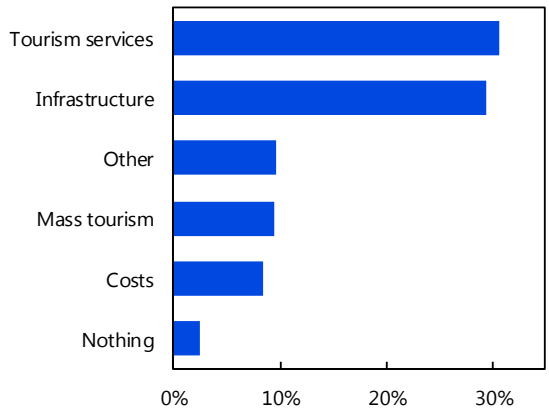


Source: IMF (2015).
1/ Includes countries where travel to GDP increased by at least 4 pp in 10 years. Ratio is rescaled to 4.

11. The global trend toward adventure tourism should continue to favor Iceland. Market experts detect a rising preference for adventure over other tourism activities. The global adventure tourism market is expected to grow by an annual average rate of 46 percent over 2016–20 (Technavio, 2016). Iceland is seen as one of the best placed destinations to capitalize on this trend. Iceland ranks at the top of the 2015 Adventure Tourism Development Index for advanced economies developed by George Washington University, and has been among the top five performers since 2009 (Adventure Travel Trade Association, 2015). Industry experts see Iceland a tourism hotspot in 2017 also, alongside China, India, and Cuba (World Travel Market 2016).

12. Tourists tend to compensate for higher costs by reducing spending or shortening visits. Rising costs might not necessarily deter tourists from making the trip, but tourist may well cut their daily outlays or shorten their stays (Alegre and Pou, 2006; Gokovali *et al.*, 2007). Culiuc (2014) finds that changes in the real exchange rate affect the "intensive margin" of the destination's real exchange rate, i.e., the length of stay, more than the "extensive margin," i.e., the decision to travel.

Figure 14. What Improvements are Needed?



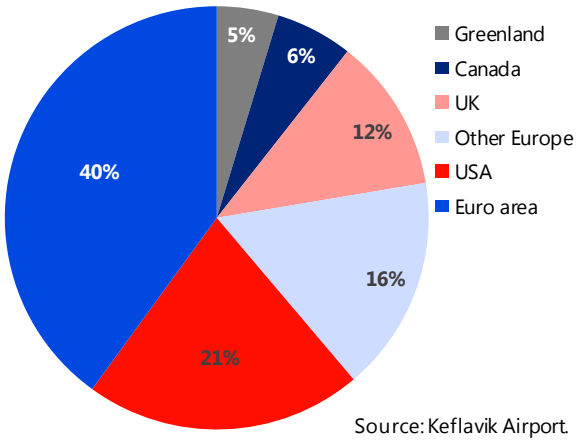
Source: Icelandic Tourist Board Survey (2016).

13. The sensitivity to price increases tends to be less pronounced for high end destinations. Higher income tourists are typically less sensitive to price changes. Lafromboise *et al.* (2014) show that the price elasticity of tourists becomes insignificant when the sample is restricted to high end destinations. Part of the explanation lies in the ability of such destinations to provide the top quality infrastructure and services needed to support high end visitors. It is not clear how much of the tourism in Iceland should be considered high end, but what is known is that the cost element does not seem the primary concern.

14. Air connectivity, a stronger tourism driver in small island economies, can be further leveraged. Acevedo *et al.* (2016) show that the number of flights significantly increases tourist arrivals, while addressing statistical endogeneity. Culiuc (2014) finds that small island destinations are more susceptible to changes in the number of direct flights than other destinations while the

elasticity of real exchange rate changes in small island destinations is negligible. The increase of airlines and direct flight connections, as well as airport capacity expansions, have brought more tourists to Iceland. Going forward, there seems to be some potential for increasing the number of direct connections with the United States. There could also be scope for direct flight connections with China—outbound tourism from China grew at an average annual rate of 17.4 percent during 2010–16, suggesting considerable potential for Iceland. It may also be an option to further develop alternative international airports, such as Akureyri in northern Iceland and Egilsstadir in the east, in line with the aim of spreading tourism more evenly across the country. Given its instrumental role in determining the number of tourists, airport development might be an effective valve for government policy to accelerate or dampen the speed of tourism growth.

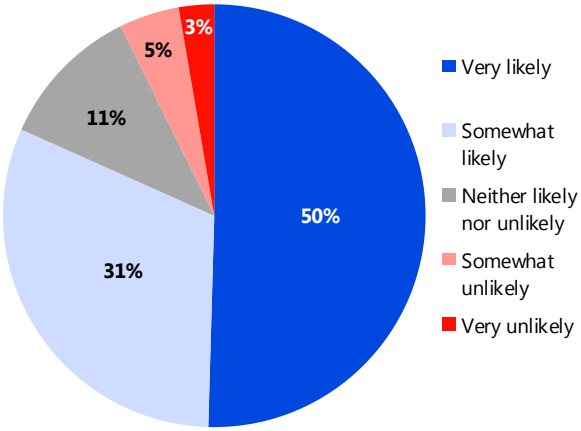
Figure 15. Direct Airlift Destinations, 2017



Source: Keflavik Airport.

15. Tourist satisfaction and likelihood to return are very high. According to recent surveys, 95 percent of tourists report that their expectations were met "to a great extent" or "for the most part" while only 1.2 percent indicate the opposite. More than 80 percent of tourists consider it very likely or somewhat likely that they will return to Iceland in the future.

Figure 16. Likely to Return?



Source: Icelandic Tourist Board Survey (2016).

D. Conclusion

16. Tourism in Iceland has exceeded all predictions and will likely keep growing, albeit at a slower pace. The explosion of tourist arrivals since the Eyjafjallajökull eruptions in 2010 is not explained by traditional determinants. Tourism is now firmly established as one of Iceland's main export pillars, with tourism revenues recently surpassing those of the main traditional export earners, fisheries, aluminum, and silicon, combined. Although visiting Iceland is more expensive than going to many alternative destinations, Iceland's unique mix of natural adventure, a welcoming culture, safety, and connectivity—all skillfully marketed—has developed an appeal. Iceland will likely continue to benefit from the ongoing global trend toward adventure tourism. While the appreciating króna will likely exert some dampening effect over time, with tourists responding by shortening their stays, evidence from other countries suggests more often than not tourism surges tend to be permanent. The overwhelmingly positive experiences of visitors and their high likelihood to return bode well for the future of Iceland's tourism sector.

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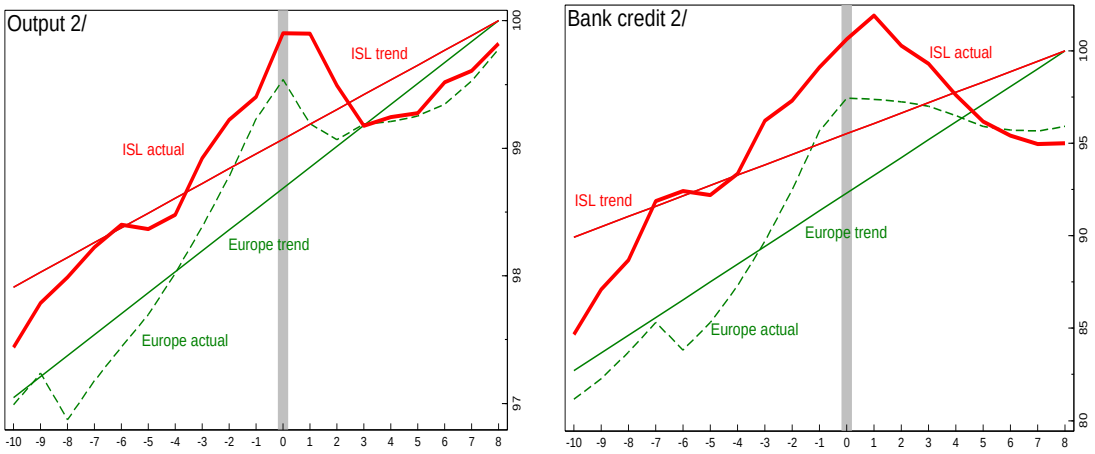
CREDIT GROWTH AND ECONOMIC RECOVERY IN EUROPE: THE CASE OF ICELAND[1]

While economic activity in many European countries has yet to fully recover eight years after the global financial crisis, Iceland is doing well. Yet in Iceland, as in most European countries, bank credit to the nonfinancial private sector remains tepid. By analyzing the dynamics of economic activity and credit during the recovery period, this study finds that: (i) Iceland's recovery has outperformed typical recoveries since 2012, except on bank credit; (ii) Iceland's relationship between economic growth and credit growth has not changed; and (iii) firms' reliance on retained earnings appears to be an important source of alternative funding in Iceland, supporting the recovery.

A. Introduction

1. The 2008–09 global financial crisis (GFC) had a significant and permanent effect on output and bank credit in many European countries, Iceland included (Figure 1). Before the GFC, most European countries enjoyed brisk real GDP growth and bank credit expansion on the back of favorable global financial conditions. When the crisis struck, both output and bank credit were above trend. The crisis saw European countries profoundly affected by the ensuing tightening of global financial conditions, with severe contractions of output and credit. Growth took three years to return to Europe as a whole, while bank credit is only now kicking in. In the case of Iceland, after a severe recession, growth showed a strong recovery, but bank credit stabilized with a lag.

Figure 1. Europe and Iceland: GDP Growth and Bank Credit to the Private Sector 1/



Sources: BIS total credit statistics; IFS; and IMF staff calculations.
Note: The pre-crisis (peak) trend is estimated up to year t=-3, and is extrapolated linearly thereafter.
1/ Expansion peaks, associated with the GFC, occurred in either 2007 or 2008, for all European countries in the sample (Annex 1), except for Albania, Kosovo, and Poland, which avoided a post-GFC recession. Gray vertical line represents 2007 for Iceland (peak for the series of real per capita GDP).
2/ Unweighted average of the logarithm of real output or bank credit per capita; expansion peak year t=0, and 100 equals respective trend in t=7.

[1] Prepared by Marco Arena (EUR), drawing on an EUR project on credit growth and recovery in Europe.

2. Considering this background, this paper draws on a cross country analysis to help inform discussions on economic and bank lending growth in Iceland. The questions it seeks to address include: (i) Are Iceland's post GFC developments in line with expectations given the scale and severity of the GFC and the credit boom that preceded? (ii) Has the relationship between economic growth and credit growth changed during the recovery period in Iceland and in Europe? (iii) What explains the significant real GDP growth rates in Iceland despite subdued bank credit? These questions are investigated using both cross country and Iceland specific data analyses.

B. The Post GFC Recovery in Iceland: Is It Different?[2]

3. The paper compares Iceland's post GFC recovery with the recovery paths of other European countries that experienced financial crises in 2008–09.[3] Drawing on Jordà, Schularick, and Taylor (2013), the local projection (LP) method is used to develop projections of "typical" recession and recovery paths. It follows the standard specification below:

$$\Delta_h y^k_{i(r)+h} = \propto^k_i + \emptyset_h N_{it(r)} + \gamma_h F_{it(r)} + \varphi_h N_{it(r)} * \left(x_{it(r)} - \overline{x_N}\right) + \theta_h F_{it(r)} * \left(x_{it(r)} - \overline{x_F}\right)$$

$$+ \sum_{j=0}^{j=1} \beta^k_j Y_{it(r)-j} + e^k_{it(r)}$$

The dependent variable (y) is the cumulative change in key macroeconomic variables (real GDP per capita, real private consumption per capita, real investment (GFCF) per capita, and real bank credit to the private sector per capita) from the beginning of each recession and recovery period included in the analysis. *N* and *F* are dummy variables indicating whether the recession and recovery episode was preceded by a financial (banking) crisis (F = financial) or not (N = nonfinancial). The control variables include: measures of excess credit accumulated during the expansion period $\left(x_{it(r)} - \overline{x_{F\ or\ N}}\right)$ preceding the recession and a vector Y of the standardized percentage change in the dependent variables two years and one year before the start of each recession. Finally, $\propto$ represents the fixed effect for *i*th country, and *e* is the error term. The projection paths are based on a sample of Advanced Economies (AE) and Emerging Market (EM) economies since the post Bretton Wood area and covers 57 countries (see Appendix 1)

4. The coefficients $\emptyset$ and γ on the nonfinancial and financial dummies are of interest. Intuitively, $\emptyset$ and γ are similar to the average cumulative response of the dependent variable at each horizon (projection) period and are used to construct the projection paths for "typical" nonfinancial and financial recessions and recoveries as plotted in the first column of the panel below. The coefficients are derived from observations on a sample of 79 recession and recovery episodes across 35 advanced and large emerging market countries (the control group) that occurred from the

[2] In the cross country paper, this analysis is performed by John Ralyea (EUR). For details on the data and methodology, see Antoshin *et al.* (forthcoming).

[3] The comparator group comprises Austria, Belgium, Denmark, Germany, Greece, Ireland, the Netherlands, Spain, and the United Kingdom.

beginning of the post Bretton Woods era up to the eve of the GFC (1971–2006). With a projection horizon of 7 years, consistent with the post GFC period 2009–15, 28 separate regressions were run (7 regressions for each dependent variable). The sample episodes include 20 recession and recovery periods in European countries. Of the total, 64 episodes were classified as nonfinancial recessions and 15 as financial recessions based on the definition of a systemic banking crisis in Laeven and Valencia (2012).[4] The Bry and Boschan algorithm was used to date business cycles across countries.[5]

5. The magnitude of the contraction was more pronounced in Iceland than in the comparator group. Based on this model, Iceland's post GFC recovery lags typical post recession recoveries for both normal and financial crisis driven recessions. Iceland's real GDP per capita experienced a larger cumulative decline during the recession period than other European countries that had a financial crisis after 2007 (Figure 2, column 1). However, Iceland has caught up with the comparator group over the last two years, reflecting its current spirited recovery.[6] As of 2014, Iceland had not eliminated the cumulative losses in real GDP per capita that followed the GFC. Also, real private consumption per capita and real gross fixed investment per capita declined much more in Iceland than in the comparator group during the recession period. While these variables are showing a faster recovery during the last three years, they are still below both the comparator's group cumulative recovery and the typical post recession recovery.

6. Lending to the nonfinancial sector has remained much more subdued in Iceland than in the comparator group. Following the collapse and restructuring of the banking sector in Iceland, lending to the nonfinancial sector showed a continuous and significant decline, related both to a reduced willingness and ability to lend due to impaired asset quality and economic uncertainty, and the continuous deleveraging process of the household and corporate sectors. Corporate and household debt have declined from levels of 250 percent and 120 percent of GDP, respectively, at the time of the crisis to levels of less than 100 percent and 80 percent of GDP as of 2016. In the last two years, on the back of a strong economic recovery, credit growth rates to the nonfinancial private sector have turned modestly positive. Bank lending to the nonfinancial sector in the comparator group would have been consistent with the projected path for financial crisis driven recessions.

7. The results for Iceland still hold after controlling for differences in external demand to account for the extremely weak global demand environment that followed the GFC. "Counterfactual dependent variable paths" were estimated to control for the extremely weak global demand environment that followed the GFC. These are shown in the second column of

[4] In a few cases, the starting date of the financial crisis was adjusted to correspond with the peak of the business cycle. Laeven and Valencia (2012) broadly define a financial/banking crisis as being characterized by significant signs of financial distress and losses in wide parts of the financial system.

[5] The number of recession and recovery episodes during 1971–2006 was 144. However, data limitations precluded use of all episodes.

[6] It is also the case that half of the countries included in the comparator group experienced a new recession period associated with the sovereign debt crisis.

Figure 2.[7] Accounting for the impact of the GFC on external demand has the effect of dampening the cumulative growth of the projected recovery paths shown in the first column of Figure 1, particularly for the typical recovery paths after financial crises. For the considered macroeconomic variables, Iceland's recovery paths are still below both the projected recovery paths after financial crisis driven recessions and the actual recovery paths of the comparator group for real private consumption per capita and real investment per capita.

8. Since the onset of the European sovereign debt crisis, however, Iceland's real GDP growth per capita has recovered faster than that of the comparator group. Since 2012, the actual recovery of Iceland's macroeconomic variables (real GDP growth per capita, real gross fixed investment per capita, and real private consumption per capita) has been much stronger than those of the comparator group (see Figure 2, column 3). Moreover, the actual recovery paths for Icelandic variables outperformed the projected paths for both types of post recession recoveries. During the last two years, the recovery path of bank lending, too, has been catching up with the recovery path of the comparator group.[8]

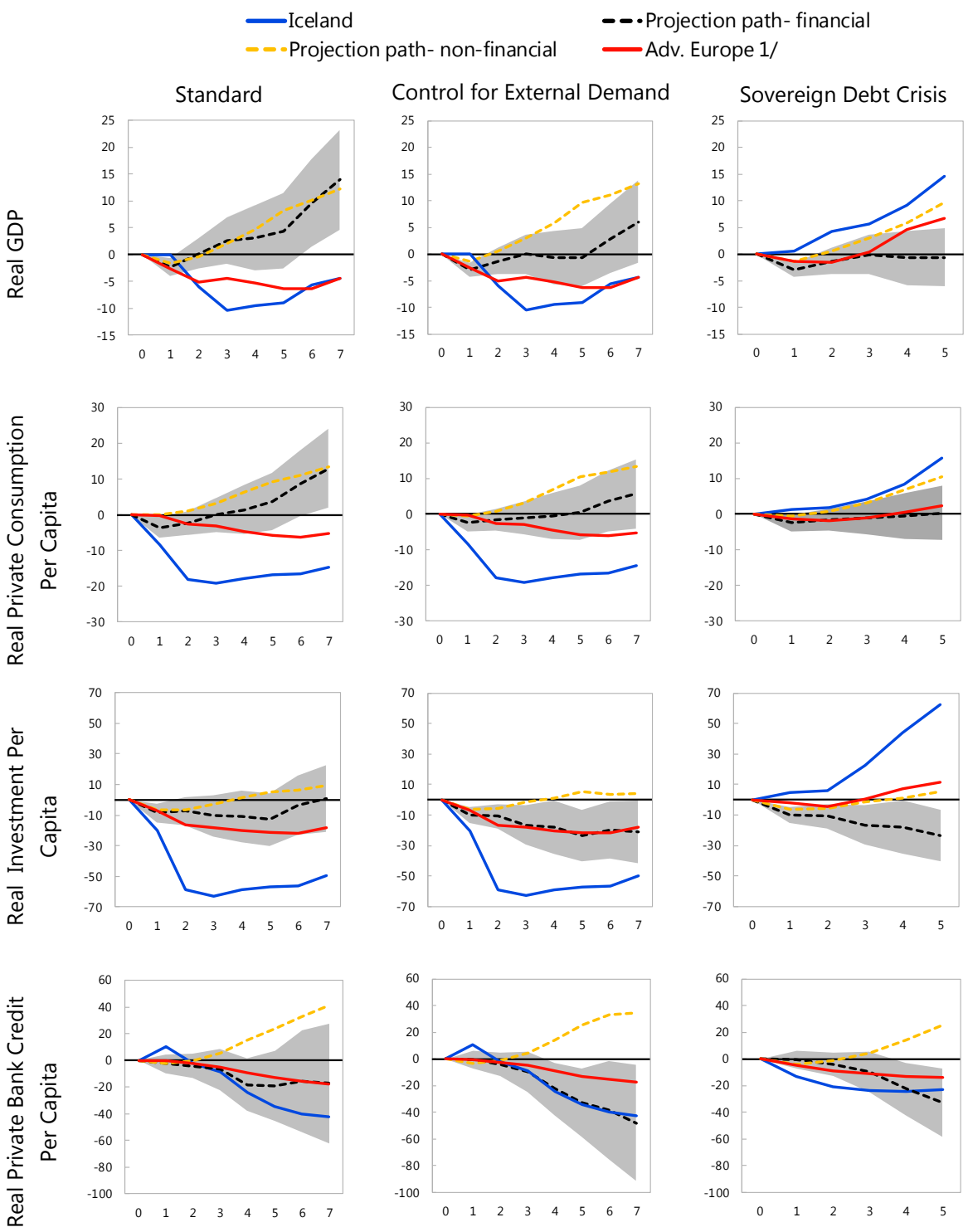
C. GDP Growth and Credit Growth in Iceland and Europe

9. The relevance of banking sector credit in facilitating economic activity is well established. As discussed by Beck and Levine (2000), financial intermediaries provide services to the economy that affect savings and allocation decisions in ways that can influence economic growth. Empirical analysis has tested this intellectual framework and found that the level of financial development is positively related to economic growth and the sources of growth, productivity growth, and physical capital accumulation (Beck and Levine, 2000; Beck, Levine, and Loayza, 2000; and Levine, Loayza, and Beck, 2000). In this context, the relevance of bank credit is especially important in more bank centric economies as is the case in most of Europe, including Iceland.

[7] As discussed in Antoshin *et al.* (forthcoming), the counterfactual paths were generated as follows: (i) a contemporaneous external demand variable based on actual data was included as a regressor in the standard regressions described above to estimate its influence on the "typical" projection path; (ii) this external demand variable was then rescaled to reflect, on average, the external demand faced by European countries after the GFC and (iii) new counterfactual dependent variables were generated using the coefficients and values of the regressors from step (i) and the counterfactual external demand values from step (ii). These steps yielded counterfactual dependent variables which represented "what if"' estimates of the dependent variables had the control group countries faced the same subdued external demand that European countries faced post GFC. The standard regressions were then re-run with the new counterfactual dependent variables to generate the coefficients used to construct the projection paths for nonfinancial and financial recession and recovery episodes plotted in column two of the panel below.

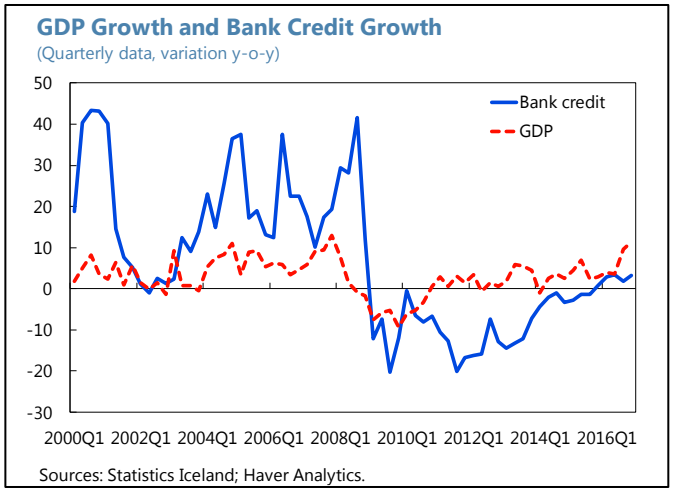
[8] This result would be consistent with the Central Bank of Iceland's finding that the financial cycle's trough was in 2013 (even later for bank credit) whereas that for GDP was in 2010. Bank credit bottomed out much later than GDP.

Figure 2. Iceland and European Countries (with financial crisis)[1/]: Performance Relative to Projection Paths
(Cumulative percentage change at each horizon from start of recession, in percent)



Sources: BIS credit data and Haver Analytics. Shaded regions are 95 percent confidence bands around the projection paths for post financial crisis recession and recovery periods.
1/ Advanced Europe includes countries with financial crises (Austria, Belgium, Denmark, Germany, the Netherlands, Greece, Ireland, Spain, and the United Kingdom).

10. However, it would appear there has been some change in the relationship between output and credit after the GFC. During the recovery period, some European countries experienced periods of positive real GDP growth rates with negative bank credit growth rates, or so called "creditless" recoveries (Abiad, Dell'Ariccia, and Li, 2011; Lian *et al.*, 2014). In the case of Iceland, there was a creditless recovery spanning 2011–14. This begs the question of whether the relationship between real GDP growth and bank credit growth changed during the recovery period.



11. In the case of Iceland, it appears the relationship between output growth and credit growth did not change during the recovery period. An initial inspection presented in Table 1 shows that the association between economic growth and bank credit growth is positive and statistically significant across all specifications, with a correlation of 0.07–0.11. Moreover, this relationship appears not to have changed during the recovery period, as indicated by the non statistically significant interaction term between bank credit growth and a recovery period dummy.

12. Panel data techniques suggest the relationship between GDP growth and bank credit growth did not change, on average, for a broader group of European countries during the recovery period. A dynamic generalized method of moments panel estimator (Blundell and Bond, 1998) is used to estimate the relationship between credit growth and indicators of economic activity using a sample of 39 European countries (21 advanced economies and 18 Central, Eastern, and Eastern European countries) for the period 1999–2015. The results presented in Table 2 show a positive and statistically significant relationship between economic growth and bank credit growth, where a 10 percent increase in domestic bank credit to the private sector would raise real GDP by an estimated 0.7–0.8 percent depending on specification and sample. Moreover, the relationship has remained essentially unchanged during the recession and recovery periods.

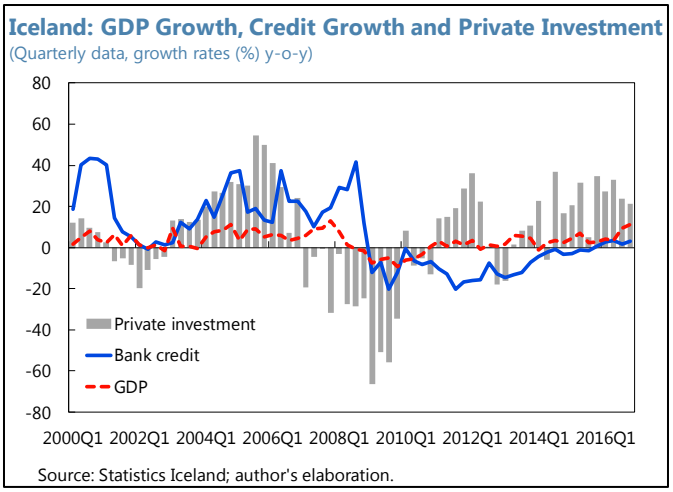
D. GDP Growth Without Credit?[9]

13. In many European countries, including Iceland, economic activity started to recover well before a recovery in bank credit. In the case of Iceland, positive y/y bank credit growth rate are observed only since Q4 2015.[10] Growth rates of GDP and private gross fixed capital formation,

[9] The author thanks colleagues at the Central Bank of Iceland, Kolbrún Þorfinnsdóttir, Kristófer Gunnlaugsson, Önundur Páll Ragnarsson, Guðrún Yrsa Richter, and Jón Magnús Hannesson, for their presentation on *Post-Crisis Credit Dynamics and Growth* during the Article IV mission. This chapter benefits from their information and insights.

[10] After adjusting by price (inflation indexed loans) and exchange rate (foreign currency denominated loans), credit in nominal terms shows positive growth since early 2015, reaching 4.2 percent in 2016.

however, turned positive as early as 2011. As discussed by Coricelli and Roland (2011), certain mechanisms can enable an economy to growth despite low or even negative bank credit growth. These mechanisms include the availability of alternative sources of funding, reallocation of resources to less credit dependent sectors, or take up of unutilized capacity. This section presents some stylized facts on the first mechanism.



14. Measures of other sources of funding, besides bank credit, have shown a continuous decline during the recovery period in Iceland. As shown in Figure 3, nonbank credit to the nonfinancial sector (bonds and notes issued in the domestic credit market, credit from foreign financial institutions, and bonds and notes issued in foreign credit markets) has exhibited negative growth rates for most of the recovery period and shows a continuous decline relative to GDP. This development is consistent with the deleveraging of the corporate sector, where debt fell from around 250 percent of GDP in 2008 to less than 100 percent in 2016. The decline is less pronounced for nonbank credit to households. Nonetheless, here too, there has been a continuous deleveraging, with household debt falling from around 120 percent of GDP in 2008 to around 80 percent in 2016. Based on these aggregate data, there seems no evidence that alternative funding from domestic or foreign markets compensated for the decline in bank lending.

15. For a sample of European countries, in contrast, nonbank funding to the nonfinancial private sector appears to have helped compensate for the decline in bank lending. Based on BIS data (long-term series of total credit to the nonfinancial sector) for a sample of 20 European countries, the growth rate of other sources of funding, in real terms, is positive for 60–95 percent of the countries in 2011–14, whereas the growth rate of bank lending is positive only for 40–50 percent of the countries during the period. The latter would provide support to the idea that access to capital markets helped cushion the decline in bank lending (see Figure 4). Moreover, replicating the panel data analysis from the previous subsection for this subsample of countries, we find that the relationship between GDP growth and total credit growth is positive and significant and that it did not change during the recession and recovery periods (see Table 3).

16. In Iceland, retained earnings played an important role during the recovery period. The Central Bank of Iceland's survey of corporate investment plans shows significant dependence on retained earnings to finance investment plans.[11] Firms in manufacturing (e.g., food and beverages, chemicals and chemical products, machinery and equipment), wholesale and retail trade, and

[11] The survey covers 102 companies representing 43 percent of total business investment (excluding airplanes, ships and energy intensive industry) as of 2015.

services (other than tourism and transport) appear to be especially dependent on internal funding. The reliance on retained earnings could help to explain the creditless nature of Iceland's recovery. It is noteworthy, however, that the transport and tourism sector has in recent years been increasing its reliance on external (to the firm) funding, including bank credit, to finance significant expansion.[12] Similarly, the fisheries sector also appears to have increased its reliance on bank credit in recent years, a result that may be dominated by large companies with access to foreign financing.[13]

Text Table 1. Share of Investment Financed by Retained Earnings in Each Sector
(excluding airplanes and ships)

Year	2012	2013	2014	2015	2016	2017*
Manufacturing	58.9	54.1	77.2	89.6	73.7	66.4
Wholesale and retail trade	91.0	95.7	86.3	87.4	94.6	95.0
Transport and tourism	85.3	95.9	73.3	69.6	41.3	39.8
Other services	37.9	43.5	63.5	61.2	69.8	67.3
Fisheries	76.1	85.4	85.0	97.2	64.4	59.6

Source: Central Bank of Iceland, Survey of Investment Plans. *Projection.

E. Conclusion

17. After controlling for the slowdown in global growth after the GFC, the analysis here reveals that Iceland's recovery continues to lag typical post recession recoveries. This holds for most of the considered macroeconomic variables (e.g., real GDP per capita, real private consumption per capita, and real private investment per capita). However, if the analysis is performed after 2011, Iceland's recovery has outperformed typical post recession recoveries, although not for bank credit.

18. This study does not find evidence that the relationship between economic growth and bank credit growth has changed fundamentally during the recovery period. Bank credit growth has shown signs of recovery in the last two years and will likely continue to increase on the back of strong economic growth. It is doubly critical, therefore, to strengthen financial sector oversight (prudential regulation and supervision) to ensure that the positive impacts of higher bank credit growth can be harnessed without jeopardizing financial stability.

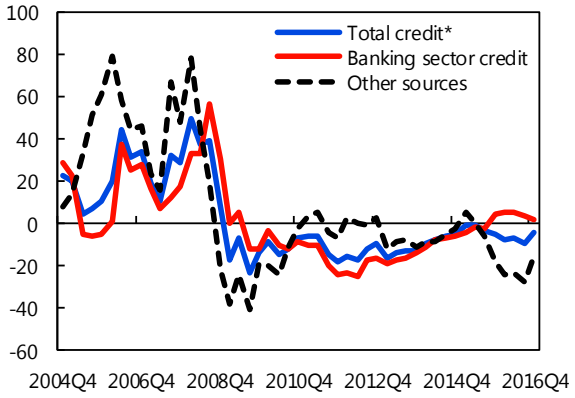
19. Firms' reliance on retained earnings appears to be an important source of financing in Iceland. This funding source provided important support to the economic recovery in recent years, playing a larger role than domestic nonbank and foreign financing. However, consistent with strong economic growth, firms in various economic sectors are now gradually increasing their recourse to external (to the firm) funding sources to finance their investment plans.

[12] This could also be the case in the transport and tourism sector, where many of the firms included in the sample have access not only to domestic but also to foreign finance. In 2016, loans to tourism companies grew by 27 percent, accounting for just over 14 percent of commercial banks' total corporate lending. Tourism represents the third largest industry class in banks' loan portfolios, after real estate companies and fisheries (Financial Stability Report, 2017-1; Central Bank of Iceland).

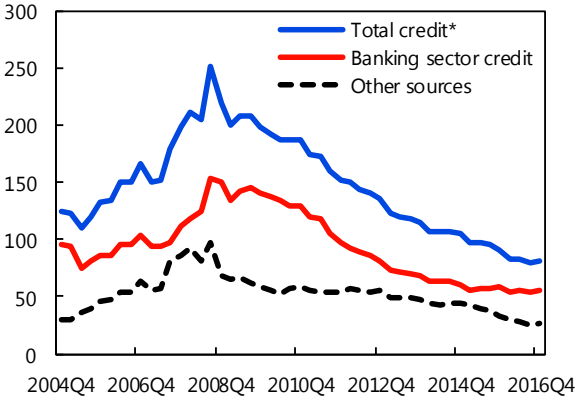
[13] The survey includes 17 companies in this category.

Figure 3: Total Credit in Iceland

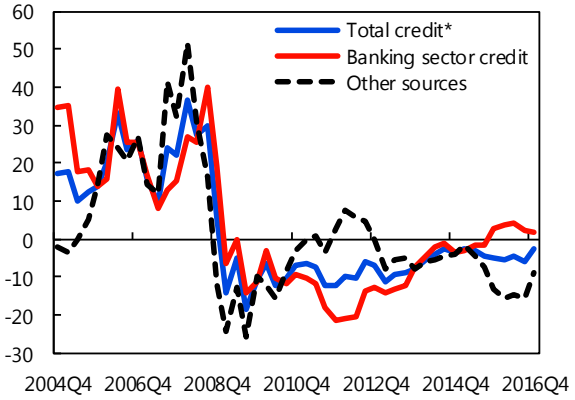
Total Credit to Non-Financial Sector
(Quarterly data in real terms, growth rates (%) y-o-y)



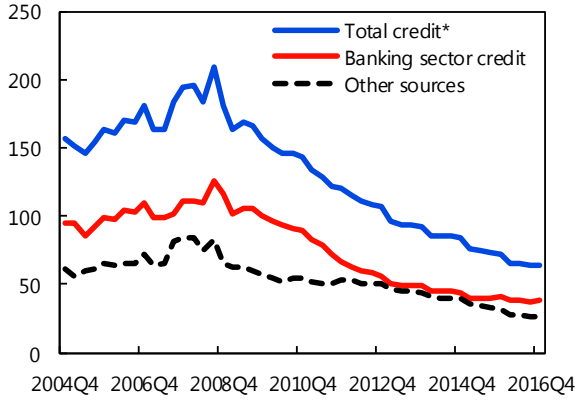
Total Credit to the Non-Financial Sector
(Quarterly data, percent of GDP)



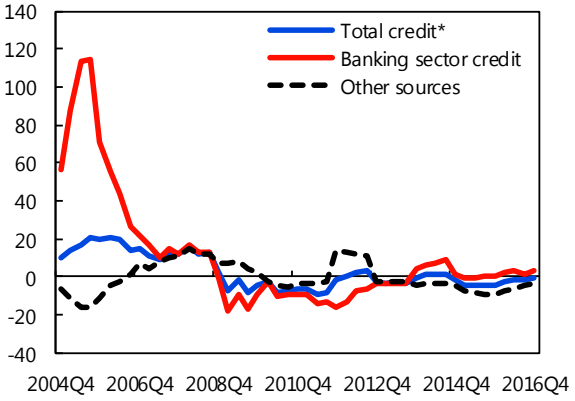
Total Credit to Households and Non-Financial Sector
(quarterly data in real terms, growth rates (%), y-o-y)



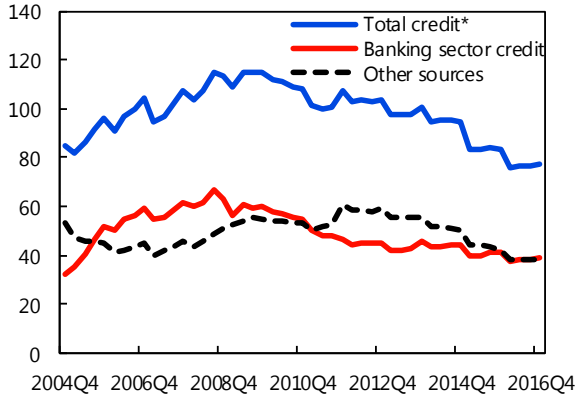
Total Credit to Households and Non-Financial Sector
(Quarterly data, percent of GDP)



Total Credit to Households
(Quarterly data in real terms, growth rates (%), y-o-y)



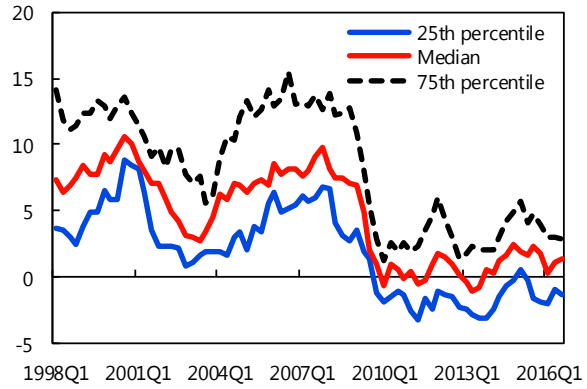
Total Credit to Households
(Quarterly data, percent of GDP)



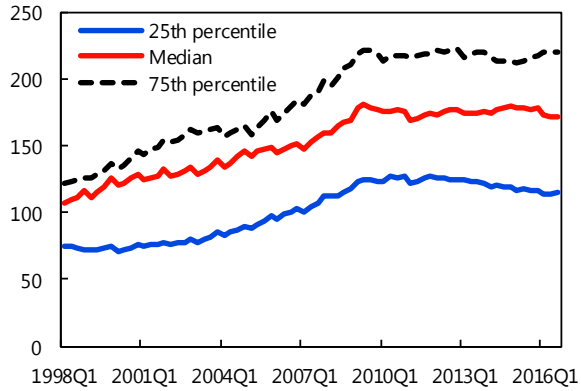
Sources: Central Bank of Iceland, and author's calculations.
*Total credit data excludes credit from resolution committees.

Figure 4. Total Credit in European Countries[1/]

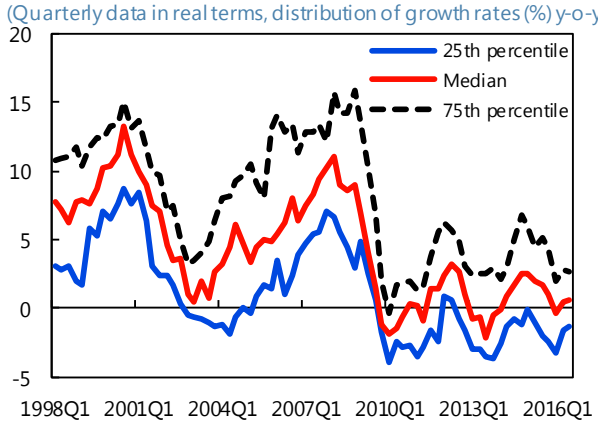
Total Credit to Non-Financial Private Sector
(Quarterly data in real terms, distribution of growth rates (%) y-o-y)



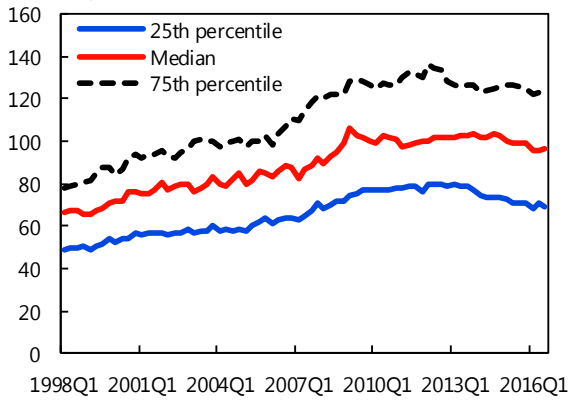
Total Credit to Non-Financial Private Sector
(Quarterly data, percent of annual GDP, distribution of ratios)



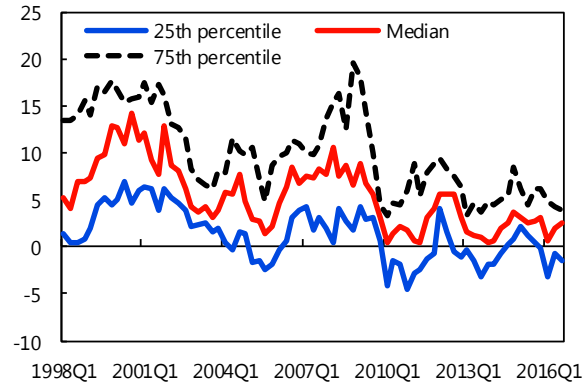
Total Credit to Non-Financial Corporates
(Quarterly data in real terms, distribution of growth rates (%) y-o-y



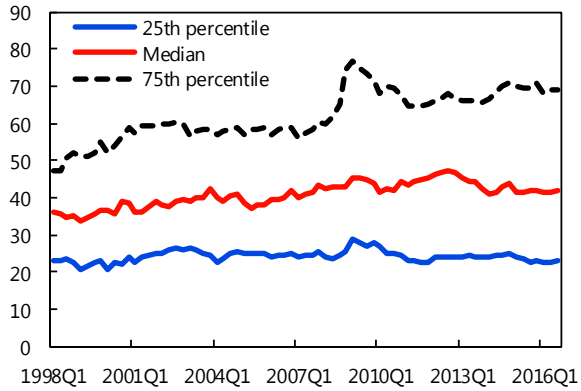
Total Credit to Non-Financial Corporates
(Quarterly data, in percent of annual GDP, distribution of ratios)



Private Non-Financial Sector: Other Sources of Funding
(Quarterly data in real terms, distribution fo growth rates (%) y-o-y)



Private Non-Financial Sector: Other Sources of Funding
(Quarterly data, percent of annual GDP, distribution of ratios)



Sources: BIS, and author's calculations.
1/ Sample comprises Austria, Belgium, Czech Republic, Denmark, Germany, Finland, France, Greece, Hungary, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Switzerland, Sweden, Turkey, and the United Kingdom.

Table 1. Iceland: GDP Growth and Bank Credit Growth

Sample period: 1999Q1-2016Q4; Estimation method: OLS

	[1]	[2]	[3]	[4]	[5]
Bank credit growth	0.07 **	0.12 ***	0.07 **	0.13 ***	0.08 **
	0.03	*0.05*	*0.03*	*0.04*	*0.03*
Bank credit growth*		-0.01	0.07	-0.03	0.05
Dummy recovery		*0.09*	*0.08*	*0.09*	*0.08*
External demand growth rate	0.28 **	-0.21	0.00	-0.26	-0.06
	0.13	*0.18*	*0.08*	*0.16*	*0.07*
Dummy 2008Q3-2009Q4		-0.11 ***		-0.09 ***	
		0.02		*0.02*	
Dummy 2008Q3-2010Q2			-0.09 ***		-0.08 ***
			0.01		*0.01*
Log (VIX)				-0.04 ***	-0.03 *
				0.02	*0.01*
Constant	0.01 **	0.04 ***	0.04 ***	0.15 ***	0.12 ***
	0.01	*0.01*	*0.01*	*0.05*	*0.04*

***, **, and * represent statistical signiifcance at 1, 5, and 10 percent, respectively.

Robust standard errors in Italics

Dummy recovery takes the value of 1 between 2010Q3 and 2016Q4 and zero otherwise.

Table 2. GDP Growth and Bank Credit to the Private Sector: Recession and Recovery

Dynamic panel data; two-step system GMM estimator
Sample of 39 European countries, estimation period: 1999-2015

	(1) Full sample	(2) AE	(3) CESEE
GDP growth rate (t-1)	0.219**	0.149**	0.0967*
	(0.085)	(0.066)	(0.060)
Private sector credit growth	0.0711***	0.0871**	0.0558***
	(0.021)	(0.031)	(0.016)
Private sector credit growth * Dummy recession[1/]	0.0726	-0.0249	0.0170
	(0.096)	(0.093)	(0.094)
Private sector credit growth * Dummy recovery[2/]	0.0308	-0.0424	-0.0581
	(0.062)	(0.063)	(0.095)
Public consumption growth rate	-0.469*	0.206**	0.0280
	(0.251)	(0.090)	(0.051)
Private sector credit-to-GDP ratio	-0.0129*	-0.00857	-0.0405***
	(0.008)	(0.011)	(0.012)
External demand [3/]	0.253**	0.216***	0.145**
	(0.077)	(0.033)	(0.063)
Log (VIX)	-0.00388	-0.00760*	-0.0148*
	(0.005)	(0.004)	(0.009)
Dummy recession	-0.0281**	-0.0123**	-0.0369***
	(0.009)	(0.006)	(0.006)
Dummy recovery	0.000669	0.00920**	-0.000121
	(0.004)	(0.004)	(0.006)
Constant	0.0349**	0.0267	0.0821**
	(0.018)	(0.021)	(0.029)
No. Obs.	576	331	244
No. countries	39	21	18
No. instruments	20	21	20
Autocorrelation test, p-value	0.317	0.162	0.317
Hansen test, p-value	0.121	0.252	0.353

Standard errors in parentheses. * p<0.10, ** p<0.5, *** p<0.001
1/ Dummy takes the value of 1 during the recession period.
2/ Dummy takes the value of 1 during the recovery period.
3/ Volume of trading partners imports weighted by exports' shares.

Table 3. GDP Growth and Total Credit to the Private Sector Growth

Dynamic panel data; two-step system GMM estimator
Sample of 22 European countries, estimation period: 1999-2015

	(1)	(2)
GDP growth rate (t-1)	0.172**	0.161
	(0.083)	(0.107)
Total credit growth rate	0.057*	0.069**
	(0.030)	(0.022)
Public consumption growth rate	0.093	0.107
	(0.106)	(0.095)
Private sector total credit-to-GDP ratio	-0.007*	-0.016**
	(0.004)	(0.007)
External demand [1/]	0.270***	0.211***
	(0.031)	(0.030)
Log (VIX)	-0.016***	-0.006**
	(0.003)	(0.002)
Private sector total credit growth * Dummy recession[2/]		-0.043
		(0.050)
Private sector total credit growth * Dummy recovery[3/]		-0.017
		(0.051)
Dummy recession		-0.012*
		(0.007)
Dummy recovery		0.012**
		(0.004)
Constant	0.055***	0.040**
	(0.011)	(0.017)
No. Obs.	349	349
No. instruments	19	21
No. countries	22	22
Autocorrelation test, p-value	0.549	0.756
Hansen test, p-value	0.236	0.170

Standard errors in parentheses. * p<0.10, ** p<0.5, *** p<0.001
1/ Volume of trading partners imports weighted by exports' shares.
2/ Dummy takes the value of 1 during the recession period.
3/ Dummy takes the value of 1 during the recovery period.

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Appendix I. Country Groups[1]

	Euro area - advanced		Other European - advanced		Central, Eastern, and Southeastern European		Other
1	Austria *	1	Denmark *	1	Albania	1	Argentina *
2	Belgium	2	Iceland *	2	Bosnia & Herzegovina	2	Australia *
3	Cyprus *	3	Israel *	3	Bulgaria	3	Brazil *
4	Finland *	4	Norway *	4	Croatia	4	Canada *
5	France *	5	Sweden *	5	Czech Republic	5	China,P.R.: Mainland
6	Germany *	6	Switzerland *	6	Estonia	6	China,P.R.:Hong Kong *
7	Greece *	7	United Kingdom *	7	Hungary	7	India *
8	Ireland *			8	Kosovo	8	Indonesia
9	Italy *			9	Latvia	9	Japan *
10	Malta *			10	Lithuania	10	Korea, Republic of *
11	Netherlands *			11	Macedonia, FYR	11	Malaysia *
12	Portugal *			12	Montenegro	12	Mexico *
13	Spain *			13	Poland	13	Philippines *
				14	Romania	14	Singapore *
				15	Russian Federation *	15	South Africa *
				16	Serbia, Republic of	16	Turkey *
				17	Slovak Republic	17	United States *
				18	Slovenia		

[1] Belarus, Luxembourg, Moldova, San Marino, and Ukraine not included in sample.

* Countries with expansion peaks in 1971-2006 that are included in LP regression to derive projection paths.

THE "NEUTRAL" REAL INTEREST RATE: A USEFUL CONCEPT FOR ICELAND?[1]

This chapter presents various estimates of the neutral real interest rate in Iceland, finding them to vary widely depending on the methodology used. Hence judgement is needed in assessing the usefulness of these methodologies. The estimates they generate need to be treated with caution given the high degree of associated uncertainty. Nevertheless, estimates based on the Laubach-Williams model—and extensions of this model—appear to give plausible, robust, and potentially useful results for Iceland. Another finding is that external variables that are beyond the control of the monetary authorities are important drivers of headline inflation in Iceland. The central bank needs to analyze carefully the implications for domestic inflation of movements in these external variables.

A. Introduction

1. The "neutral" real rate of interest (NRIR) can be defined in at least two ways. From an operational view point, it can be defined as the short-term real interest rate consistent with stable inflation and a closed output gap in the medium term, once transitory shocks to aggregate demand and supply have subsided. Alternatively, from a longer-term perspective, it can be defined as the real interest rate that balances savings and investment at full employment (Rachel and Smith, 2015).

2. The concept is of importance to monetary authorities. The distance between the real policy interest rate and the neutral real interest rate is an indicator of the monetary policy stance (Hassan and Redford, 2016). Money is "tight" and the policy stance contractionary (pulling down aggregate demand) if the real policy rate is above the neutral rate, and "loose" if the real policy rate is below the neutral rate. When the two rates are equal, *and in the absence of future shocks to the economy*, there is neither upward nor downward pressure on inflation in the medium term—this, then, is the desired stance for interest rate policy when inflation over the policy relevant horizon is on target. At least in principle, therefore, understanding where the real policy interest rate is relative to the neutral rate should be of interest to monetary policy makers (Kirker, 2008).

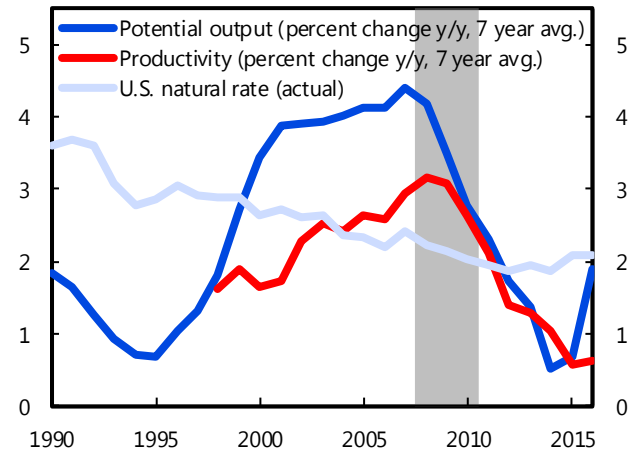
3. Estimating the NRIR is not a simple exercise. Neither is the NRIR directly observable, nor is its measurement straightforward. Moreover, the rate may change over time in response to structural trends and/or permanent shocks to aggregate demand or supply.

4. In the case of Iceland, several factors suggest the NRIR may have fallen since the global financial crisis (Figure 1). Factors arguing in this direction include an observed trend decline in growth of potential output and of trend productivity since the start of the global financial crisis, and conditions in global financial markets, with declining long-term real interest rates globally and declining spreads on Icelandic government bonds. Going forward, conditions in global financial

[1] Prepared by Rina Bhattacharya (FIN) with econometric support from Xingwei Hu (FIN).

markets may be expected to have a stronger influence on Iceland's NRIR given the removal of capital controls.

Figure 1. Potential Driver of Natural Rate
(Percent)



Sources: Central Bank of Iceland, Statistics Iceland, and U.S. Federal Reserve System.

5. More recently, however, burgeoning tourism growth may have begun a reversal of this trend. More specifically, the boom, and the associated influx of foreign labor, is likely to be reversing the trend decline in potential output growth, as shown by the clearly visible uptick in Figure 1. Other things being equal, this should raise the NRIR.

6. This chapter uses four approaches to obtain time varying estimates of the NRIR for Iceland. These include application of a Hodrick-Prescott (HP) filter and estimation of three models of the NRIR: (i) the Implicit Common Stochastic Trend; (ii) the Laubach-Williams model; and (iii) the Laubach-Williams model augmented with a policy reaction function. The estimation period for all models is 2002–16, with quarterly data, starting shortly after Iceland's adoption of an inflation targeting regime in 2001. The chapter then goes on to examine the relationship between these estimates of the NRIR and future inflation before sketching some policy implications for Iceland.

B. Models and Methodologies

7. A wide variety of approaches have been used in the empirical literature to estimate the NRIR. Broadly speaking, there are two types of methodologies: statistical time series approaches, including a rolling moving average of past real policy rates or the HP filter, and model driven estimates. The latter include estimates of the NRIR derived from (i) models of the spread between short- and long-term interest rates in economies with well developed financial markets, (ii) models based on the Taylor Rule (with and without inflation expectations) in inflation targeting economies, and (iii) structural/semistructural macroeconomic models. Some recent empirical studies on the NRIR include Basdevant *et al.* (2004), Adolfson *et al.* (2011), Ogunc and Batmaz (2011), Magud and Tsounta (2012), Perrelli and Roache (2014), Hassan and Redford (2016), and Danielsson *et al.* (2016).

HP Filter

8. The first approach tried here is to apply a standard HP filter to a time series of the real short-term interest rate. The interest rate series used is the Central Bank of Iceland (CBI) policy rate deflated by one-year ahead expected inflation. An ARMA(1,1) model of (period average) inflation (including seasonal dummies) is estimated, and a four quarter ahead (static) forecast is used as an estimate of one year ahead expected inflation after smoothing the series. This estimate of one year ahead expected inflation is then used in the estimation of all dynamic models in this study.

Implicit Common Stochastic Trend (ICST) Model

9. The first model driven estimate is based on the term structure of interest rates. In economies with well developed financial markets the yield curve can provide information about the economy's monetary policy stance and the NRIR: a steepening yield curve, for example, may be signaling that the real policy rate is below its neutral level. Building on this intuition, we follow Basdevant *et al.* (2004) and estimate the following four equation dynamic model:

Measurement Equations

$$i^{TB}_t = r^*_t + \pi^e_{t+1} + \varepsilon_t^1$$
$$R_t = r^*_t + \alpha_t + \pi^e_{t+1} + \varepsilon_t^2$$

State equations

$$r^*_t = r^*_{t-1} + \omega_t^1$$
$$\alpha_t = \mu_0 + \mu_1\alpha_{t-1} + \omega_t^2$$

where

$i^{TB}_{t,}$ the nominal short-term rate of return (90 day treasury bill rate), is equal to the sum of the NRIR, (one year) ahead inflation expectations π^e_{t+1} , and a stochastic disturbance term;

$R_{t,,}$ the nominal long-term rate of return (10 year government bond yield), is equal to sum of the short-term nominal interest rate, a term premium α_t, and a stochastic disturbance term;

The transition equation for r^*, the (state variable) NRIR, is assumed to follow a random walk; and

The transition equation for α_t, the term premium (the other state variable in the model), is assumed to be an AR(1) process with drift.

10. The core assumption in the model is that there is a common stochastic trend between short- and long-term nominal interest rates. Also, an observed simultaneous shift in both the long- and short-term interest rates (after cyclical fluctuations have been taken into account) is interpreted as a shift in the NRIR. The model is estimated using a Kalman filter, with the assumption that all stochastic disturbances in the model are i.i.d. processes with zero means and constant variances. The initial starting values for r^*_t and α_t are 2.0 percent and -2.5 percent; the latter is based on the fact that, over the sample period, the 10 year government bond yield was consistently, and for the most part significantly, lower than the 90 day treasury bill rate. This in turn is presumably a reflection of market participants consistently expecting future declines in short-term interest rates.

Laubach-Williams (LW) Model

11. The next model estimated is the widely used semi structural model of Laubach and Williams (2003). The model consists of an IS curve and a backward looking Phillips curve, which requires the real policy rate to equal the NRIR when the output gap is zero and inflation is stable at its target. Specifically, we estimate the following system of equations:

Measurement Equations

$$(y_t - y^*_t) = \alpha^{y^*}(y_{t-1} - y^*_{t-1}) - \alpha^{r^*}(r^P_t - r^*_t) + \varepsilon_t^1$$
$$\pi_t = \beta_0 + \beta^{\pi^*}\pi_{t-1} + \beta^{y^*}(y_{t-1} - y^*_{t-1}) - \beta^{N^*}\Delta NEER_t + \beta^{O^*}\Delta Oilprice_t + \varepsilon_t^2$$

State Equations

$$r^*_t = c^* g_t + z_t$$
$$y^*_t = y^*_{t-1} + g_{t-1} + \omega_t^1$$
$$g_t = g_{t-1} + \omega_t^2$$
$$z_t = z_{t-1} + \omega_t^3$$

where

y_t is actual output (GDP);

y^*_t is potential output;

r^P_t is the real policy interest rate;

π_t is the current rate of inflation;

$\Delta NEER_t$ is the percentage change in the nominal effective exchange rate, with a rise representing an appreciation;

$\Delta Oilprice_t$ is the percentage change in the world oil price; and

the other variables are as defined earlier.

12. The equations seek to explain movements in the output gap and in inflation. The first measurement equation depicts the IS curve, where deviations of real GDP from potential (the output gap, $y_t - y^*_t$) is assumed to be a function of its lagged value and of the deviation of the actual real monetary policy rate from the NRIR, as given by $(r^P_t - r^*_t)$. The second measurement equation represents the Phillips curves and assumes that inflation π_t is a function of its lagged value, of the lagged output gap, and of movements in the nominal effective exchange rate $NEER_t$ and in the world oil price $Oilprice_t$.[2] The (unobserved) NRIR is modeled as a linear combination of the growth of

[2] The average crude price, in $ per barrel. of U.K. Brent Light, Dubai Medium, and Alaska NS Heavy.

potential output and a composite variable z_t, which encompasses time preference along with a risk premium and other unspecified factors such as demographic trends.

Laubach-Williams with Policy Reaction Function (LWPRF)

13. The third and last model augments the Laubach-Williams model by introducing a Taylor Rule type monetary policy reaction function. Monetary policy is assumed to follow a Taylor rule, with the policy rate responding to one year ahead expected inflation and to deviations of (i) real GDP from its potential level, and (ii) inflation from the central bank's target. When both deviations are equal to zero, the interest rate should be at the NRIR. The complete model is given by the following system of equations:

Measurement Equations

$$(y_t - y^*_t) = \alpha^{y^*}(y_{t-1} - y^*_{t-1}) - \alpha^{r^*}(r^P_t - r^*_t) + \varepsilon_t^1$$
$$\pi_t = \beta_0 + \beta^{\pi^*}\pi_{t-1} + \beta^{y^*}(y_{t-1} - y^*_{t-1}) - \beta^{N^*}\Delta NEER_t + \beta^{O^*}\Delta Oilprice_t + \varepsilon_t^2$$
$$r^P_t = r^*_t + \theta^{\pi^*}(\pi_t - \pi^*_t) + \theta^{y^*}(y_t - y^*_t) + \varepsilon_t^3$$

State Equations

$$r^*_t = c^* g_t + z_t$$
$$y^*_t = y^*_{t-1} + g_{t-1} + \omega_t^1$$
$$g_t = g_{t-1} + \omega_t^2$$
$$z_t = z_{t-1} + \omega_t^3$$

where π^*_t is the inflation target of the central bank, and all the other variables are as defined earlier.

C. Data Sources and Results

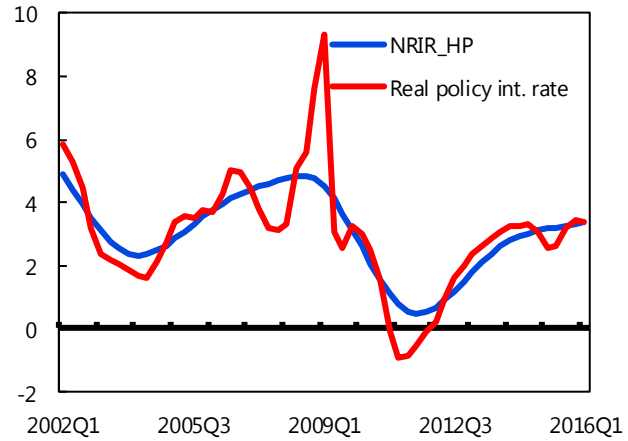
14. Details on the data sources for the variables used in the NRIR estimations for Iceland are provided in Table 1. The models outlined above were estimated using quarterly data from the CBI, Statistics Iceland, the IFS, the IMF's Global Data Source database, and IMF staff calculations.

Table 1: Data Sources	
Variable	**Data Source**
Central Bank Policy Rate: 2002 - April 2009: Collateralised lending rate April - September 2009: Current Account Rat October 2009 - 21 May 2014: Simple average of current account rate and maximum rate on 28-day Certificates of Deposit From 21 May 2014: Seven-day Term Deposit Rate	Central Bank of Iceland's website.
90-day Treasury Bill Rate	IFS Statistics
10-year government bond yield	IFS Statistics
CPI inflation	Statistics Iceland
12-month ahead inflation expectations	Central Bank of Iceland
Output gap	IMF staff estimates based on the Central Bank of Iceland's QMM model, after seasonal adjustment and smoothing
Oil price	IFS Statistics
Nominal effective exchange rate	IMF GDS (Global Data Source) database

HP Filter

15. As expected, the HP filter gives a relatively smooth path for the NRIR (Figure 2). The model estimate of the NRIR for Q1 2016—the last period for which dynamic estimates of the NRIR could be obtained using our measure of one year ahead expected inflation—is 3.4 percent. While this technique is straightforward to compute, the approach lacks structural interpretation, ignores structural breaks and regime shifts, and is without economic foundation. Moreover, as is well known, the HP filter is generally biased in that it puts more weight on the most recent observations of the data series. In contrast with time series estimates, model driven estimates—such as the ones presented below—are therefore more suitable for the analysis of the NRIR, as they allow for the specification

Figure 2. NRIR Estimate – HP Filter



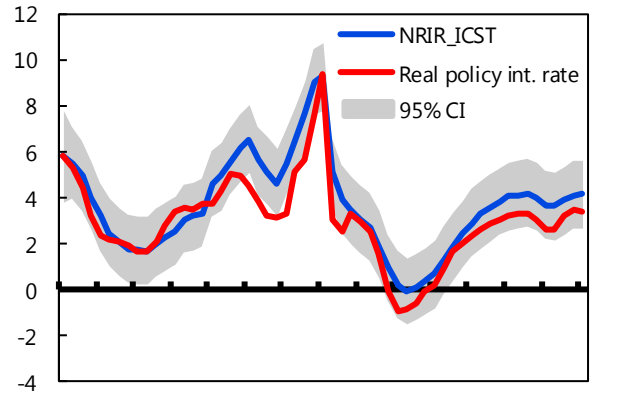
Sources: Central Bank of Iceland and IMF staff calculations.

of economic shocks (Magud and Tsounta, 2012). However, these models often produce volatile estimates of the NRIR. Also, the results are sensitive to the choice of model and, when using state space models (such as the Kalman filter), to the choice of starting values for the model parameters.

ICST Model

16. Estimates of the NRIR from this model show considerable variation over the sample period (Figure 3). This could be because the term spread reflects not just the NRIR but also the degree of uncertainty about future inflation, which is likely to have been rather volatile in the case of Iceland. Estimates of the NRIR range from 9.2 percent to -0.1 percent over the sample period, with a value of 4.1 percent for Q1 2016. Such wide variation sits uncomfortably with the notion of the NRIR being broadly stable over time, responding slowly to structural shifts in the economy.

Figure 3. NRIR Estimate – ICST



Sources: Central Bank of Iceland and IMF staff calculations.

17. Combining Bayesian estimation techniques with the application of Kalman filters can provide more robust estimates, and indeed are used for the next two models. The use of the Kalman filter can, however, give results that vary considerably depending on the starting values. This problem can to some extent be overcome through Bayesian estimation of the measurement equations of the model. The Bayesian approach starts with prior distributions for the model parameters that are then combined with the data using the likelihood function to estimate the posterior distributions for the parameters. This approach has two main strengths, as discussed in Honjo and Hunt (2006). First, starting with prior distributions for the parameters allows other empirical evidence from a range of sources as inputs into the estimation. Second, use of prior distributions makes the highly nonlinear optimization algorithm considerably more stable, making it feasible to apply the technique when sample periods are short. An added advantage is that Bayesian estimation allows for measurement errors in the data. The next two models are estimated using a combination of Bayesian estimation (for the measurement equations) and Kalman filters (for the state equations). The choice of priors and the resulting posterior distributions are in Table 2.

Table 2. Priors and Posteriors of the LW and LWPRF Models

Parameter	Prior			LWPRF Estimate			LW Estimate		
	distribution	mean	se	Mean	se	sig	Mean	se	sig
			Measurement Equation Coefficients						
α^{y*}	beta	0.600	0.200	0.632	0.103	***	0.725	0.307	**
α^{r*}	beta	0.100	0.090	0.050	0.025	**	0.170	0.204	
β_0	n/a			2.186	0.169	***	2.030	0.643	***
β^{y*}	beta	0.100	0.090	0.116	0.021	***	0.114	0.177	
$\beta^{\pi*}$	beta	0.500	0.200	0.484	0.034	***	0.494	0.040	***
β^{N*}	lognormal	LN(10)	1.000	13.886	0.053	***	13.628	0.104	***
β^{O*}	uniform(1,3)	2.000	0.600	1.862	0.080	***	1.884	0.203	***
$\theta^{\pi*}$	beta	0.667	0.250	0.372	0.061	***			
θ^{y*}	beta	0.875	0.110	0.729	0.143	***			
			Standard Deviation of Shocks						
ε_t^1	lognormal(-1,1)	0.607	0.482	0.031	0.000		0.143	1.851	
ε_t^2	lognormal(-1,1)	0.607	0.482	0.846	0.017		0.687	0.251	
ω_t^1	lognormal(-1,1)	0.607	0.482	0.029	0.000		0.434	0.549	
ω_t^2	lognormal(-1,1)	0.607	0.482	0.037	0.000		0.649	0.666	
ω_t^3	lognormal(-1,1)	0.607	0.482	0.364	0.039		0.542	0.855	
ε_t^3	lognormal(-1,1)	0.607	0.482	0.003	0.000				

Significance Levels: *** p<0.01, ** p<0.05, * p<0.1

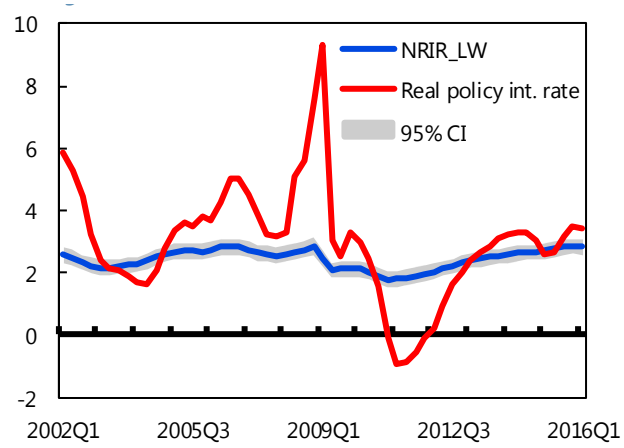
LW Model

18. In contrast with the ICST model, NRIR estimates from the LW model show little variation over time (Figure 4). The LW estimates vary within a narrow range of 1.8–2.8 percent, and show little correlation with the actual real policy rate. They show a downward trend from Q3 2006 to Q4 2010 and rise fairly steadily thereafter, reaching 2.8 percent in Q1 2016. Another notable feature is the finding from the parameter estimates (Table 2) that external factors (movements in the exchange rate and in world oil prices) have a much more powerful impact on headline inflation than do domestic demand pressures (as proxied by the output gap).

LWPRF Model

19. Adding a policy reaction function to the LW model considerably increases the variation of the result (Figure 5). The estimated NRIR moves more closely with the actual real policy rate, and the parameter estimates again highlight the importance of external factors (as opposed to domestic demand pressures) as the main drivers of headline inflation. There is a sharp downward trend from the beginning of 2007 until mid 2011 (when the economy began to recover), with the NRIR increasing fairly steadily thereafter. The model gives an estimate of 3.5 percent for the NRIR at the end of the period, in Q1 2016.

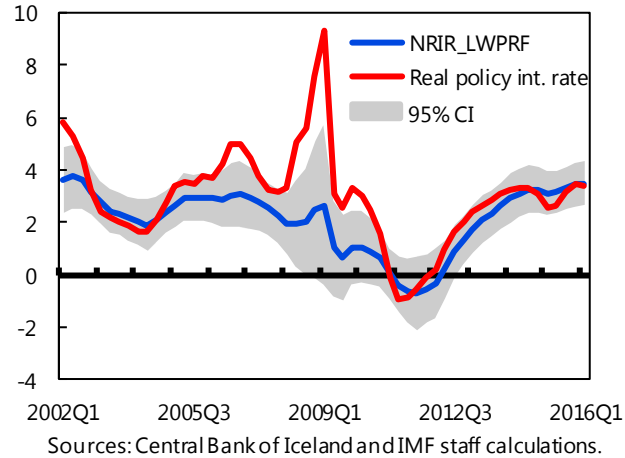
Figure 4. NRIR Estimate – LW



Sources: Central Bank of Iceland and IMF staff calculations.

20. To sum up this section, the LW and LWPRF models generate the most intuitively sensible estimates of the NRIR. As noted above, the usefulness of the NRIR_HP estimates is limited from a policy perspective because it is lacking in economic foundation. The volatility of the NRIR_ICST estimates is troubling and is at odds with the concept of the NRIR being broadly stable over time and moving slowly in response to long-term structural shifts in the economy; also, the estimated value of around 9 percent at end 2008—the onset of the financial crisis—seems too high to be plausible. The NRIR_LW estimates are broadly stable over time, consistent with what one would expect from the way the NRIR is defined. The NRIR_LWPRF estimates are more variable but could also be plausible if one argues the tourism boom in recent years amounts to a major positive real external demand shock with long-lasting effects on the structure of the economy. Based on this, one could argue that the NRIR is currently somewhere between 2.8 percent and 3.5 percent.

Figure 5. NRIR Estimate – LWPRF



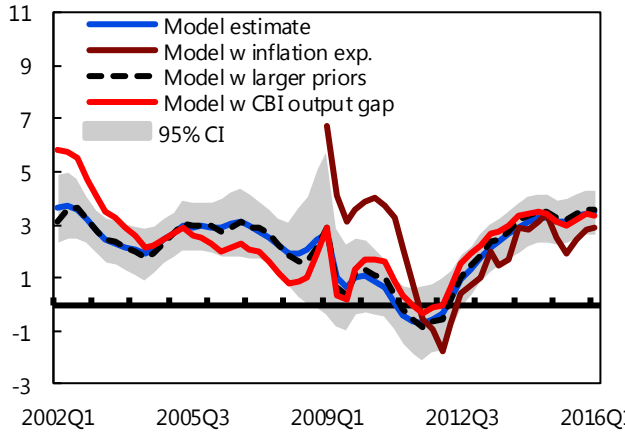
Sources: Central Bank of Iceland and IMF staff calculations.

D. Robustness Checks

21. Robustness tests carried out on the LWPRF model gave reassuring results. Robustness of the model estimates was tested to (i) different measures of inflation expectations, (ii) changes in priors, and (iii) alternative measures of the output gap. The first test used market expectations of

inflation expectations one year ahead from surveys carried out by Gallup; as the survey only began in 2009 this data source was not used in the base estimations. The second test looked at the impact of doubling the initial priors for the standard errors of the disturbance terms for the state variables in the model. The third test replaced the model's endogenously estimated output gap with a (seasonally adjusted and smoothed) measure of the output gap derived from the CBI's QMM model. The results are illustrated in Figure 6. These alternative estimates of the NRIR move broadly in line with NRIR_LWPRF over the sample period, and are very close to the model estimates from mid 2012 onward.

Figure 6. Robustness of the NRIR – LWPRF Estimate



Sources: Central Bank of Iceland, Gallup, and IMF staff calculations.

E. The Relationship between the NRIR Estimates and Future Inflation

22. NRIR-based measures of the monetary policy stance do not show a statistically significant negative correlation with future inflation. The NRIR is defined as the real interest rate that is neutral in terms of its impact on aggregate demand and inflationary pressures, when the economy is in equilibrium and in the absence of future shocks to the economy. The difference between the actual real policy rate and the NRIR—what we call the real interest rate gap or RGap—can thus be taken as a measure of the tightness/looseness of the monetary policy stance. The RGaps associated with our various estimates of the NRIR, and their relationship with future inflation—one year, two year, and 30 months ahead—are shown in Figures 7–10 below. Only RGap_ICST appears to have a significant negative correlation with future inflation, as shown in Table 3.

Table 3. RGaps and Correlations with Future Inflation

	Inflation one year ahead	Inflation two years ahead	Inflation 30 months ahead
RGAP_HP	-0.196	-0.144	-0.009
RGAP_ICST	-0.582***	-0.340**	-0.064
RGAP_LW	0.186	0.167	0.235
RGAP_LWPRF	0.274*	0.06	0.056

F. Conclusions

23. Estimates of the NRIR vary widely depend on the methodology used. Judgement is therefore needed in assessing the usefulness of the various methodologies and the estimates they generate. These estimates need to be treated with caution, especially given the high degree of uncertainty associated with estimation of unobservable variables such as the output gap.

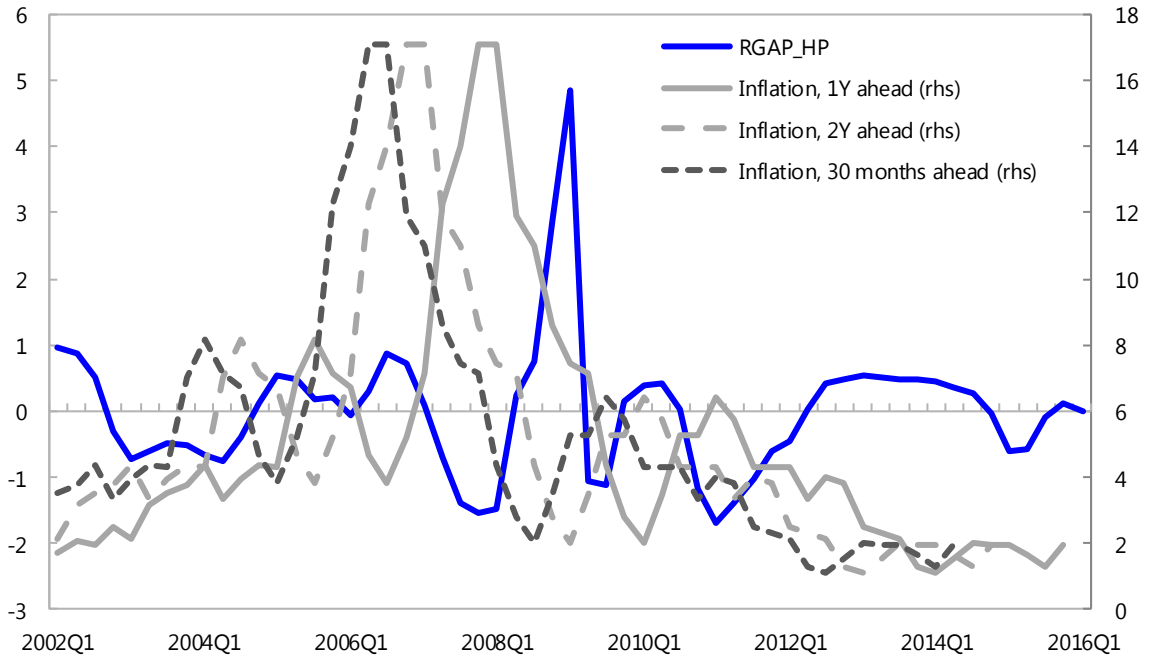
Nevertheless, the Laubach-Williams (LW) and Laubach-Williams with Policy Reaction Function (LWPRF) models appear to give plausible and robust estimates of the NRIR for Iceland.

24. The empirical results suggest plausible measures of the monetary policy stance do not have much impact on future (headline) inflation. Only the Implicit Common Stochastic Trend (ICST) model gives estimates of the interest rate gap that are consistent with higher policy rates having a significant and negative impact on future inflation (one year and two years ahead); however, this measure of the NRIR is too volatile to be plausible. Overall, the lack of a significant negative correlation with future inflation is in line with what one might expect for a small open economy like Iceland, with external variables (such as the exchange rate and world oil prices) having a more powerful impact than domestic demand pressures—consistent with the findings from the LW and LWPRF models. It is also relevant to note that correlation does not imply causality, which can go both ways: expectations of future inflation can influence current monetary policy.

25. There are clear implications for the inflation targeting regime. Gudmundsson (2008, 2016) makes the case that global financial integration has weakened the interest rate transmission channel of monetary policy in small open economies with relatively developed financial markets. For these economies, he argues the exchange rate channel increases in importance, and the interest rate channel weakens, with global financial integration and the lifting of restrictions on capital flows. The empirical findings of this chapter support this argument and show that external variables that are beyond the control of the monetary authorities are indeed important drivers of headline inflation in Iceland. Needless to say, the central bank must bear this in mind when setting monetary policy and analyze carefully the implications for domestic inflation of movements in the external variables.

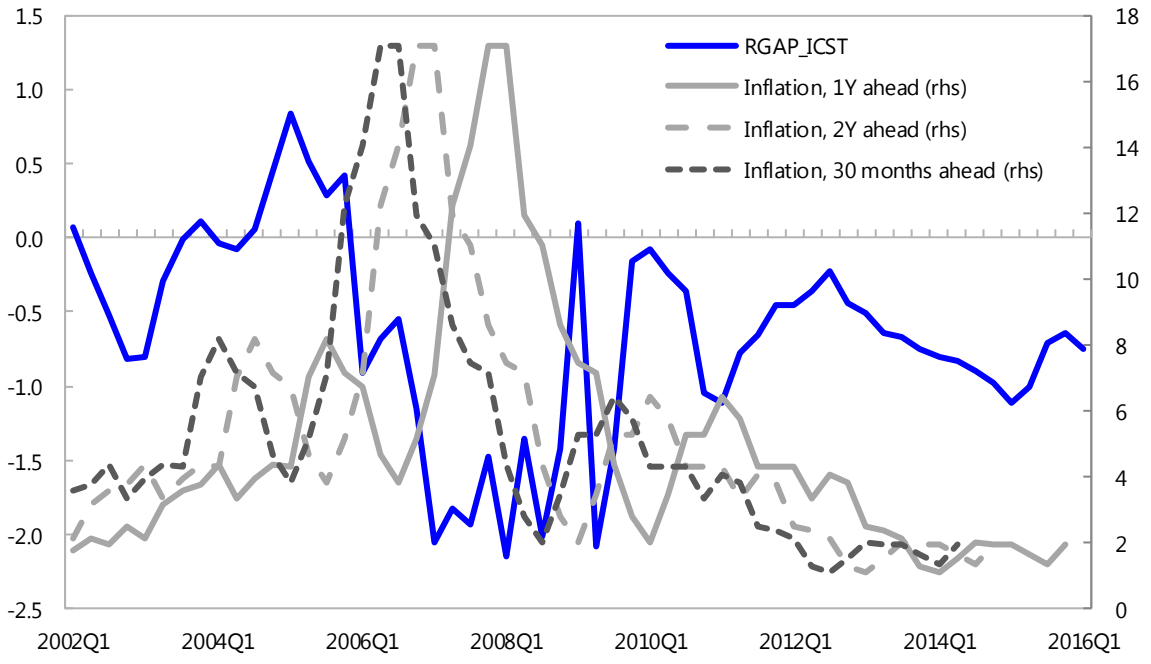
26. Open economy models of the Icelandic economy would likely give more insights into the effectiveness and transmission mechanisms of monetary policy, but present challenges of their own. An obvious extension of the empirical work carried out here would be to develop open economy models that better reflect the features of the Icelandic economy and use these to estimate the NRIR. This, however, is a challenging task given Iceland's recent history of imposing and lifting capital controls and the periods of heavy exchange market intervention by the central bank.

Figure 7. RGap_HP and Future Inflation
(Percent)



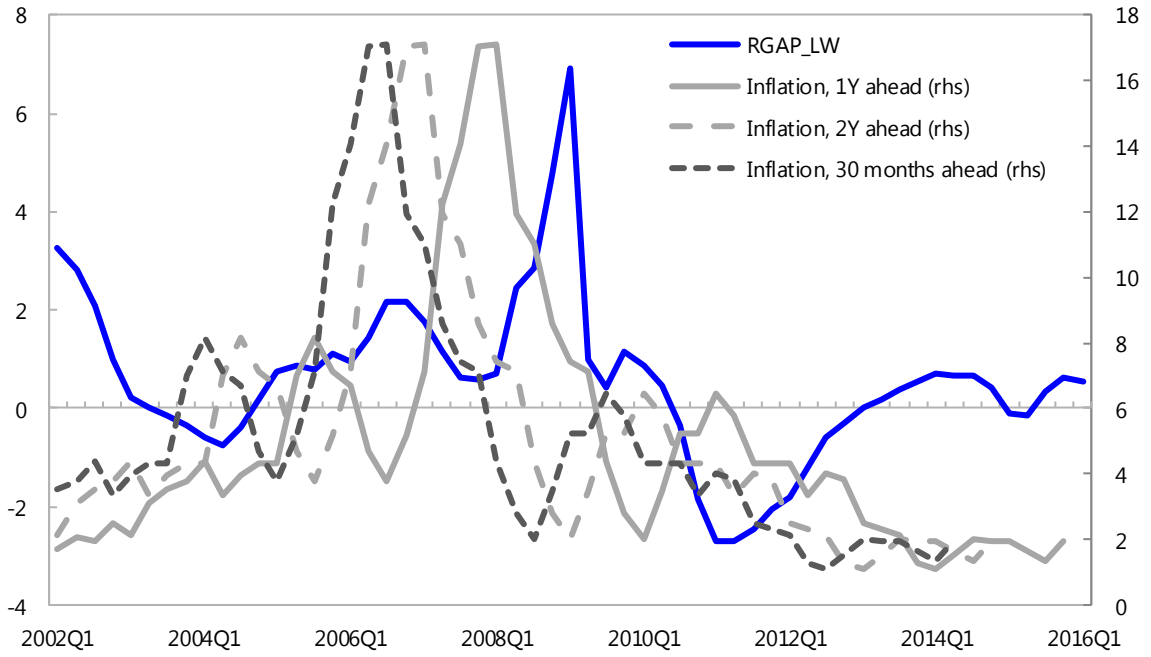
Sources: Central Bank of Iceland and IMF staff calculations.

Figure 8. RGap_ICST and Future Inflation
(Percent)



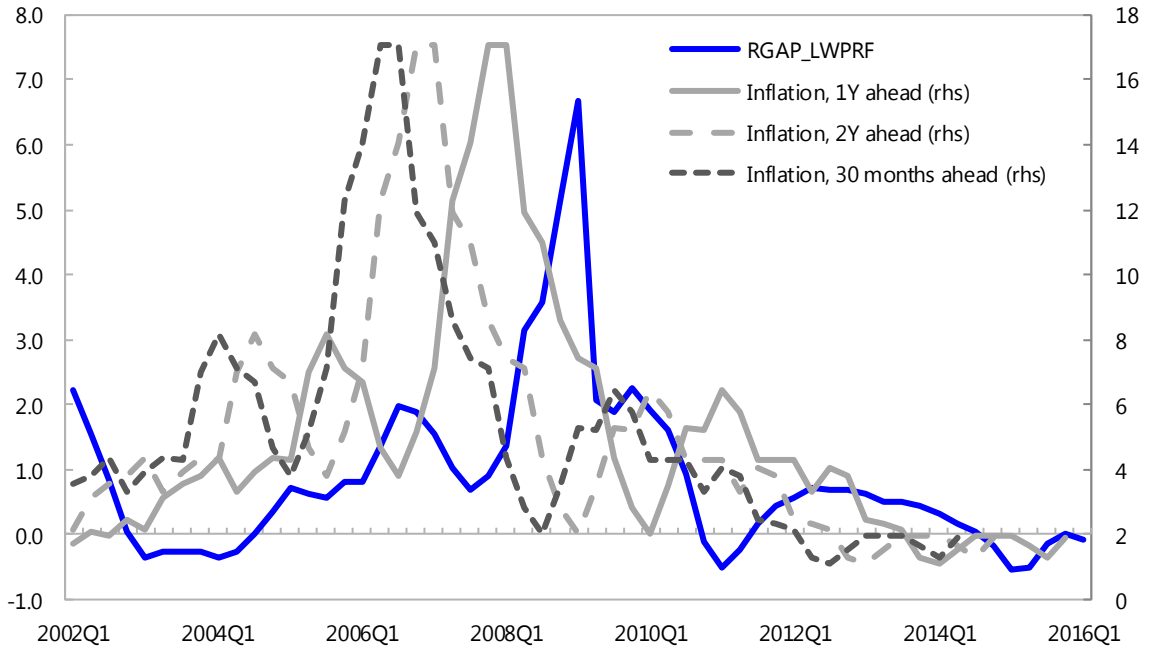
Sources: Central Bank of Iceland and IMF staff calculations.

Figure 9. RGap_LW and Future Inflation
(Percent)



Sources: Central Bank of Iceland and IMF staff calculations.

Figure 10. RGap_LWPRF and Future Inflation
(Percent)



Sources: Central Bank of Iceland and IMF staff calculations.

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