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By

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How “Natural” is the Natural Rate? Unemployment Hysteresis in Iceland*

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Abstract

This paper estimates the Non-Accelerating Inflation Rate of Unemployment (the NAIRU) for Iceland based on the Phillips curve using an iterative regression process and the Kalman filter. According to our results, the NAIRU rose sharply in the wake of the financial crisis, peaking at 5½% or 7% depending on estimation methodology. We evaluate what factors influence changes in the NAIRU. In particular, we assess whether changes in the NAIRU have been influenced by structural changes or changes in actual unemployment and therefore aggregate demand; i.e., whether there is evidence of hysteresis in unemployment. We find that time variation in the NAIRU is to a large extent due to hysteresis effects but to a lesser extent due to structural factors. This implies that monetary policy can have long-run effects on unemployment and its conduct is thus more complicated. Prudence in the government’s conduct of fiscal policy and labor unions’ and their counterparties’ wage bargaining becomes more important in the presence of hysteresis in unemployment, as inflationary pressures must be countered with a rise in interest rates, which can cause an increase in the NAIRU. Keeping inflation low becomes more important for the real economy in the presence of hysteresis in unemployment.

Keywords: Iceland, unemployment, NAIRU, Phillips curve, hysteresis

JEL Classification: E24, E31, J6

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1 Introduction

The past several years have been anomalous in Icelandic labor market history. Since the 1950s, the Icelandic labor market has been characterized by a very low and stable rate of unemployment, as is shown in Figure 1. Apart from 1993-1997, unemployment has fluctuated below 3 percent. In the deep recession beginning with the financial crisis of 2008, however, the unemployment rate as registered by the Directorate of Labour jumped from less than 1% to more than 8%, and although it has declined to roughly 5%, it currently remains far above its historical average.

Two competing hypotheses present different views on the persistence of increased unemployment. The natural rate hypothesis, argued for in the seminal contributions of Phelps (1967) and Friedman (1968), assumes that changes in unemployment are deviations from a long-run steady state. Such deviations will be followed by a convergence towards the long-run rate, which is determined by the supply side of the economy: in particular, structural features such as wage rigidity, labor market institutions, and matching frictions. If these structural factors remain unchanged and the natural rate hypothesis correctly predicts the dynamics of the unemployment rate, all deviations from the natural rate will be relatively short-lived, or at least not permanent. A later branch of the literature initiated by Blanchard & Summers (1986) argues that unemployment is a process characterized by hysteresis; that is, the natural rate also depends on past unemployment. This means that temporary economic shocks can have persistent, or even permanent, effects on unemployment. Furthermore, because the unemployment rate is influenced by aggregate demand, the natural rate will also be affected by the factors influencing aggregate demand, such as interest rates, government spending, and expectations of future economic developments.

The financial crisis of 2008 and the ensuing recession brought the unemployment rate up into unknown territory in the Icelandic context. In the aftermath of the recession, a central question remains: how extensive and long-lasting will its impact be on unemployment and therefore the real economy? In light of the two aforementioned hypotheses, the answer to this question will depend on whether the rise in the unemployment rate was a temporary deviation from a fixed natural rate or whether the natural rate is now at a higher level, either because of pre- or post-recession structural changes or because the rise in the unemployment itself will yield persistently or permanently higher unemployment because of unemployment hysteresis.

The contribution of the current paper is twofold. First, we estimate the Non-Accelerating Inflation Rate of Unemployment (NAIRU) using recently introduced estimation procedures: an Iterative Phillips Curve (IPC) procedure based on the method developed in Ball & Mankiw (2002) and further in Ball (2009), and a Kalman filter. We then assess possible explanations for changes in the NAIRU and evaluate whether there is hysteresis in unemployment. Our results show that there was a substantial increase in the NAIRU following the financial crisis. The results from the Kalman filter procedure show the NAIRU to peak at about 7%, whereas the IPC method shows a peak of 5½%. This increase began

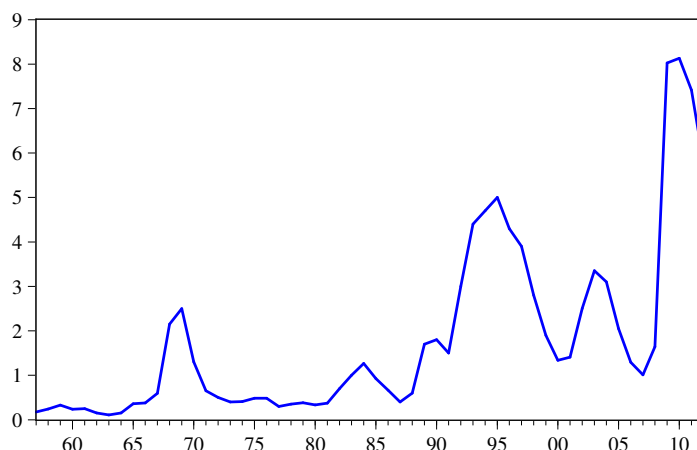


Figure 1: Unemployment 1957-2012

Sources: National Economic Institute, Directorate of Labour

to subside in mid-2011, and we forecast that the NAIRU will have fallen and stabilized at just above 4% by 2015.

We do not find that changes in structural factors provide strong explanations for changes in the NAIRU. In general, the structure of labor unions and the institutional framework remained largely unchanged during our sample period. However, the extension of the unemployment benefit period, in addition to an already long benefit period and high benefits in international context, may have put upward pressure on the NAIRU in the wake of the financial crisis. In the expansionary pre-crisis period, there was a substantial build-up of mismatches in the labor market, reflecting to a degree a general shift from the tradable to the non-tradable sector, implying a decrease in the NAIRU for a given unemployment rate, which was mostly reversed in the recession. These factors may have contributed to time variation in the NAIRU.

Our results indicate that hysteresis is the main source of variation in the NAIRU. First, we find that the NAIRU is countercyclical and changes in unemployment are partially transferred into the NAIRU with a lag. A particularly promising idea explaining hysteresis in unemployment involves long-term unemployment and depreciation of human capital in particular. Workers who have been unemployed for a long time become detached from the labor market, either because of reduced search intensity or because long-term unemployment signals reduced human capital and firms become reluctant to hire these workers. The long-term unemployed exert less downward pressure on wages than the short-term unemployed. Furthermore, if an initial decrease in aggregate demand leads to increased unemployment – concentrated in short-run unemployment – a prolonged recession will lead to a build-up of long-term unemployment and a consequent rise in the NAIRU. We assess this hypothesis. We find that while the short-term unemployed have a significant negative effect on inflation, the effect of the long-term unemployed is significant but non-negative.

The negative pressure that short-term unemployment puts on wages and therefore inflation is reduced by the share of workers who are long-term unemployed and have become detached from the labor force.

The remainder of the paper is organized as follows. Section 2 sets out a simple framework for the subsequent analysis. Section 3 lays out the empirical methodology, and Section 4 contains the estimation results. In Section 5 we discuss, evaluate, and test various explanations for changes in the NAIRU during the sample period and assess the hysteresis hypothesis. Section 6 presents some policy implications that can be derived from our main results. Section 7 concludes.

2 Theoretical framework

A simple theoretical framework that is consistent with a natural rate of unemployment is the structural model of price and wage setting presented in Layard et al. (1991).¹ The expectations-augmented Phillips curve can be derived from the model and the corresponding natural rate of unemployment; i.e., the NAIRU. We derive a simple version of the model to underpin the methodology for estimating NAIRU and the discussion that follows.

Imperfect competition is assumed where firms set prices with a mark-up over marginal cost. The price-setting equation can be written as:

$$p_t - w_t^e = -\gamma_t + \mu_t \quad (1)$$

where γ_t is labor productivity in logarithm and μ_t is the mark-up.

The wage-setting equation can be written in a simple form as:

$$w_t - p_t^e = \gamma_t - \phi u_t + z_t \quad (2)$$

where p_t^e is the expected level of prices, u_t is the unemployment rate, and z_t is a variable that accounts for exogenous wage pressure factors such as union and benefit effects.

If prices and wages are at their expected values ($p_t = p_t^e, w_t = w_t^e$), equilibrium unemployment is given by inserting one of the above equations into the other, which yields:

$$u_t^* = \frac{\mu_t + z_t}{\phi} \quad (3)$$

In particular, two features of the equilibrium should be mentioned. First, the equilibrium unemployment rate depends positively on the mark-up of prices on marginal costs. Therefore, if mark-ups rise – e.g., because product-markets become less competitive – the equilibrium unemployment level will rise. Second, wage-pressure factors also raise the equilibrium unemployment rate. Factors such as increased union wage bargaining power, increased unemployment benefits, or extension of the benefit period will raise the equilib-

¹For a detailed description and derivation of the model, see Chapter 8 in Layard et al. (1991)

rium unemployment rate.² These two features have an important implication: the fact that equilibrium unemployment depends on factors such as unemployment benefits and product-market competition implies that there is significant latitude for policy measures to affect long-term unemployment.

If expected prices and wages are not realized, the unemployment rate is:

$$\begin{aligned} u_t &= \frac{\mu_t + z_t - (p_t - p_t^e) - (w_t - w_t^e)}{\phi} \\ &= u_t^* - \frac{(p_t - p_t^e) + (w_t - w_t^e)}{\phi} \end{aligned} \quad (4)$$

Assuming that unexpected variations in wages and prices are similar, we can write:

$$u_t - u_t^* = -\frac{1}{\alpha}(p_t - p_t^e) \quad (5)$$

Equation (5) can then be rewritten in the form of the Phillips curve:

$$\pi_t = \pi_t^e - \alpha(u_t - u_t^*) \quad (6)$$

where π_t is inflation; i.e., the change in the price level. If we assume static inflation expectations – i.e., $\pi_t^e = \pi_{t-1}$ – we can think of the equilibrium unemployment rate, u_t^* , as the non-accelerating inflation rate of unemployment (NAIRU): When unemployment is below u_t^* , inflation is increasing, but when unemployment is above u_t^* it is decreasing.

3 Methodology

3.1 Iterative Phillips curve estimation

Ball & Mankiw (2002) use a two-step procedure to estimate a time-varying NAIRU based on the simple Phillips curve in equation (6). Assuming inflation expectations to be static, they first estimate α in the equation:

$$\pi_t = \pi_{t-1} + \alpha(u_t - u_t^*) + \varepsilon_t \quad (7)$$

using OLS, assuming u_t^* to be constant and where ε_t captures short-run supply shocks.

Rearranging equation (7) gives:

$$u_t^* - (1/\alpha)\varepsilon_t = u_t - (1/\alpha)(\pi_t - \pi_{t-1}) \quad (8)$$

where the right-hand side can be calculated using the estimate of α . The right-hand side is then smoothed using the Hodrick-Prescott filter.³ This gives an estimate of the

²Note that the equilibrium unemployment rate does not depend on labor productivity. Consistent with empirical evidence, unemployment does not trend while there has been trend productivity growth.

³With the smoothing parameter at the standard value for quarterly data, $\lambda = 1600$.

time-varying NAIRU.

There is an internal inconsistency in the Ball-Mankiw method, however. The purpose is to estimate a time-varying NAIRU, but in the estimation of α , the NAIRU is assumed to be a constant. Ball (2009) resolves this inconsistency by iterating over the steps of the Ball-Mankiw method. After a series for u^* is obtained, equation (7) is re-estimated and the new estimate of α used to construct a new series for u^* . Equation (7) is re-estimated and a new u^* series calculated until convergence in u^* and α has been achieved.

3.2 A Kalman filter approach

An alternative approach is to estimate a time-varying NAIRU directly by means of the Kalman filter (see, e.g., Richardson et al., 2000, Gianella et al., 2008, and Guichard & Rusticelli, 2011).⁴ Following Guichard & Rusticelli (2011), three supply shock variables are included in the Phillips curve: oil price shocks, import price shocks, and productivity shocks.⁵ Oil price shocks are calculated as real oil price inflation weighted by the oil intensity of production; i.e., the ratio between imports of oil and GDP. Import price shocks are measured as real import price inflation weighted by import penetration; i.e., the ratio of imports to domestic demand. Finally, productivity shocks are measured as the deviation of labor productivity from trend. As in Gordon (1997), it is assumed that no feedback from inflation to unemployment exists and thus there is no simultaneity bias due to a contemporaneous unemployment rate in the Phillips curve. If dynamic homogeneity is assumed to hold, the Phillips curve takes the form:

$$\begin{aligned} \Delta\pi_t = & \sum_{j=1}^m \chi_j \Delta\pi_{t-j} + \beta (u_t - u_t^*) + \sum_{j=0}^n \eta_j MGS_{t-j}^{SH} (\pi_{t-j}^{MGS} - \pi_{t-j}) \\ & + \sum_{j=0}^l \kappa_j OIL_{t-j}^{SH} (\pi_{t-j}^{OIL} - \pi_{t-j}) + \gamma \ln(prod/prodt)_t + v_t \end{aligned} \quad (9)$$

where π_t is CPI inflation, $u_t - u_t^*$ is the difference between unemployment and the NAIRU, MGS_t^{SH} measures import penetration, π_t^{MGS} is import price inflation, OIL_t^{SH} measures oil intensity of production, π_t^{OIL} is oil price inflation, $prod$ is measured labor productivity, and $prodt$ its trend value. The model was initially estimated with four lags of the inflation variables ($m = n = l = 4$), and then insignificant lags were dropped.

Assumptions must be made regarding the stochastic processes governing the NAIRU and following Gianella et al. (2008) two transition equations are used, one specifying the properties of the NAIRU and one for the properties of the unemployment gap. The NAIRU is assumed to follow the random walk process:

$$u_t^* = u_{t-1}^* + \varepsilon_t \quad (10)$$

⁴Standard references on the Kalman filter include Kalman (1960), Harvey (1990), and Hamilton (1994).

⁵We would like to thank Stephanie Guichard and Elena Rusticelli for information about the technical details of their estimation procedure.

where the error term is normally distributed and uncorrelated with the error term in the Phillips curve.

Consistent with Friedman (1968), who showed that the unemployment rate cannot deviate permanently from its natural rate, the process for the unemployment gap is such that it ensures that the unemployment rate converges to the NAIRU in the absence of shocks. An implication is that the NAIRU is estimated not only on the basis of inflationary pressures but also on unemployment developments themselves. As in Laubach (2001), an autoregressive process for the unemployment gap is assumed:

$$u_t - u_t^* = \psi(L)(u_{t-1} - u_{t-1}^*) + \xi_t \quad (11)$$

where the error term is normally distributed and uncorrelated with the error term in the equation for the NAIRU. The unemployment gap is assumed to follow an AR(2) process (cf. Jaeger & Parkinson, 1994) and, as in Guichard & Rusticelli (2011), the sum of the parameters are constrained to ensure sensible time-series properties such as stationarity and prevent convergence problems that might arise if the sum is close to unity.

Some further assumptions are required to run the Kalman filter. The values and variances of the NAIRU and the unemployment gap in the initial period must be prespecified. Following Guichard & Rusticelli (2011), the initial value of the NAIRU is set equal to the average unemployment rate in the first year of the sample, and the initial value of the unemployment gap is set equal to the difference between the unemployment rate in the initial period and the prior for the NAIRU. The variances are set to reflect the uncertainty concerning the initial value of the NAIRU. Some assumptions must also be made about the relative variances of the error terms in the model. The variance of the error term in the transition equation for the NAIRU relative to the Phillips curve (the signal-to-noise ratio) determines the smoothness of the NAIRU with a smaller signal-to-noise ratio translating into less volatile NAIRU estimates. Similarly, the smaller the relative variance of the error term in the transition equation for the unemployment gap, the more volatile is the estimate of the NAIRU.

While the Kalman filter procedure offers the possibility of estimating the variances of the error term jointly with the other model parameters, this often leads to disappointing results (see, e.g., Richardson et al., 2000). Therefore, as in various other empirical applications, the variances are fixed (see, e.g., Laubach, 2001, Llaudes, 2005, or Guichard & Rusticelli, 2011).

4 Estimation results

We present our estimates of NAIRU using the Iterative Phillips curve method, henceforth referred to as IPC, and the Kalman filter, along with the measured unemployment rate

in Figure 2.⁶ Shaded areas represent business cycle downturns as identified in Einarsson et al. (2013), extended to 2012Q4.

In broad terms, the two estimation methods give results that show similar evolution of the NAIRU. However, we prefer the estimates based on the Kalman filter to those from the IPC method. There are two main reasons for this. First, the Kalman filter method uses a state-space representation of the theoretical model presented in Section 2. Although both are based on estimating the Phillips curve, the Kalman filter method entails a more structural approach to identifying the NAIRU. Second, the IPC method in Ball (2009) explicitly assumes some degree of smoothness of the NAIRU by using the Hodrick-Prescott filter, which will affect the NAIRU estimates in comparison to the Kalman filter estimates. This is clearly visible in Figure 2, where in the period 2004 to 2006 the Kalman filter finds a decrease in the NAIRU that is of high enough frequency that it is passed through the Hodrick-Prescott filter employed in the IPC method. As the Figure also shows, the estimated NAIRU follows measured unemployment fairly closely with the Kalman filter estimates and somewhat closer than the NAIRU estimated with the IPC procedure. For these reasons, we base our analysis on NAIRU estimated with the Kalman filter.

Several characteristics of the estimated NAIRU should be noted. The first is that the NAIRU – the equilibrium unemployment rate – is far from being constant over the estimation period. A second feature is that, although the unemployment rate reaches levels as low as in the beginning of the sample period twice over the period, the NAIRU is significantly higher. The third and most interesting property is that the NAIRU is highly countercyclical, following the evolution in the unemployment rate. As a fourth characteristic, the correlation between the NAIRU and the unemployment rate peaks at 0.87 at the lag of one quarter.

There have been some structural changes that may explain the time variation of the NAIRU, at least to some extent.⁷ Alongside financial market deregulation in the late 1980s, which led to a significant increase in real interest rates, macroeconomic policy underwent a shift of focus, with increased importance placed on price stability at the cost of full employment. Also, the Icelandic labor unions reformulated their bargaining strategy in the beginning of the 1990s by shifting the focus from nominal wage increases to securing purchasing power. These structural changes, along with other negative shocks that decreased labor demand, help explain the increase in the NAIRU from 1990 to 1995. The following years were characterised by increased macroeconomic stability, with low inflation and shrinking unemployment and NAIRU.

In early 2001, the Central Bank of Iceland adopted an inflation target and the króna was floated. After an initial spike in inflation, a period of disinflation followed from 2002 until 2004. The years that followed, leading up to the recession that began in 2007Q4-2008Q1, were characterized by increased demand pressures with subsequent rising inflation

⁶To prevent possible end-point problems with using the Kalman and Hodrick-Prescott filters, the Central Bank of Iceland's forecast, presented in *Monetary Bulletin* 2012/4, is added to the end of the sample. The forecast horizon is 2013Q1 to 2015Q4.

⁷Section 5 is devoted to exploring various plausible explanations for changes in the NAIRU.

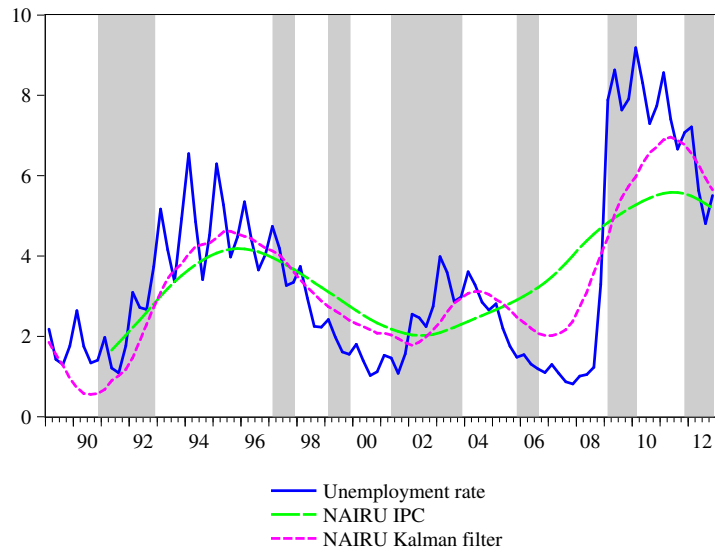


Figure 2: Estimates of time-varying NAIRU and measured unemployment rate. Source: Statistics Iceland, Einarsson et al. (2013), authors' calculations.

and decreasing unemployment, coinciding with a decrease in the NAIRU. The NAIRU then rose rapidly, peaking at 5.6-7.0% in 2011. Since then, the NAIRU has fallen once more and is estimated at 5.2-5.6% at the end of 2012.

With the exception of the OECD, which has recently begun to include Iceland in its estimates of member country NAIRUs (see Guichard & Rusticelli, 2011), there are, to the authors' knowledge, no recent studies focusing on developments in the NAIRU in Iceland. There are a few from the turn of the century, however. Gudmundsson & Zoega (1997) estimate the NAIRU for the period 1960-1995. They find that the NAIRU was about 4% in 1995, consistent with the estimates presented in this paper for that period. Pétursson (2002) estimates a model of wage- and price formation for the period 1973-1999, which, while not explicitly estimating a NAIRU, allows for the calculation of one. As in Gudmundsson & Zoega (1997), Pétursson finds that, around 1993, the NAIRU increases to 2-3.5%, again consistent with the estimates presented in this paper. Zoega (2002) updates Gudmundsson & Zoega (1997) to include the years 1995-1998 and finds that the NAIRU peaks at 5% in 1995, which is in line with the estimates presented here. The OECD estimate spans the period from 1990Q1 to 2011Q1. The OECD's results are very close to the estimates presented in this paper, both in regard to developments over time and in the level of the NAIRU. The estimated NAIRU presented in this paper is thus consistent with previous estimates present in the literature for overlapping periods.

Table 1: Forecast of unemployment and the NAIRU

	Unemployment rate	IPC-NAIRU	Kalman filter NAIRU
2013	5.0	5.4	5.1
2014	4.1	4.9	4.5
2015	3.7	4.3	4.2

Notes: Forecast conditional on the Central Bank of Iceland macroeconomic forecast published in *Monetary Bulletin* 2012:4.

Source: Central Bank of Iceland, authors' calculations.

4.1 Forecast

From a policy perspective, it is important not only to know the current value of the NAIRU but also to have an idea about its future developments. The unemployment gap can be an important policy guide as a measure of the state of the labor market with regard to wage pressures and thus possible inflationary pressures. An accurate forecast of a time-varying NAIRU and thus a forecast of the unemployment gap is therefore a useful additional guide for monetary policy.

To that end, it is possible to estimate the future path of the NAIRU, conditional on forecasts of the other variables used in both methods. Table 1 presents such an estimate, conditional on the Central Bank of Iceland macroeconomic forecast published in *Monetary Bulletin* 2012/4.⁸

According to the forecast, the measured unemployment rate and the NAIRU, as measured by both methods, continue to decline throughout the forecast horizon. However, the measured unemployment rate is forecast to decrease faster than the NAIRU and is forecast to be an average of 0.1-0.4 percentage points lower than the NAIRU in 2013, 0.4-0.8 percentage points lower in 2014, and 0.5-0.6 percentage points lower in 2015. This would imply a tighter labor market with a negative unemployment gap rather than a positive one, as is presented in the Central Bank's forecast, with the difference being largest in 2013 but shrinking over the forecast horizon. These results, with a tighter labor market implying greater wage pressures and thus greater inflationary pressures, could therefore lend support to tighter monetary policy than would the *Monetary Bulletin* forecast.

⁸Some caveats are in order. First, the NAIRU estimate used in the Central Bank's macroeconomic model, QMM, is quite different from the one estimated here, which has implications for the forecast of unemployment (for details on the QMM, see Daniélsson et al., 2009). Second, because the present paper uses unemployment as measured by the Directorate of Labour – i.e., registered unemployment – to estimate the NAIRU (to match the use of the same measure of unemployment in the Bank's QMM), the forecasted NAIRU may fail to incorporate structural changes to measured unemployment caused by deregistration of those who have exhausted their entitlement to unemployment benefits. Both of these effects could cause the NAIRU, and thus pressure from the unemployment gap, to be overestimated. Finally, as we do not use data beyond the official forecast horizon, the forecasted NAIRU may suffer from the usual end-point problems associated with the use of filtering techniques.

5 Explanations for changes in the NAIRU

Our empirical estimations show that the natural rate of unemployment is not constant, but rather that the rate varies significantly over time. These variations, or changes from one state to another, may arise due to a variety of reasons. There may be structural shocks, such as changes in the level or growth rate of technology, changes on the supply side of the economy – e.g., oil price shocks (see Bruno & Sachs (1986)) – structural imbalances in the labor market (see Layard et al. (1991)), or changes in the structure of labor market institutions such as unemployment benefits, job protection, and organization of unions (see e.g., Layard et al. (1991)).⁹ On the other hand, a strand of literature initiated by Blanchard & Summers (1986) has assigned the time-varying structure of the natural rate to changes in the unemployment rate itself, a phenomenon referred to as unemployment hysteresis. Transitory shocks, such as recessions, that lower aggregate demand and raise unemployment may have long-lasting, or even permanent, effects on unemployment through their effects on the natural rate. In what follows, we discuss the factors that may explain variations and shifts in the natural rate of unemployment in Iceland.

5.1 Unemployment insurance

Changes in the structure of unemployment insurance, either in benefits or the length of the benefit period, may lead to higher unemployment. The reason is that the incentives for active job search are reduced, which further reduces the downward pressure that unemployment puts on wages. Hence, as is demonstrated by the inclusion of z_t in equation (3), this yields a higher natural rate of unemployment.

Figure 3 plots the replacement rate, calculated as the ratio of unemployment benefits to guaranteed minimum income, and the unemployment rate. Until 1997 there was a direct link between benefits and minimum income, but since then benefits have generally not kept pace with the rise in minimum income. However, the replacement ratio does move in the same direction as unemployment.

During the last two decades, the length of the benefit period has been changed. It was reduced in 1997, from almost no time limitation to a maximum of five years, and again in 2006, to three years. As a response to rising unemployment in 2008, however, the benefit period was extended temporarily to four years. Currently, the replacement rate is high and benefit period is long in an international context (see Central Bank of Iceland (2012)). Furthermore, both the countercyclical replacement ratio and the extended benefit period may reduce the incentive to work, putting upward rather than downward pressure on the NAIRU.

⁹In a seminal paper, Calmfors & Driffill (1988) argue that there is a non-linear relationship between the coverage of union wage bargaining and the level of unemployment. In particular, there is an inverted U-shape relationship, where unemployment is low when bargaining coverage is either very low or very high.



Figure 3: Replacement rate and unemployment
Note: The replacement rate is calculated as the ratio of unemployment benefits to guaranteed minimum income.

5.2 Mismatch in the labor market

It is also interesting to examine whether, and if so, to what extent, structural imbalances can explain unemployment developments in Iceland. To do so, we follow a simple framework of how the structure of unemployment is related to its average level.¹⁰

Assuming constant returns to scale in different types of labor and a Cobb-Douglas production function, we have:

$$Y = \phi \prod_i N_i^{\alpha_i}, (\sum \alpha_i = 1) \quad (12)$$

and a nominal price level given by:

$$P = \prod_i W_i^{\alpha_i} / \kappa \phi \quad (13)$$

where κ is an index of product-market competitiveness.

Normalizing the price level at unity and taking logs gives the feasible real wage frontier:

$$A = \sum \alpha_i \log W_i \quad (14)$$

where $A = \log(\kappa \phi)$. Assuming double logarithmic wage functions of the form:

$$\log W_i = \gamma_{0i} - \gamma_i \log u_i \quad (15)$$

¹⁰See Layard et al. (1991), Chapter 6.3.

and substituting into the feasible real wage frontier gives the unemployment frontier:

$$A = \sum \alpha_i \gamma_{0i} - \gamma_i \sum \alpha_i \log u_i \quad (16)$$

which shows the locus of all combinations of sectoral unemployment rates that are consistent with the absence of inflationary pressure, given the behavior of wage setters.

To derive the expression showing how average unemployment is related to the dispersion of sectoral unemployment rates, we add $\gamma_i \log u$ to both sides and divide by γ_i , giving:

$$\log u = \text{const.} - \sum \alpha_i \log \frac{u_i}{u}. \quad (17)$$

Expanding $\log u_i/u$ around 1 gives:

$$\log u \approx \text{const.} - \sum \alpha_i \left(-\frac{1}{2} \right) \left(\frac{u_i}{u} - 1 \right)^2 \quad (18)$$

$$= \text{const.} + \frac{1}{2} \text{var} \left(\frac{u_i}{u} \right) \quad (19)$$

where the constant, $(\sum \alpha_i \gamma_{0i} - A)/\gamma_i$, gives the minimum level of log unemployment, $\log u_{min}$, and occurs when unemployment rates have been equalized across sectors. The term $\frac{1}{2} \text{var} (u_i/u)$ is therefore a measure of proportional excess unemployment over its minimum. As it is zero, if, for each sector, labor demand bears the same proportion to labor supply, “mismatch” can thus be defined as:

$$MM = \frac{1}{2} \text{var} \left(\frac{u_i}{u} \right) = \log u - \log u_{min} \quad (20)$$

Table 2 presents measures of mismatch, as calculated by equation (20), for 15 industrial sectors, nine occupations, three education levels, sex, three age groups and three locations.¹¹ The final column, “Total”, is the sum of the imbalances, assuming that they are orthogonal to each other. As the table shows, the largest mismatch in unemployment is in differences across occupation, followed by differences across education and industry at about $\frac{2}{3}$ the effect of occupational differences. This is because unemployment is higher, on average, among unskilled workers – i.e., workers who have generally only completed primary education – than among skilled workers; therefore, unemployment is higher, on average, in occupations and industries that rely more heavily on unskilled labor, which increases the measured mismatch by these categories. It is interesting to note that sex, age difference, and location have negligible effects on unemployment mismatch.

Figure 4 plots the results of table 2 for a graphic exposition of unemployment mismatch dynamics. The figure shows that unemployment mismatches due to differences in sex, age, and location have been quite stable and, if anything, decreasing. At the same time, mismatches due to differences in industry, occupation, and education have varied much

¹¹Data on unemployment by industry, occupation, education, sex, age, and location are only available for 2001 to 2011.

Table 2: Measures of mismatch by category

	Industry	Occupation	Education	Sex	Age	Location	Total
2001	0.14	0.44	0.27	0.07	0.03	0.01	0.95
2002	0.11	0.32	0.26	0.01	0.08	0.02	0.81
2003	0.12	0.23	0.28	0.00	0.08	0.02	0.74
2004	0.13	0.24	0.27	0.02	0.05	0.02	0.72
2005	0.16	0.32	0.27	0.05	0.01	0.01	0.83
2006	0.27	0.37	0.28	0.07	0.03	0.01	1.02
2007	0.50	0.36	0.26	0.06	0.04	0.05	1.26
2008	0.30	0.37	0.21	0.00	0.02	0.01	0.92
2009	0.22	0.24	0.12	0.02	0.04	0.01	0.64
2010	0.20	0.30	0.13	0.01	0.02	0.01	0.66
2011	0.17	0.38	0.12	0.00	0.01	0.01	0.69
Average	0.21	0.32	0.22	0.03	0.04	0.02	0.84

Notes: Industry covers 15 sectors. Occupation covers nine occupational classifications from managers to unskilled labor. Education is classified as primary education, vocational- or secondary education and college degree. Age is classified as 16-24, 25-54 and 55-74 years of age. Location is classified as capital, capital area and outside the capital area. The column Total sums the imbalances of each category under the assumption that they are orthogonal. Unemployment by industry and occupations is based on last employment. In calculating $var(u_i/u)$, u is the mean of the category-specific unemployment rates. Data is only available for 2001 to 2011.

Source: Directorate of Labour, Statistics Iceland.

more over time. Of these, differences in education are the least volatile, remaining at just under 0.3 until they decreased to just over 0.1 in 2009 and onwards, when unemployment of workers with vocational or secondary education and a college degree rose significantly for the first time in the sample period. Mismatch due to occupation was quite high in the beginning of the century due to relatively high unemployment among unskilled workers, but it decreased during the first years of the sample due to a general rise in unemployment across all occupations. In 2005, unemployment fell across all occupations but relatively the least among unskilled workers, increasing the measured mismatch once more. In 2009, the mismatch decreased again when unemployment rose across all occupations following the financial crisis, but it fell relatively less for unskilled workers than on average for the other categories. In 2010 and 2011 unemployment began to fall for most occupations while unemployment of unskilled and office workers continued to rise, increasing the measured mismatch.

Mismatch by industry was quite low at the beginning of the century but rose rapidly during the boom years, peaking in 2007, before decreasing again from 2008 onwards. This development is due to a general fall in unemployment across industries but a relatively greater fall in industries close to the average of unemployment across industries, such as retail and repairs, hotels and restaurants, construction, power and utilities, and general manufacturing. At the same time, unemployment in the industries with the highest unemployment, such as marine product processing and other community services, organizations

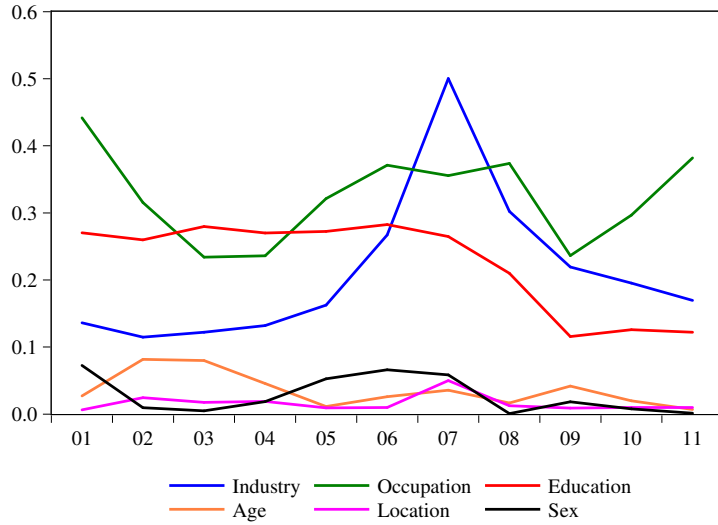


Figure 4: Labor market mismatch by category

and cultural services, fell relatively less and thus diverged more from the average across industries, increasing the measured mismatch.

Following the financial crisis, these developments reversed, as industries that had experienced a relatively greater fall in unemployment saw unemployment rise relatively more, while industries that had seen a relatively smaller decrease in unemployment saw unemployment rise relatively less than average, causing the measured mismatch to decrease. Since the onset of the recession, the unemployment mismatch has decreased by all measures, except for the mismatch due to occupation, which should, given a measured rate of unemployment, imply an increasing NAIRU.

These developments in mismatch by industry seem to bear the mark of credit cycle developments, with low interest rates and reduced credit constraints fueling increased demand for consumption and investment, and causing a shift of focus from the tradable sector to the non-tradable sector. This results in asymmetries between industries, with industries that benefitted more from the expansion of credit suffering more from the contraction (see, e.g., Aizenman et al., 2013). As is emphasised in Borio et al. (2013), for potential output, the credit cycle, through reallocation of resources between sectors of the economy, can cause output to follow an unsustainable path even though conventional measures classify them as sustainable. A similar argument may be valid with regard to the the unemployment gap. If an expansion in the credit cycle causes such an unsustainable reallocation of resources between sectors and a similar reallocation of labor, measures of the unemployment gap may be biased towards zero. This issue is not explored further in the present paper.

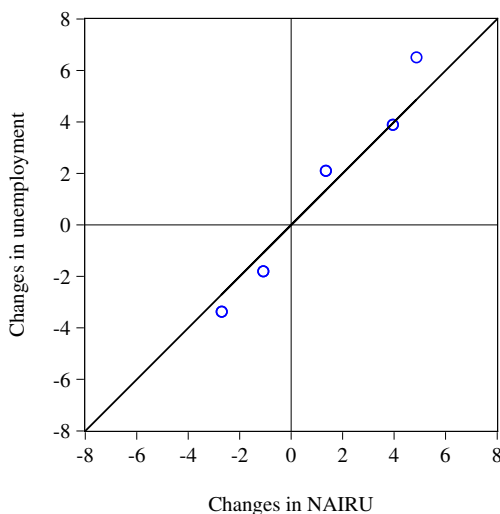


Figure 5: Changes in measured unemployment and estimated NAIRU
Notes: Changes in the unemployment rate and the NAIRU estimated with a Kalman filter are calculated between inflection points in the NAIRU. The periods are: 1991Q1-1995Q3, 1995Q4-2001Q4, 2002Q1-2004Q2, 2004Q3-2006Q4, 2007Q1-2011Q3.

5.3 Hysteresis

An extensive body of literature, gaining momentum with Blanchard & Summers (1986), has challenged the existence of a unique natural rate and has argued that the labor market exhibits unemployment hysteresis; equilibrium unemployment is not a “natural rate” determined only by supply-side factors but also depends on past unemployment.¹² According to this theory, changes in unemployment persist beyond the force initially reducing labor demand.

Within the simple framework presented in Section 2, the presence of hysteresis effects on unemployment means that wage- and price-setting behavior depends both on the level of unemployment and on changes in unemployment. Modifying the model in this respect, the Phillips curve can be written as:

$$\pi_t = \pi_t^e - \alpha(u_t - u_t^*) - \beta(u_t - u_{t-1}) \quad (21)$$

Thus, a short-run NAIRU, which lies between the last period’s unemployment and the long-term NAIRU, is given by:

¹²It should be noted that the concept of unemployment hysteresis has not been uniquely defined in labor market theory. According to Blanchard & Summers (1986), unemployment exhibits hysteresis in a presence of a unit root in a linear dynamic system. In Layard et al. (1991), on the other hand, the hysteresis effect is used as a synonym for persistence, while the authors refer to pure hysteresis as an existence of unit root in their linear model. In the current paper, we use the term generally, in accordance with the literature, to refer to any mechanism that permits transitory shocks to have persistent effects on unemployment, although not necessarily permanent effects; i.e., there is a root in the model that is very close to unity, if not quite unity.

$$u_{s,t}^* = \frac{\alpha}{\alpha + \beta} u_t^* + \frac{\beta}{\alpha + \beta} u_{t-1} \quad (22)$$

Under this modification, transitory shocks to unemployment have persistent effects on the NAIRU, where the longevity of the effects depends on the parameter values α and β .

The question remains whether unemployment in Iceland is highly persistent and, if so, whether this persistence arises from hysteresis effects. Estimating an AR(1) process for unemployment for the period 1980-2012 gives:

$$u_t = 0.984u_{t-1}, \quad R^2 = 0.83$$

(0.022)

The degree of first-order serial correlation measures very high, meaning that unemployment is highly persistent. Although this may indicate that hysteresis is at play, the idea of hysteresis as originally presented in Blanchard & Summers (1986) was that unemployment exhibits a weak tendency to return to its mean or that there is a unit root in unemployment. This is counterintuitive, as one would tend to assume the unemployment rate to be stationary because of its nature of being bounded between 0 and 1.¹³ But if changes in unemployment have very long-lasting or near permanent effects on unemployment, we may reject the hypothesis of stationarity within a finite data sample. In line with this theory, we reject the hypothesis of no unit root in unemployment at conventional significance levels using a standard augmented Dickey-Fuller test.

A simple but general approach to testing the hysteresis hypothesis, as suggested in Galí (2009), is to compare changes in the unemployment rate, u_t , to changes in the natural rate, u_t^* . According to the hysteresis hypothesis, changes in the natural rate are driven by changes in the unemployment rate itself. That is, increases (decreases) in unemployment are partially transferred into an increased (decreased) natural rate. This means that we would expect the inequality $|\Delta u| > |\Delta u^*|$ to hold. To explore this property, we calculate the changes in the estimated NAIRU between inflection points and the changes in the unemployment rate for the same periods. The results are then plotted in Figure 5. As the figure demonstrates, the inequality clearly holds, indicating hysteresis in unemployment.

The general test results presented above show highly persistent unemployment and point to hysteresis effects in unemployment. However, we have not indicated any mechanisms that may explain this phenomenon. Several theories have been proposed to explain this hysteresis effect. The main theories relate to effects from changes in physical capital, human capital, and tension between insiders and outsiders in wage bargaining. We will discuss these in turn and assess how relevant they are for explaining persistence and possible hysteresis effects in unemployment in Iceland.

¹³Because unemployment is bounded between zero and unity its variance is less than infinity.

Table 3: NAIRU and changes in capital stock

	NAIRU Kalman filter	NAIRU IPC
<i>const</i>	3.79 (0.16)	3.65 (0.13)
$\Delta_4 \ln KBUS_t$		-0.07 (0.02)
$\Delta_4 \ln KBUS_{t-3}$	-0.17 (0.03)	
R^2	0.27	0.09

Notes: Coefficient estimates in a regression of the NAIRU estimates on a constant and four quarter changes in log business sector capital stock, $KBUS_t$. Standard deviation of coefficient estimates in parenthesis.

Sources: Statistics Iceland, Central Bank of Iceland, authors' calculations.

5.3.1 Physical capital effect

Recessions and adverse shocks cause a reduction in the capital stock, as firms may be forced to close plants and scrap capital; e.g., because the cost of production increases. Low aggregate demand also causes investment to fall below the level necessary to keep up with depreciation of the capital stock. Less activity will lower labor demand. As firms will only be able to respond to increased demand with a lag, the effect on unemployment will persist beyond the length of the recession.

A simple test for the presence of such a relationship would be to regress the NAIRU on changes in the capital stock. Table 3 presents the results of regressions of both NAIRU estimates on a constant and four-quarter changes in the logarithm of business sector capital stock, $KBUS$.¹⁴ In both cases, consistent with the theory, a negative and highly significant relationship between estimates of the NAIRU and changes in the capital stock emerges. This is also demonstrated in Figure 6. The results indicate that changes in the business sector capital stock occur contemporaneously with changes in the IPC NAIRU, but they lead changes in the Kalman filter NAIRU by three quarters. These results do not necessarily qualify as proof of a causal relationship between changes in the capital stock and the NAIRU, however.

An obvious objection to a relationship that states that a reduction in physical capital has a long-lasting effect on unemployment is that it neglects the possibility of a substitution between capital and labor following a negative shock. Moreover, as is highlighted in Sigurdsson (2011), adjustment in labor input in Iceland takes place almost equally along the intensive and extensive margins, generating sufficient slack for a short-term adjustment to temporary shocks. Furthermore, such a negative shock to the stock of physical capital should have a similar effect on unemployment as a negative supply shock, which would not

¹⁴A general-to-specific specification was used, starting with contemporaneous and four lags of changes in business sector capital stock.

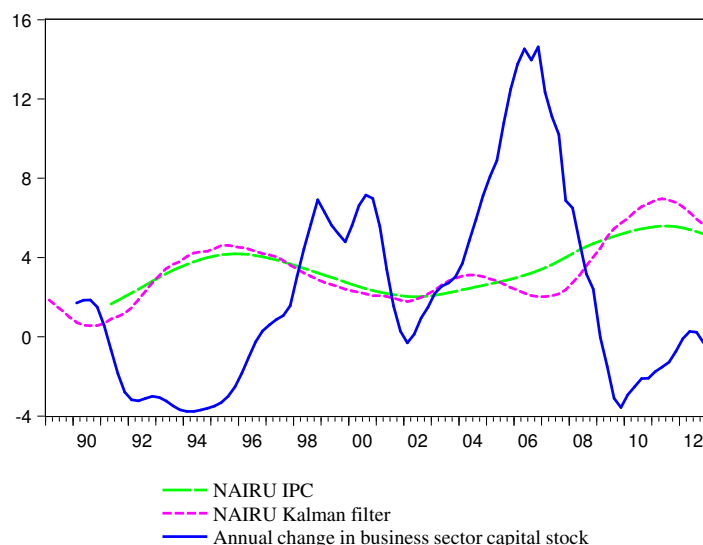


Figure 6: Estimates of the NAIRU and changes in business sector capital stock

have a long-lasting effect on unemployment unless there is long-lasting real wage rigidity.

5.3.2 Human capital effect

Unemployed workers have limited opportunities to maintain their knowledge and skills; i.e., their human capital. This deteriorating effect will be of greater significance as the duration of an unemployment spell grows longer. Therefore, long-term unemployed workers will be less attractive, as firms view them as being of lesser quality. Furthermore, firms may use unemployment as a screening device, evaluating workers on the basis of frequency and duration of unemployment spells. As a result, the long-term unemployed may become “locked” in prolonged unemployment spells. Increased unemployment and a lower job-finding rate may generate a higher natural rate of unemployment.

Another side of this effect is that workers may become more discouraged as the duration of their period of unemployment grows longer. This may cause them to reduce their search intensity and the time spent on a job search, reducing further their possibility of becoming employed. In a recent paper, Krueger & Mueller (2011) provide evidence showing that the time devoted to job search declines sharply over the unemployment spell. As a result, increased long-term unemployment will increase the friction that always exists in the matching of unemployment to vacancies.

Figure 7 shows that long-term unemployment, defined as the number of workers who have been unemployed longer than a year, began to increase substantially in Iceland from very low levels in mid-2009. Furthermore, long-term unemployment has remained relatively constant, although short-term unemployment has fallen. In order to assess how sensitive long-term unemployment is to short-term unemployment, we estimate a dynamic regression

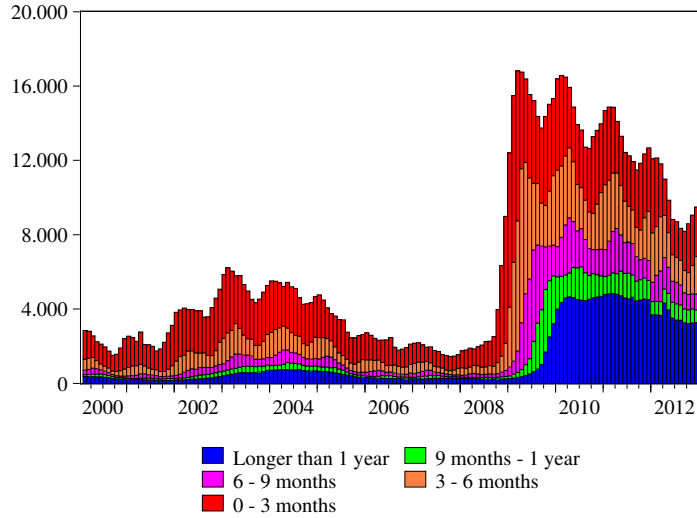


Figure 7: Unemployment by duration

of the long-term unemployment rate u_t^{LT} on a constant, lags of u_t^{LT} , and both contemporary and lagged short-term unemployment rates u_t^{ST} for the period 2000-2012:¹⁵

$$u_t^{LT} = -0.169 + 0.928u_{t-1}^{LT} - 0.371u_{t-2}^{LT} + 0.224u_{t-3}^{LT} + 0.029u_{t-1}^{ST} + 0.106u_{t-3}^{ST}, \quad \bar{R}^2 = 0.98$$

(0.04) (0.12) (0.16) (0.10) (0.01) (0.02)

According to this estimation, long-term unemployment depends positively on short-term unemployment and is highly persistent. Similar results are found for other OECD countries in Guichard & Rusticelli (2010), using aggregate unemployment rather than short-term unemployment.¹⁶ The persistence in long-term unemployment may cause an increase in structural unemployment due to the aforementioned negative human capital effects.

There may be reasons to argue that rising long-term unemployment following large macroeconomic shocks may have more permanent effects on the NAIRU. One such reason is that wage increases are often linked to seniority. Ellis & Holden (1991) argue that if wage increases due to age are greater than productivity increases, firms will have an incentive to fire workers in absence of legal contracts or possible reputation effects. However, very large shocks may lead firms to fire such senior workers, who may be unable to find a job paying their previous wage. If there exists a benefit system that ensures workers benefit entitlements closely related to their previous wage, they will have limited incentive to adjust their reservation wage. This mechanism can generate hysteresis in unemployment.

¹⁵Those variables whose coefficients are not significant at the 5% level were excluded. Standard errors are in parentheses.

¹⁶Short-term unemployment is used in the present paper to prevent possible endogeneity problems caused by using contemporaneous aggregate unemployment in the regression which includes long-term unemployment.

5.3.3 Insider effects in wage bargaining

In wage bargaining, incumbent workers, the so-called insiders, may dominate wage formation, while those who are unemployed, the outsiders, may have limited influence. Because labor turnover costs make it costly to replace insiders with outsiders, the insiders have market power. If the insiders' position is strong, their wage demands will be consistent with the current level of employment. As a result, insiders' wage pressure will prevent wages from falling enough for the outsiders to become employed. Furthermore, as is emphasized by Layard et al. (1991), changes in unemployment may have different effects on wages at different unemployment rates; increased unemployment has a smaller effect on wages when unemployment is already high than when the labor market is tight. For example, if an employer finds that the number of applicants for a job increases from 1 to 2 candidates, it is likely to lower wages more than if the number of applicants rose from 11 to 12.

Empirical research has shown that the long-term unemployed have weaker influence on wage bargaining than the short-term unemployed; see, e.g., Elmeskov & MacFarlan (1993). Hysteresis can therefore be viewed as a situation where the long-term unemployed, *ceteris paribus*, exert less downward pressure on real wages than the short-term unemployed. The reason is that the long-term unemployed become detached from the labor market, either because they reduce the effort and time spent searching for jobs or because being unemployed for a long time reduces human capital, which prompts firms to respond by being reluctant to hire those workers. Furthermore, the long-term unemployed could be considered a group of outsiders in wage bargaining. As a result, while a high level of short-term unemployment puts downward pressure on wage inflation, high long-term unemployment does not exert such negative pressure. In order to assess whether the composition of the unemployed affects wage pressure and therefore inflation, we follow Guichard & Rusticelli (2010) by looking separately at unemployment by duration; i.e., long-term vs. short-term.

Using the Kalman filter, we estimate the following Phillips curve:

$$\begin{aligned} \Delta\pi_t = & \sum_{j=1}^m \chi_j \Delta\pi_{t-j} + \beta^{ST} (u_t^{ST} - u_t^{ST*}) + \beta^{LT} (u_t^{LT} - u_t^{LT*}) + \gamma \ln(\text{prod}/\text{prodt})_t \\ & + \sum_{j=0}^n \eta_j MGS_{t-j}^{SH} (\pi_{t-j}^{MGS} - \pi_{t-j}) + \sum_{j=0}^l \kappa_j OIL_{t-j}^{SH} (\pi_{t-j}^{OIL} - \pi_{t-j}) + v_t \end{aligned} \quad (23)$$

where the superscript *ST* denotes short-term unemployment and *LT* denotes long-term unemployment. In the Phillips curve estimated, the two parameters of interest are β^{ST} and β^{LT} , representing the influence of the short-term and long-term unemployment gaps, respectively, on inflation.

Estimation results are reported in Table 4 along with the estimate of the effect of the overall unemployment gap, β in Equation (9). An increase in short-term unemployment above the estimated short-term NAIRU has a negative and significant effect on changes

Table 4: Influence of short-term vs. long-term unemployment

Unemployment gap	Short-term unemployment gap	Long-term unemployment gap
-2.578*	-1.818*	2.078*
(0.086)	(0.092)	(0.217)

Notes: Standard errors are in parenthesis. * denotes significance at the 1% level. Estimation period is 2000-2012.

in inflation. Compared to the total unemployment gap, the effect of the short-term unemployment gap is significantly less, indicating a flatter Phillips curve. The long-term unemployment gap has also a significant effect on inflation, but counterintuitively, the coefficient is positive. This would indicate that long-term unemployment not only reduces the negative wage pressure from short-term unemployment but actually increases wage pressure. While dismissing the results for the long-term unemployment gap as unreasonable, our results can still be interpreted as evidence of insider-outsider effects and hysteresis in unemployment. When the share of long-term unemployed in unemployment increases, insiders' relative bargaining power increases, which raises the bargained wage.

5.4 Institutional effects

The recent surge of workers into unemployment registers in Iceland may in itself be a source of a rise in equilibrium unemployment and therefore persistently high unemployment. The Icelandic labor market has historically been characterized by a very low and persistent rate of unemployment. The institutional structure that has been built up in recent decades has therefore been adjusted to managing an unemployment rate in the 1-3% range. When there are cyclical changes in unemployment, and especially if there is a sudden and drastic change in unemployment, labor market institutions such as employment offices and training programs do not adjust fully to account for these changes, mainly because these institutions depend on government financing, which there is generally a long process to increase, and because general frictions in hiring and firing may prevent rapid growth of such institutions.

As we have emphasized, rising long-term unemployment seems to be a channel through which the natural rate of unemployment rises. Therefore, policies aimed at preserving or enhancing human capital, reducing skill mismatches and efficiently transmitting unemployed workers into vacant jobs – active labor market policies – may help reduce long-term unemployment and therefore the natural rate. Following the rising unemployment in 2008 and 2009, participation in existing programs at the DoL increased significantly. New programs were also started, with focus placed on training programs, trial employment, and employment subsidies in the private sector. Table 5 summarizes the results of the labor market initiatives in 2010 and 2011. The initiatives can be separated into four groups: basic initiatives, education and training, employment-related initiatives, and employment

Table 5: Results of labor market initiatives

	Status after 3 months after ending of program		
	Unemployed	De-registered	De-registration rate
Basic initiatives	6.715	2.383	26%
Education and training	11.363	5.062	31%
Employment related initiatives	409	276	40%
Employment training programs	931	1.702	65%

Notes: Numbers are for the results of labor market initiatives in 2010 and 2011.

Source: Directorate of Labour.

training programs. We see that employment-related initiatives, where workers receive benefits and participate, for instance, in volunteer work or development, and, in particular, employment training programs, where workers are employed by firms that pay wages but receive subsidies equal to unemployment benefits, are effective. The de-registration rate – i.e., the rate of workers not registered as unemployed three months after the ending of the program to all participants – is 40% for the employment-related initiatives and 65% for employment training programs. This result accords with the literature examining the effectiveness of active labor market policies. Conducting a meta analysis, Card et al. (2010) find that job search assistance programs are effective, especially in the short run. However, classroom and on-the-job training programs do not have a favorable impact in the short-run but have positive effects after two years.

6 Policy implications

According to the natural rate hypothesis, shifts in demand will move unemployment away from its natural rate, but in the long-run unemployment will always return to its equilibrium level. This means that monetary policy cannot cause long-run changes in unemployment. In the presence of hysteresis in unemployment, however, there are mechanisms that influence the natural rate through the impact of aggregate demand on unemployment, and the former does not hold true. If inflation begins to rise – e.g., because of wage increases – and the central bank responds by tightening monetary policy, the result may not be a cost in the form of a short-term increase in unemployment, but rather a persistent and even long-run increase in unemployment. Furthermore, the unemployment rate consistent with the inflation target will be higher than before.

The presence of unemployment hysteresis therefore makes the conduct of monetary policy trickier than it would be otherwise. The cost of any rise in inflation, which must be counteracted by a central bank preserving price stability, will take the form of an increase in unemployment, which may be persistent due to hysteresis effects. From a policy perspective, the implications are twofold. On the one hand, central banks should focus their

policy less on inflation in the presence of hysteresis in unemployment. In particular, in periods of declining aggregate demand it is important that monetary policy be sufficiently loose. On the other hand, the hysteresis phenomenon increases the importance of government, labor union, and corporate decision-making. It is therefore even more important that the government be prudent in conducting its fiscal policy, and it is important that unions and their negotiators be prudent in wage bargaining. Keeping inflation low will be more important for the real economy in the presence of hysteresis effects than it would be otherwise.¹⁷

Our finding of the mechanisms behind the hysteresis in unemployment in Iceland also puts the importance of efficient labor market institutions at the forefront of important policy measures in responding to increases in unemployment. Employment agencies, employment training programs and employment subsidies can help with the transmission of unemployed workers into vacant jobs and help reduce skill mismatches. These institutions are particularly important in reducing long-term unemployment, which is found to increase the natural rate of unemployment. Looking ahead, how effectively unemployed workers are placed in available jobs will affect the evolution of the natural rate of unemployment and the necessary response by the Central Bank to rises in inflation.

7 Conclusions

This paper presents new estimates of the NAIRU for the Icelandic economy using two different methods: an iterative Phillips curve method and a Kalman filter. The estimates show that the NAIRU is far from being constant over time and is, in fact, highly countercyclical and follows the evolution of the actual unemployment rate, with the correlation between the two peaking when the NAIRU is lagged by one quarter. According to our estimates, the NAIRU reached a new high during the recent financial crisis, peaking in 2011. From then on, the NAIRU has decreased and is forecast to stabilize at just above 4% by 2015, according to the Kalman filter estimates.

The results on the drivers of the NAIRU give limited weight to changes in structural factors. While unemployment insurance has been slightly countercyclical, labor unions and the labor market institutional framework have remained mostly unchanged. Substantial build-up of mismatches in the labor market occurred during the pre-crisis expansionary period, implying a decreasing NAIRU for a given rate of unemployment, which largely reversed in the recession.

The results indicate that the main source of changes in the NAIRU is hysteresis. First, as stated above, the NAIRU is countercyclical and changes in the unemployment rate are partially transferred into the NAIRU with a lag. Second, a prominent theory explaining

¹⁷The relative flexibility of the Icelandic labor market should be highlighted in this context. The results of Central Bank of Iceland (2012) are that the labor market is indeed very flexible, particularly with regard to real wages, working hours, and labor supply. Furthermore, Sigurdsson (2011) finds that the intensive margin is as important as the extensive margin in adjustment of labor input, suggesting that the rise in unemployment responding to decreased aggregate demand would be less than it would be otherwise.

hysteresis states that workers who are unemployed for an extended period of time become detached from the labor market, either due to reduced search intensity or due to firms interpreting long-term unemployment as a signal of reduced human capital and thus being less willing to hire such individuals. The long-term unemployed will thus put less downward pressure on wages than the short-term unemployed. Furthermore a prolonged recession, where an initial rise in short-term unemployment leads to a build up of long-term unemployment, can cause a rise in the NAIRU. We assess this hypothesis empirically and find strong support in the data.

This finding underscores the importance of having efficient labor market institutions to help prevent short-term unemployment from becoming long-term unemployment. By easing the transmission of unemployed workers to vacant jobs, institutions that reduce long-term unemployment – such as employment agencies, employment training programs and employment subsidies – become very important in the presence of hysteresis, as they help prevent an increase in the NAIRU.

The presence of hysteresis also has important implications for macroeconomic policy. From a monetary policy perspective, a monetary policy response to an increase in inflation aimed at reducing aggregate demand may entail not only a temporary rise in unemployment but rather a persistent and even long-run increase in unemployment. In addition, the unemployment rate consistent with an inflation target would rise accordingly. Consequently, there may be reason for the central bank to be less aggressive in its conduct of monetary policy. At the same time, the presence of hysteresis places greater responsibility on the government and labor unions to follow prudent policies, the government in its conduct of fiscal policy, and labor unions and firms in their wage bargaining. Maintaining low inflation becomes much more important for the real economy in the presence of hysteresis.

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