# Inflation dynamics in the post-crisis period: Korea's experience

Min Chang,[1] Changho Choi[2] and Keunhyeong Park[3]

## Abstract

This note presents preliminary evidence of recent structural changes to inflation dynamics in Korea, and sets out some possible causes and policy implications. First, the estimated Phillips curve changed significantly during 2011–12, which helps to better explain the prolonged low inflation in the post-2012 period. Second, various measures of trend inflation are estimated to have fallen to about 2% in the post-2012 period from about 3% before 2011, which provides further evidence of changes in the inflation process during the recent past. Third, we focus on the role of changes in economic structures following the global financial crisis in driving changes in the inflation dynamics in the post-2012 period, and discuss some implications for monetary policy.

Keywords: Inflation dynamics, Phillips curve, trend inflation, changes in economic structures, monetary policy

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[1] Director General, Research Department, the Bank of Korea.

[2] Senior Economist, Research Department, the Bank of Korea.

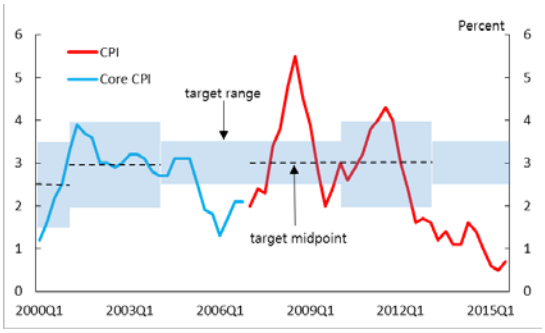
[3] Junior Economist, Payment and Settlement Systems Department, the Bank of Korea.

# 1. Motivation

Inflation dynamics in Korea appear to have undergone substantial changes during the recent past. While inflation rates fluctuated during and immediately after the global financial crisis, as one would expect, their subsequent post-crisis evolution is much less compatible with standard models of the inflation process. In fact, inflation rates in Korea have weakened more rapidly and persistently since 2012 than can be explained by variations in economic slack and other inflation determinants.

The low inflation that has emerged from 2012 onward is unprecedented in terms of its duration and severity: inflation has been running below the target range or the tolerance interval for 37 consecutive months from, November 2012 to November 2015, with the average deviation amounting to –1.4 percentage point.[4] This marks the longest period over which inflation has remained below target since the adoption of inflation targeting in 1998.[5] Indeed, the recent decline in Korea's inflation is twice the OECD average. While this low inflation is in large part due to supply shocks, especially from the second half of 2014, its timing and severity raise the question of whether structural changes may have influenced the inflation process in Korea in the post-crisis period.

Inflation rates[1] in Korea — Graph 1




Notes

[1] Year-on-year. [2] The shaded blue area represents either the target range or the tolerance interval.

Recent changes in inflation[1] — Table 1

| | 2001–07 (A) | 2012–14 (B) | B–A |
|---|---|---|---|
| Korea | 3.1 | 1.6 | –1.5 |
| OECD average | 2.7 | 1.9 | –0.8 |

Note

[1] Average CPI inflation rates over the specified period.

Our purpose in this note is to provide a preliminary assessment of potential changes in inflation dynamics during the recent past in order to better understand the prolonged low inflation since 2012, and to present some possible causes and policy implications of these changes. To this end, Section 2 sets up the analysis of whether inflation dynamics have changed during the recent past using Phillips curves. Section 3 presents three measures of trend inflation, and tests for structural breaks in their level. Section 4 discusses possible causes of recent changes in inflation

[4] The inflation target was the 3% midpoint of the tolerance interval of 2–4% during 2010–12, while the target range was 2.5–3.5% during 2013–15.

[5] The second longest period of the deviation below the target range or the interval is 27 months, from July 2005 to September 2007, with the average deviation being only –0.5 percentage point.

dynamics. Finally, Section 5 summarises the main findings, and considers potential policy challenges.

## 2. Analysis of changes in inflation dynamics using Phillips curves

This section examines potential changes in the Phillips curve relationship so as to better understand the prolonged low inflation from 2012 onward. The first subsection estimates a standard Phillips curve to document how the model fares with actual inflation rates. The second subsection then estimates an augmented Phillips curve allowing for parameter change, to analyse the curve's ability to improve the empirical fit of the model, particularly during the recent past.

### 2.1. Standard Phillips curve

Following the specifications in Friedrich (2014), we estimate a standard Phillips curve for the headline inflation rates:

$$\pi_t = \alpha + \beta\pi_t^e + \gamma y_t + \delta imp_t + \varepsilon_t,$$

$\pi$: CPI inflation, $\pi^e$: Household inflation expectations (one year)

$y$: GDP gap, imp: Import price inflation (in KRW)

where current inflation is explained by inflation expectations, the GDP gap, import price inflation, and other residual factors. The use of household inflation expectations is in line with Coibion and Gorodnichenko (2015), who find that household inflation expectations help to explain missing disinflation in the United States during the Great Recession. Due to the availability of data, the sample used for the estimation is in quarterly frequency, and spans the period from Q1 2003 to Q4 2014.

Table 2 shows the estimated coefficients of the standard specification, and Graph 2 illustrates the resulting in-sample fit. As shown in Table 2, the coefficients of inflation expectations, the GDP gap, and import price inflation are statistically significant, and their signs are consistent with economic theory. However, as depicted in Graph 2, while the standard Phillips curve relationship generally does a good job in predicting inflation rates in the period before 2011, it does not do well in predicting inflation rates from 2012 onward. A closer examination reveals that the in-sample prediction is consistently higher than actual outturns in the post-2012 period, suggesting that some aspects of inflation dynamics are likely to have changed around the period 2011–12.

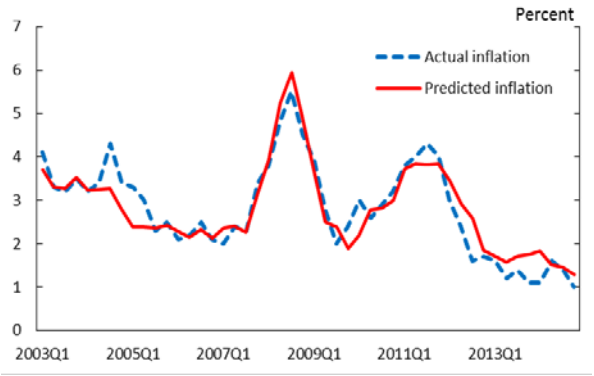
Estimated coefficients using the standard Phillips curve — Table 2

| Variable | Coefficient |
|---|---|
| Constant ( $\alpha$ ) | –0.39 |
| Inflation expectations ( $\beta$ ) | 0.87*** |
| GDP gap ( $\gamma$ ) | 0.13** |
| Import price inflation ( $\delta$ ) | 0.05*** |

Note

[1] *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

In-sample fit[1] using the standard Phillips curve — Graph 2




Note

[1] Year-on-year.

## 2.2. Augmented Phillips curve

In order to account for potential changes in inflation dynamics parsimoniously, we estimate an augmented Phillips curve which adds a post-2012 dummy and interacts it with the other explanatory variables:

$$\pi_t = \alpha_1 + \beta_1 \pi_t^e + \gamma_1 y_t + \delta_1 imp_t + \alpha_2 D_t + \beta_2 \pi_t^e D_t + \gamma_2 y_t D_t + \delta_2 imp_t D_t + \varepsilon_t,$$

$\pi$ : CPI inflation, $\pi^e$ : Household inflation expectations (one year), $y$ : GDP gap,

imp: Import price inflation (in KRW), $D$ : Post-2012 dummy variable (1 from Q1 2012 onward)

where the dummy takes on the value of 1 from Q1 2012 onward, and 0 otherwise. Interacting the post-crisis dummy with other explanatory variables in the equation allows the effects of the constant term, inflation expectations, the GDP gap and import price inflation to differ between the pre-2011 and post-2012 periods. The definition of the remaining variables and the sample period are the same as those with the standard Phillips curve.

Table 3 indicates that inflation is more sensitive to inflation expectations but less sensitive to import price inflation during the post-2012 period. Further, the constant term in the inflation process is much smaller, implying that the Phillips curve may have shifted downward in the post-2012 period. However, unlike the coefficients of the other variables, there is no significant change in the sensitivity to the output gap during the post-2012 period.

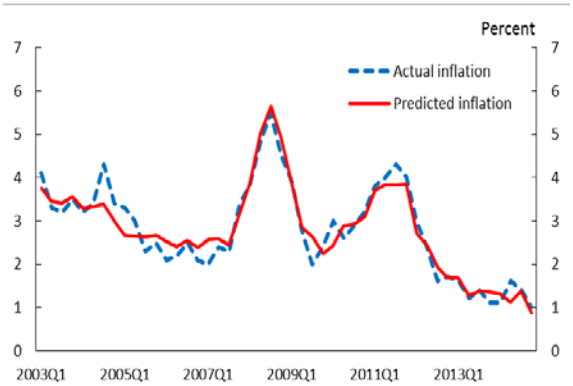
Estimated coefficients using the augmented Phillips curve — Table 3

| Variables | | Coefficient |
|---|---|---|
| Constant ($\alpha_1$) | | 0.19 |
| Inflation expectations ($\beta_1$) | | 0.76*** |
| GDP gap ($\gamma_1$) | | 0.06 |
| Import price inflation ($\delta_1$) | | 0.05*** |
| Dummy variable | ($\alpha_2$) | –2.25** |
| | ($\beta_2$) | 0.53* |
| | ($\gamma_2$) | 0.68 |
| | ($\delta_2$) | –0.11** |

Note

[1] *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

In-sample fit[1] using the augmented Phillips curve — Graph 3




Note

[1] Year-on-year.

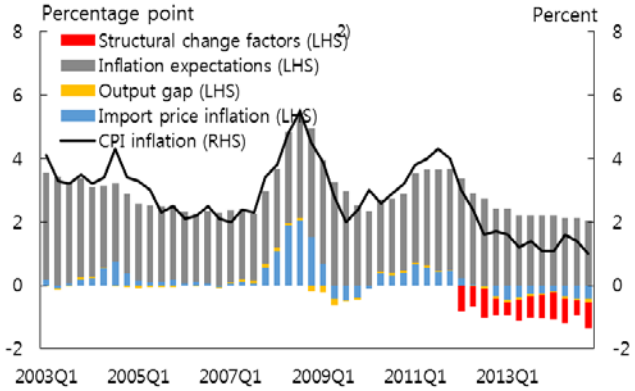
Graph 3 depicts the resulting in-sample fit based on the augmented Phillips curve specification. It shows that adding the post-2012 dummy and interacting it with standard determinants substantially improves the explanatory power of the model, especially during the recent past.

Viewed as a whole, the estimation results suggest that inflation dynamics in Korea are likely to have undergone substantial changes around the period 2011–12, and accounting for this change helps to better explain the prolonged low inflation during the post-2012 period. Further, the downward shift in the Phillips curve may have played a prominent role in driving changes in the inflation process.

Before scrutinizing the lower-frequency inflation process further, it is helpful to quantify the contribution of structural change factors in explaining the inflation fluctuations during the post-2012 period. To this end, we conduct a historical decomposition of the determinants contained in the augmented Phillips curve, and define structural change factors as the sum of the terms associated with the post-2012 dummy interacted with a constant term and other explanatory variables.

Graph 4 shows that inflation expectations explain a large part of the inflation process over the entire period, which is similar to Friedrich (2014). Meanwhile, the GDP gap and import price inflation generally played a role in boosting inflation rates in the pre-2011 period, whereas they have played a role in reducing inflation rates since 2012, albeit by a smaller magnitude relative to inflation expectations. Further, since 2012, structural change factors have played a role in lowering inflation rates by 0.4–0.9 percentage point, a magnitude that is greater than those of the GDP gap and import price inflation calculated based on the pre-2011 coefficients.

Contributions of individual inflation determinants[1] Graph 4




Notes

[1] Results are based on the augmented Phillips curve. [2] Structural change factors consist of the post-2012 dummy interacted with a constant term and other explanatory variables.

## 3. Analysis of changes in inflation dynamics using trend inflation

This section investigates potential changes in the evolution of trend inflation in order to further our understanding of the protracted low inflation during the post-2012 period. Trend inflation measures the underlying trend in inflation after removing transitory price movements due to short-run disturbances. Thus, it is reasonable to attribute its persistent shift to structural changes in the inflation process.

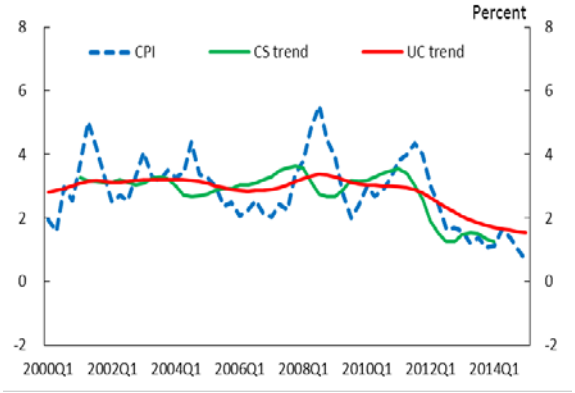
We start by estimating trend inflation using three econometric methods: vector autoregressions by Cogley and Sbordone (2008) (henceforth CS), an unobserved component model by Harvey and Koopman (2009) (henceforth UC), and a dynamic factor model by Giannone and Matheson (2006) (henceforth DFM). The use of multiple methods is to check for the robustness of our results to alternative methods for estimating trend inflation.

Specifically, the CS model constructs four-variable vector autoregressions consisting of inflation, the GDP gap, the short-term interest rate and unit labour costs, and then defines trend inflation as the level to which inflation is expected to settle after short-run fluctuations die out. Next, the UC model decomposes inflation into trend and cyclical components using a state-space model, and then takes the trend component as trend inflation. Finally, the DFM model extracts common factors from various disaggregated price inflation rates, and derives trend inflation by removing any short-term fluctuations from common factors. Meanwhile, in line with the availability of data, the sample used for the estimation is at a quarterly frequency from Q1 2000 to Q1 2015 for the CS and UC models, and is at a monthly frequency from January 2000 to March 2015 for the DFM model.

Graph 5 shows the evolution of trend inflation since 2000 estimated using the CS and UC models, while Graph 6 shows the evolution of trend inflation estimated using the DFM model. In the period before 2011, the three measures of trend inflation are estimated to have been hovering around 3%, which is the midpoint of the inflation

target over this period. However, they are estimated to have undergone persistent decline over the years 2011–12, descending to about the 2% level on average during the recent past. This evidence echoes the finding in the Phillips curve analysis that structural changes in the inflation process seem to have occurred around the period 2011–12. Compared across different estimation methods, trend inflation estimated using the DFM model shows a relatively smaller decline recently, while showing more fluctuations in the pre-2011 period.

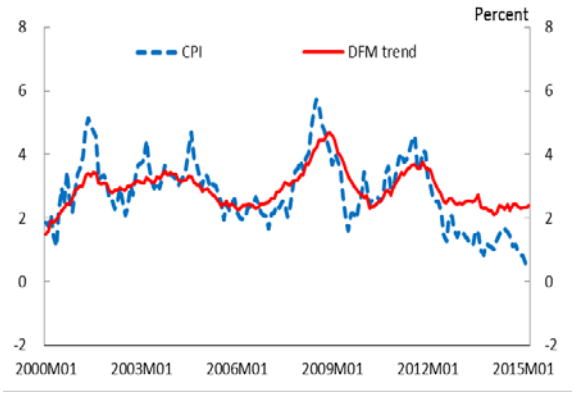
Trend inflation from CS and UC models[1, 2] Graph 5




Notes

[1] CS indicates a model by Cogley and Sbordone (2008), while UC indicates an unobserved component model by Harvey and Koopman (2009). [2] The CS and UC trend inflations are estimated using quarterly data for the period from Q1 2000 to Q1 2015.

Trend inflation from DFM Model[1, 2] Graph 6




Notes

[1] DFM indicates a dynamic factor model by Giannone and Matheson (2006). [2] The DFM trend inflation is estimated using monthly data for the period from January 2000 to March 2015.

As the next step, we test for structural breaks in the level of trend inflation as developed in Bai and Perron (2003) to investigate whether the trend inflation process underwent structural changes since 2000. Table 4 shows the resulting timing of significant structural breaks occurring for each measure of trend inflation. The estimation results show that the three measures of trend inflation experienced structural breaks during the period 2011–12. Specifically, the CS and UC trend inflation show structural breaks in Q3 2011 and Q3 2012, respectively, while the DFM trend inflation shows structural changes in June 2012 as well as in April 2005, July 2007 and October 2009.

Test for structural breaks in trend inflation Table 4

| | Timing of structural changes[1] |
|---|---|
| CS trend inflation | Q3 2011 |
| UC trend inflation | Q3 2012 |
| DFM trend inflation | April 2005, July 2007, October 2009, June 2012 |

Note

[1] The timing of structural breaks is determined based upon values minimising the Schwarz test statistic modified by Liu, Wu and Zidek (1997).

## 4. Possible causes of changes in inflation dynamics

In the light of our findings that the inflation process may have changed during the recent past, this section considers possible causes of the decline in trend inflation, and discusses some policy implications.

A traditional macroeconomic view states that long-run inflation is fundamentally a monetary phenomenon, and is determined by monetary policy and its effects on long-term inflation expectations.[6] However, given that economic stagnation has persisted despite exceptional monetary policy stimulus following the financial crisis, an alternative view has gained traction, namely that economic structures other than monetary factors may influence inflation over a longer period of time.

For example, BIS (2015) decomposes inflation drivers into short-run, cyclical, and secular factors, and shows that secular drivers, such as globalisation, wage structure, and technology, have significant impacts on the low-frequency component of inflation. Faust and Leeper (2015) argue that most of the unusual inflation dynamics, known as disparate confounding dynamics, could be explained by taking proper account of structural economic factors, such as debt structure, demographics, etc. Our main focus in this section is the role of economic structures in explaining long-run inflation in Korea.

One fundamental background fact is that the Korean economy has been in the course of gradual transition from a fast- to a slow-growth model starting since the mid-2000s, a transition that accelerated in the aftermath of the global financial crisis. In terms of growth accounting, the increase in the labour force is constrained by rapid population ageing, and capital accumulation has slowed due to weak domestic investment opportunities. A slowdown in productivity growth further reinforces the deceleration in growth potential.

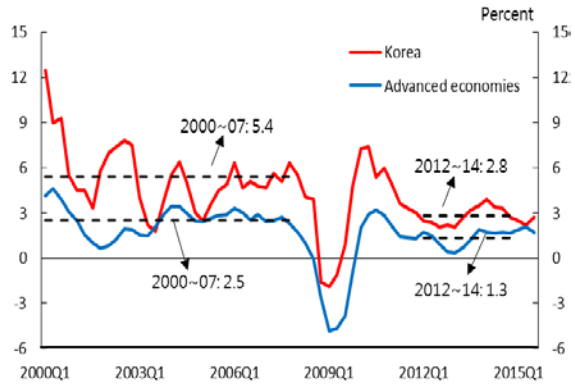
In principle, these factors could have both inflationary and disinflationary consequences: they reduce underlying inflation by weakening domestic demand, but they also tend to increase inflation by limiting production capacity. However, the overall impact seems to be disinflationary, especially because the growth deceleration interacts with other structural vulnerabilities, such as the labour market duality and the inadequacy of the social insurance system.

The other important factor is the rapid increase in economic integration following the global financial crisis. Increased economic integration could put downward pressure on aggregate inflation by intensifying competition between domestic and foreign markets (see Rogoff (2003), and Guerrieri et al (2010) for more detail). Further, higher trade openness is likely to magnify and prolong the transmission of external shocks into domestic inflation.[7] Thus, small open economies such as Korea's are more likely to experience prolonged low inflation in times of lacklustre global growth in the wake of the financial crisis.

[6] See Friedman (1963) among others.

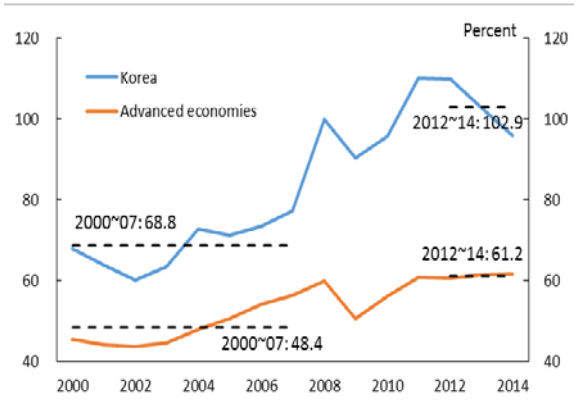
[7] See Milani and Park (2014) for more detail.

Output growth rates Graph 7




Sources: Bank of Korea, IMF.

Trade openness[1] Graph 8




Note

[1] Trade openness is measured as the ratio of the sum of exports and imports over GDP multiplied by 100.

Source: IMF.

Despite our focus on economic structures, monetary policy may have played a part in prolonging low inflation during the recent past. For example, monetary authorities in small open economies may find it desirable not to respond to persistently negative inflation shocks from abroad as aggressively as they have to other types of shock.[8] Obviously, further study is necessary so as to better understand the precise role of monetary policy in explaining low inflation.

## 5. Summary and policy challenges

This note makes a preliminary assessment of recent changes in inflation dynamics in order to better understand the prolonged low inflation from 2012 onwards, and to set out its possible causes. The analysis yields three main findings. First, the Phillips curve is estimated to have changed significantly during the period 2011–12, and taking into account this change better explains the low inflation in the post-2012 period. Second, various measures of trend inflation are estimated to have fallen to about 2% in the post-2012 period from about 3% before 2011, which provides further evidence of recent changes in the inflation process. Third, we focus on the role of changes in economic structures in driving changes in the inflation dynamics in the post-2012 period, highlighting that both structural transition and high economic integration may act as persistent disinflationary forces, particularly in times of lacklustre global growth in the aftermath of the global financial crisis.

Given that trend inflation appears persistently lower, two further issues arise with regard to the conduct of monetary policy. One issue is the need to provide better measures of potential output and underlying inflation in real time. The other issue is to analyse how the decline in trend inflation affects the relationship between real activity and inflation, namely the slope of Phillips curve. Clarification of these issues

[8] See Kim et al (2015) for more detail.

would seem to be important for the better calibration of monetary policy in an environment of changing trend inflation.

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