THE NEW KEYNESIAN PHILLIPS CURVE: 

A META-ANALYSIS

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Abstract. The purely forward-looking New Keynesian Phillips Curve (NKPC) is presented as the new consensus on inflation theory. Yet this canonical NKPC is now challenged by a hybrid NKPC (HNKPC) that incorporates a backward-looking component. Standard empirical estimations remain inconclusive on this controversy, with conflicting results that favour either the NKPC, or the HNKPC, depending on the econometric approach.

This article explores the debate about the empirical estimation of the HNKPC by using a different method: a meta-analysis technique. I collect 891 estimations, which come from 79 papers. I find a significant backward-looking component in the HNKPC (about one third), although the forward-looking share is significantly dominant (about two thirds). This macroeconomic result is also seen at the microeconomic level, in which firms’ surveys indicate about one third of prices are formed on a backward-looking basis. The implications of this result for the conduct of the inflation targeting regime are examined.

Keywords. New Keynesian Phillips Curve; Meta-analysis; Inflation persistence; Inflation targeting

JEL Classification: C42; C82 ; E31; E32 ; E52
1. Introduction

The New Keynesian Phillips Curve (NKPC) originated in the New Keynesian theory of price stickiness *cum* rational expectations hypothesis (Calvo, 1983). This results in a purely forward-looking formula as the baseline or ‘canonical’ NKPC. These New Keynesian rigidity hypotheses are supposed to constitute robust theoretical microfoundations and lead the NKPC to surpass the old Phillips curve or its expectations augmented or accelerationist versions that had the disadvantage of emerging from empirical results. It is generally considered that the analysis of the NKPC began with Roberts (1995). Nowadays some academics suggest that the NKPC has become ‘the closest thing there is to a standard specification’ (McCallum, 1997, p.357). Indeed, the NKPC is the core inflation equation of the simple New Keynesian model of the inflation targeting regime, and this New Keynesian ‘science’ of optimal monetary policy pretend to lead the academic field: ‘Deviate from this, and you are not a member of the In Crowd’ (Goodhart, 2006, p.1). The NKPC shows so clearly that it is the short term inflation equation of both New Keynesian and New Classical, forming one of the main pillars of the NNS (New Neo-classical Synthesis)¹ that nowadays is the standard underlying structural model of the inflation targeting regime.

Nevertheless, beyond the veil of polite academic consensus, the NKPC has been undermined by a series of lasting and intractable controversies in both theory and practice. It has led McCallum (2007, p.1) to change his mind about the Calvo-NKPC: ‘There are reasons, however, to be somewhat dissatisfied with this state of affairs’. The Calvo price equation is a ‘heroic’ hypothesis, with a highly unrealistic time-dependent lottery as theory of firms’ pricing rule, with a fix probability to change price at each period. The Calvo pricing is nowadays controversial, and competes with state-dependent price theory, or sticky information theory of price rigidity. Moreover the Dynamic Stochastic General Equilibrium² models (DSGE) using the Calvo pricing equation struggles to match stylised facts, and
generally add a non realistic degree of price duration to reproduce the reality. Hence, microfoundations are not necessary based on empirical grounds.

Therefore, the purely forward-looking NKPC seems unable to reproduce the inflation dynamics observed in data: the hump-shaped response of inflation to a shock, with a gradual and delayed response to the shock. Contrary to its initial ambitions, the NKPC does not seem, in the empirical point of view, a better option than the old models of the Phillips Curve. In the New Keynesian perspective, this empirical failure is a severe drawback, as realism is a key foundation of this school. In particular, inflation persistence is regarded by New Keynesians as a basic stylised fact that the model should be able to reproduce (Taylor, 1999). These theoretical and empirical limits to the NKPC mean that it cannot be used in practice as a robust theory of inflation by central bankers under an inflation targeting regime.

Due to these limits, the purely forward-looking NKPC is increasingly challenged by a hybrid NKPC (HNKPC). This includes a backward-looking component to deal with the empirical question of inflation persistence, and more generally intends to reconcile the theory of inflation with empirical inflation dynamics. This inclusion of lagged inflation tends to suggest, however, that there are reasons to doubt the rational expectations hypothesis for modelling inflation. One thus returns, to a certain extent, to the previous accelerationist Phillips Curve which relied on adaptive expectations.

Since the beginning with Irving Fisher and next with Phillips in 1958, the Phillips’ type equation has been an empirical issue. It is for this reason that this paper focuses on the empirical aspect of the NKPC. The analysis aims to investigate the empirical degree of forward-lookingness of the NKPC, in order to provide evidence as to the validity of the canonical purely forward-looking NKPC.

Yet, there is a controversy about the optimal econometric methodology used to measure the respective forward-looking and backward-looking components of the NKPC. Indeed,
different econometric methods of estimation give conflicting results: the NKPC could be empirically either mainly forward or backward-looking. In the face of this intractable controversy on the empirical form of the NKPC, a meta-analysis is employed to reduce the methodological dilemma. This method is intensively used in medical and social science, and recently became common in economics, both among academics and central banks (Card and Krueger, 1995; Knell and Stix, 2003; Nijkamp and Poot, 2004; De Grauwe and Costa Sorti, 2004; Rose and Stanley, 2005). This technique is applied to a sample of 891 empirical estimations of the HNKPC, sourced from 79 articles.

The first section analyses the prospects for the NKPC, and next the different problems. The second section is dedicated to the empirical analysis, using a meta-analysis method, of the degree of forward/backward lookingness of the HNKPC. Finally, section three draws the implications of the results for the conduct of monetary policy, and more generally for the conduct of the inflation targeting regime.

2. The NKPC: claims and criticisms

2.1 The alleged superiority of the NKPC

2.1.1 Microfoundations and rational expectations: a robust structural equation

Traditional Phillips curves were empirical. Even the Phelps (1967) or Friedman (1968) expectations augmented Phillips curves were used as empirical equations, calibrated to match the data. Expectations were mainly adaptive: a backward looking autoregressive process. The lack of solid microfoundations was a non-issue because reproducing facts was the Keynesian macroeconometric priority. This accelerationist Phillips curve respected the natural rate hypothesis defended by New Classicals.
Due to the rational expectations revolution, microfoundations have become the core requirement of the macroeconomics agenda. New Keynesians claim to satisfy this standard by integrating their price rigidity hypothesis into the rational expectations scheme via, for example, the Calvo (1983) pricing equation. With this pricing equation, New Keynesians pretend to offer solid microfoundations for the Phillips Curve. This means that the NKPC is different in the sense that it possesses rational expectations hypothesis microfoundations: it is a theoretical curve, instead of the old empirical Phillips curves. Thus, in contrast to the empirical Phillips curve, the NKPC is supposed to respect the natural rate hypothesis, and, being a structural equation, to be immune to the Lucas critique (1976). As emphasised by Gagnon and Khan (2001, p.1), ‘The main advantage of the NKPC over the traditional Phillips curve is that the former has theoretical foundation and, therefore, a clear structural interpretation, whereas the latter is a reduced-form relationship\(^3\). In light of the new macroeconometric standards, this enables New Keynesian to claim that the NKPC is superior to previous curves.

The NKPC is the core supply equation of the three equations New Keynesian model (NKPC, IS, Taylor rule), which is now textbook optimal monetary policy analysis\(^4\). It is also the basic firms’ price theory and supply theory of larger mainstream models: the DSGE models. Moreover, because it is embedded in the rational expectations and microfoundations paradigm, the NKPC is also accepted by New Classicals. This explains why the NKPC is one of the core equations of the new consensus in macroeconomics, the NNS.

2.1.2 The importance of forward-looking expectations

The NKPC that derives from the Calvo pricing is purely forward-looking, in contrast with the old Phillips curve equations that were based on lagged values: ‘Another important way that the new Phillips curve differs from the old is that it is fully forward-looking’ (Gali and Gertler, 2007, p.33); it is of the form:
\[ \pi_t = \beta E_t \pi_{t+1} + \alpha x_t \tag{1} \]

\(\pi\): inflation ; \(x\): output gap ; \(E\): expectation operator.

The inflation expectations formation process \(E_t \pi_{t+1}\) consists in future expectations at \(t+1\) formed in the current period \(t\). It is in contrast with the Lucas supply curve where inflation expectations for the present period were formed at the previous period \(t-1\) (\(E_{t-1} \pi_t\)). This difference is crucial because it means that current value of inflation depends on the future expected value of inflation. As a consequence, if agents’ future inflation expectations are controlled, current inflation is also controlled. It opens the door to the ‘expectations management’ that consists, for the central bank, of the intention to turn agents’ expectations into a forward-looking phenomenon that conforms to the theory of expectations presented in the NKPC (Woodford, 2003).

2.1.3 A reasonable empirical fit

The NKPC is the short to medium term inflation theory of the inflation targeting regime. New Keynesians claim that the baseline Calvo-NKPC has demonstrated strong empirical performances in reproducing the inflation data, and provides ‘a reasonably good description of inflation dynamics’ (Gali and Gertler, 1999, p.219). Thus the NKPC should be employed by central banks in their large scale models to produce inflation forecasts and so be at the centre of the decision-making process of the inflation targeting regime.

2.2 Some limits to the NKPC

The baseline NKPC suffers from both theoretical and empirical limitations, and has now become controversial. The literature sheds light on the surprising theoretical fragility of the
Calvo scheme: a time-dependent pricing equation in which firms change their price according to a Poisson Process. This is an *ad hoc* process, and a ‘lottery’ that does not satisfy New Keynesians themselves – although analytically convenient, it is a poor theory of price change.

Microfoundations can turn to be *ad hoc* when not realistic. That is why some New Keynesians propose a sticky information Phillips curve as an alternative to the NKPC (Mankiw and Reis, 2002). Even some New Classicals prefer state-dependent pricing equations (Dostey and King, 2005). On top of that, some New Classicals affirm that the NKPC does not respect the natural rate hypothesis\(^7\).

### 2.2.1 The empirical failure of the NKPC in matching inflation persistence

The Calvo pricing is mainly scrutinised on the empirical field. Indeed, the NKPC is unable to reproduce the empirical inflation dynamics\(^8\): ‘we argue in this paper that various recent macroeconomic models based on sound microeconomic foundations fare poorly when confronted to the data’ (Estrella and Fuhrer, 2002, p.1026). In particular, the NKPC does not have the ability to reproduce inflation persistence: the hump shaped response of inflation to shocks, that is to say a gradual and delayed response\(^9\). This is a basic stylized fact of New Keynesian economics\(^10\), and, from the beginning, has been a constant problem for the NKPC\(^11\): ‘prevailing specifications fail to match the facts of actual macroeconomic experience - in particular, the fact that both nominal and real variables respond sluggishly but substantially to monetary shocks’ (McCallum, 1998, p.357). This problem of lack of inflation persistence of the NKPC continues during its development, and is now commonplace in literature: ‘the pure NKPC lacks sufficient inertia to adequately explain the path of actual inflation’ (Barkbu *et al.*, 2005, p.4). Very recently, this was acknowledged by the authors of the NKPC themselves: ‘The macroeconomic variables within the baseline model appear to display greater persistence in practice than the basic framework can capture’ (Gali and Gertler, 2007, p.42).
The purely forward-looking NKPC describes inflation as a ‘jump’ variable, and not a persistent variable. In order to reproduce inflation persistence, DSGE models incorporate large price durations that are at odds with empirical surveys.

2.2.2 Towards a hybrid NKPC (HNKPC)

This statement of a NKPC ‘flying in the face of facts’ has raised the necessity to restore a backward-looking mechanism in the NKPC to improve its empirical fit, and in particular its ability to properly reproduce inflation persistence. This was achieved by introducing a source of ‘intrinsic persistence’ with lagged inflation as an additional explanatory variable. The canonical NKPC became a ‘hybrid’ NKPC (HNKPC) that includes both a forward-looking share ($\beta_f$) and a backward-looking share ($\beta_b$), forming the equation (2):

$$\pi_t = \beta_f E_t \pi_{t+1} + \beta_b \pi_{t-1} + \alpha_t$$

(2)

The HNKPC is a compromise between robust microfoundations and empirical fit — an ambition to reconcile the ‘science’ and ‘art’ of the inflation dynamics. The condition $\beta_f + \beta_b = 1$ is often imposed on the NKPC to satisfy the natural rate hypothesis and to respond to critiques of the NKPC formulated by Sims and McCallum. Generally, in the literature, this type of HNKPC is modelled by a difference, that is $\beta$, (1 - $\beta$), adopting the formulation:

$$\pi_t = \beta E_t \pi_{t+1} + (1 - \beta) \pi_{t-1} + \alpha_t$$

(3)

Backward-lookingness is introduced via indexation of firms’ prices on past inflation. This backward indexation seems to be confirmed by microeconomic surveys of firms, which
demonstrate that about 30% or one third of firms’ prices are indexed on past inflation, a result in favour of the HNKPC\textsuperscript{16}.

The rise of the HNKPC is a critique of the scheme NKPC \textit{cum} rational expectations hypothesis since lagged inflation can be seen as a departure from full rationality\textsuperscript{17}.

Despite these theoretical and empirical weaknesses, the controversy NKPC \textit{versus} HNKPC is still alive. This is because New Keynesian theoreticians continue to claim that the purely forward-looking NKPC is a robust and realistic theory of inflation dynamics. In order to contribute to this debate, a meta-analysis of the empirical estimates of the HNKPC is undertaken below.


To my knowledge the meta-analysis has not yet been applied to the NKPC, although it seems an appropriate technique to alleviate the controversy over its empirical estimate. This meta-analysis aims to evaluate the NKPC \textit{versus} the HNKPC by testing the empirical validity of the NKPC: does $\beta_b = 0$ ?

Nevertheless, the meta-analysis should be applied with care. Firstly, it is necessary to determine if the empirical estimates of the HNKPC is a topic suitable for the application of the meta-analysis method. Secondly, one must construct a robust database, based on rigorous criteria. In the following paragraphs we explain the criteria of exclusion and inclusion of estimates in the database.

3.1 Why a meta-analysis?

The meta-analysis is ‘a body of statistical methods that have been found useful in reviewing and evaluating empirical research results’ (Stanley, 2001, p.131). This definition of meta-analysis\textsuperscript{18} indicates that this method is appropriate for the study because empirical estimations of the HNKPC are collected and because the degree of backward-lookingness ($\beta_b$) in the
HNKPC is an empirical question. From the beginning the form of the Phillips curve has been an empirical matter.

The main reason for this methodological choice is that there is an intractable controversy on the robust econometric method to test the HNKPC. The traditional method to estimate the HNKPC is the generalised method of moment (GMM), used in the pioneer articles of Gali and Gertler (1999), and of Gali et al. (2001). This method, in particular, has been criticised for its bias (overestimating $\beta_b$), and its weak identification problem. This is why some authors – such as Fuhrer (1997) or Lindé (2005) - prefer a full information maximum likelihood method (FIML). More recently, DSGE models employ Bayesian estimation. Accordingly, there is an intractable controversy on the econometric technique to evaluate empirically the HNKPC: ‘the debate on the appropriate technique to use when estimating Phillips curve remains open’ (Barkbu et al., 2005, p.6). These three methods lead to conflicting estimations: the NKPC could be empirically either mainly forward or backward-looking. There are three competing views regarding the empirical form of the NKPC, or three conflicting results:

a) $\beta_f = 1, \beta_b = 0$. According to the mainstream, the NKPC should be purely forward-looking, that is $\beta_f = 1$ and $\beta_b = 0$. Effectively, they claim that the backward-looking share is different from 0, but is small enough to be neglected: ‘the structural estimates suggest that this fraction, while statistically significant, is not quantitatively important’ (Gali and Gertler, 1999, p.219).

On the contrary, the HNKPC’s view considers that $\beta_b > 0$. Among these advocates of the hybrid view, there are two main schools:

b) $\beta_f > \beta_b$. One school is a simple watering down of the mainstream view by adding an inflation persistence component to the canonical NKPC, but the HNKPC remains mainly forward-looking, so they claim that $\beta_f > \beta_b.$
c) \( \beta_t < \beta_b \). The other school considers that the HNKPC is predominantly backward-looking\(^{23}\).

This view is relatively similar to the traditional accelerationist Phillips curve. Hence, depending on the method, the value of \( \beta_b \) can vary considerably: ‘Empirical estimates of the hybrid model have yielded conflicting results and interpretations’ (Jondeau and Le Bihan, 2005, p.522). The meta-analysis is a useful technique to analyse this sort of problem: ‘meta-analysis has become the accepted practice for evaluating the current flood of conflicting evidence’ (Stanley, 2001, p.132).

The meta-analysis consists in combining a set of different techniques for evaluating empirical results of several studies. Consequently, this aggregation of estimates from different econometric methods (GMM, FIML) is not a weakness, but a condition of valid meta-analysis.

Moreover, given the discussion on the robust method to test the NKPC, the meta-analysis offers less controversial results than a single article or estimation technique considered in isolation. This is an advantage in an intractable controversy, such as the empirical estimation of the HNKPC.

Furthermore, the meta-analysis permits the combination, integration and comparison of disparate estimates coming from various techniques, thus allowing for a global comparative assessment of estimates, facilitating a comprehensive survey of the literature.

Finally, the meta-analysis seems appropriate due to the growing volume of literature on the empirical NKPC. Due to the large number of studies on this issue, a narrative survey of this research would have produced a very long article, and synthesis would only have been manageable with difficulty. The meta-analysis seems the appropriate technique to review the wealth of literature, as it is a quantitative survey, which preserves a synthetic view of the current state of the literature.
3.2 The meta-analysis technique

The meta-analysis rests upon rigorous criteria for selecting the relevant estimates to be included, and are presented below.

3.2.1 Data and selection procedures

Only estimations for the HNKPC, and not for the NKPC, are selected. Because the NKPC does not allow for backward-looking elements, the purpose of investigating the basic hypothesis of the canonical NKPC cannot be fulfilled: \( \beta_f = 1 \) and \( \beta_b = 0 \).

The selection of estimations available in the literature has been made according to the two criterions of coverage and precision\(^{24}\).

In terms of coverage, the papers chosen cover the period from 1995 and 2007, as the literature on the NKPC began with Roberts in 1995.

As to precision - that is to say if estimations are representative of the literature – articles on EconLit are consulted, as is usual in meta-analysis\(^{25}\). Journal articles as well as working papers at Repec-Ideas and central banks’ web sites are used. Journal articles cannot be judged a complete enough resource, as the NKPC is a recent literature, meaning that many working papers on the subject are still unpublished due to the normal publication delays. Journal articles would have limit the number of available estimations. Moreover, it is generally considered in the meta-analysis literature that unpublished papers should be incorporated because the number of estimations is a way to avoid the possible bias in a particular methodology\(^{26}\). The biases are present in the estimation of the NKPC, implying that the inclusion of working papers to enlarge the number of estimates is essential. The idea of the meta-analysis is to collect as many estimates as possible\(^{27}\). Furthermore, the criterion of ‘precision’ also consists of retaining only closed-economy estimations of the NKPC, and excluding estimates of the NKPC with money as an explanatory variable. Statistically non
significant estimates are also included. All these estimates are combinable because they test
the same equation: the HNKPC.

The issue of ‘publication bias’ is a constant preoccupation in the construction of meta-
analysis databases (Stanley, 2008). Three standard solutions, proposed in the literature, are
employed to tackle this problem. The first is the inclusion of a significant number of working
papers, and not only published articles (Stanley, 2005, p.310). The second is to incorporate
non significant results. The third is to consider a large sample because this can be expected to
reduce the bias (Stanley, 2005, p.321). To judge the importance of the sample, the sample
sizes of various articles in economics using meta-analysis are shown in table 1 (see appendix).

Having considered these factors, the meta-analysis collects 891 comparable estimates of the
NKPC from 79 papers. The same weight is put on each of these estimates.

As it is suggested in the literature the NKPC is the inflation theory of the inflation
targeting regime, the focus is on countries that have adopted this regime – such as Australia,
Canada, New-Zealand, Sweden and the United-Kingdom. The estimations collected from
these five countries for the two coefficients $\beta_f$ and $\beta_b$, of the HNKPC (equation 2), respectively
the forward and backward-looking components.

Due to the debate regarding the necessity for the HNKPC to respect the natural rate
hypothesis, an initial robustness check is undertaken by only selecting the estimations that
fulfil the condition $\beta_f + \beta_b = 1$. Then a second robustness check of the results of inflation
targeting countries is conducted by collecting estimations of the USA and the Euro Zone as
examples of non inflation targeting countries. Finally a meta-analysis for all the countries -
targeters and non targeters – is done.

### 3.3 Results and descriptive statistics

This study is interested in the debate NKPC versus HNKPC: that is to say the validity of the
views a), b) and c) presented above. The results of the meta-analysis are reported in the scatter
graphs (figures 1 to 14). Each scatter plot in lozenge form represents a collected estimation. The x axis shows the forward-looking share of the HNKPC ($\beta_f$), while the y axis indicates the backward-looking share ($\beta_b$). The scatter plot in pink (square form) is the mean of the estimates, while that in yellow (triangular form) is the median.

Figures 1 to 8 relates to inflation targeting countries. Figures 1 to 5 are case studies of the five countries (cited above) under inflation targeting regimes. Figure 6 is the aggregation of all the estimations of these inflation targeting countries. Figure 7 represents the same estimation as Figure 6 but has a selection of estimations that satisfy the natural rate hypothesis, and thus are compatible with equation (3). This choice has been made in response to the criticisms of the NKPC by Sims and McCallum, on the basis that it does not fulfil the natural rate hypothesis.

For this reason, only the estimations that satisfied the restriction $\beta_f + \beta_b = 1$ are retained. This explains why the estimation points are on the same line. Finally, in figure 8, only the post 1990 estimations - i.e. not just after the birth of the inflation targeting regime - are retained. Figure 8 also deals with the question of estimations that do not correspond to the inflation targeting time period.

The visual impression of the graphs for inflation targeting countries is one where the backward-looking component does not appear to be zero. Similarly, inflation targeters seem to differ substantially regarding the ratio forward:backward-looking components of the HNKPC, and so struggle to lead exactly the same type of inflation targeting, because they are not confronted with identical inflation dynamics. Additionally, Figure 8 indicates that the adoption of inflation targeting does not eliminate the backward-looking fraction of the HNKPC. Nevertheless, given the low number of observations, this should be received with caution.
Figure 1: Australia
N = 9 observations

Figure 2: Canada
N = 51 estimations

Figure 3: New-Zealand
N = 9 estimations

Figure 4: Sweden
N = 12 estimations

Figure 5: United-Kingdom
N = 41 estimations

Figure 6: All inflation targeting countries
N = 122 estimations

Source: author
Figures 9 to 14 investigate the robustness of previous results. Figures 9 to 12 compare them with the results of two non inflation targeting countries: USA and the Euro Zone; while Figures 13 and 14 realise the aggregation of estimations of targeting and non targeting countries. Some estimations points for the US are at odds with the baseline NKPC, as they lack a forward-looking component or present a negative coefficient. Visually, these robustness checks tend to confirm that the coefficient on the backward-looking share is different from zero. They also confirm, especially with US and, to a lesser degree, with the Euro Zone, that the domination of the forward-looking component over the backward-looking is not as obvious as view a) claims. In summary, *prima facie*, the view b) seems the most likely candidate for representing the empirical HNKPC.

*Source:* author
Figures 11 to 23 present statistics in the form of histograms and box plots. Tables 2 to 5 are descriptive statistics. These figures and tables show that the bias in the distribution goes both forward and backward, so that there is apparently no systematic bias. Estimations are generally not symmetrically distributed: the mean differs from the median. Nevertheless, a simple t-test indicates that for $\beta_f$ and $\beta_b$, the mean and the median are not significantly different.

**Figure 15: All inflation targeting countries**

**Figure 16: Box plot**

**Table 2**

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Mean</th>
<th>Variance</th>
<th>Standard deviation</th>
<th>Skewness (Pearson)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.00</td>
<td>1.45</td>
<td>0.68</td>
<td>0.64</td>
<td>0.07</td>
<td>0.27</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Source: author
In Table 6, a t-test\textsuperscript{31} is undertaken to see if on average $\beta_f = 1$, as suggested by advocates of the baseline NKPC (view a). This hypothesis is not valid, with the exception of Sweden. However because of the limited number of estimations for this country, the t-test result, in line with standard theory should be viewed with caution. In order to investigate the doctrine of the baseline NKPC (view a), a further t-test is carried out to see if on average $\beta_b = 0$. The results are not significant, except, once again, for Sweden, where the same reservations as previously prevail. A further t-test is used to examine if, as defended by view b), the mean of the forward-looking fraction is more important than the mean backward-looking share. This hypothesis is valid, with the exception of New-Zealand. This result – like that for Sweden – is problematic, due to the limited number of estimations.

\textit{Source:} author
Table 6. Results of the meta-analysis.

<table>
<thead>
<tr>
<th></th>
<th>Forward share ((\beta_f))</th>
<th>Backward share ((\beta_b))</th>
<th>Mean (\beta_f = 1) (t-test)</th>
<th>Mean (\beta_b = 0) (t-test)</th>
<th>Mean (\beta_f &gt; \beta_b) (t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Mean</td>
<td>Median</td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>0.55</td>
<td>0.52</td>
<td>0.44</td>
<td>0.47</td>
<td>-8.36</td>
</tr>
<tr>
<td>Canada</td>
<td>0.58</td>
<td>0.65</td>
<td>0.29</td>
<td>0.29</td>
<td>-11.88</td>
</tr>
<tr>
<td>New-Zealand</td>
<td>0.57</td>
<td>0.56</td>
<td>0.43</td>
<td>0.44</td>
<td>-5.80</td>
</tr>
<tr>
<td>Sweden</td>
<td>1.02</td>
<td>0.99</td>
<td>-0.02</td>
<td>0.002</td>
<td>0.27***</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.57</td>
<td>0.60</td>
<td>0.43</td>
<td>0.39</td>
<td>-10.3</td>
</tr>
<tr>
<td>All inflation targeting countries</td>
<td>0.64</td>
<td>0.68</td>
<td>0.27</td>
<td>0.28</td>
<td>-14.57</td>
</tr>
<tr>
<td>All inflation targeting countries ; natural rate hypothesis</td>
<td>0.69</td>
<td>0.69</td>
<td>0.29</td>
<td>0.29</td>
<td>-12.34</td>
</tr>
<tr>
<td>All inflation targeting countries, estimations post 1990</td>
<td>0.57</td>
<td>0.54</td>
<td>0.44</td>
<td>0.46</td>
<td>-11.01</td>
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<tr>
<td>USA</td>
<td>0.54</td>
<td>0.59</td>
<td>0.44</td>
<td>0.40</td>
<td>-54.46</td>
</tr>
<tr>
<td>USA ; natural rate hypothesis</td>
<td>0.54</td>
<td>0.58</td>
<td>0.46</td>
<td>0.40</td>
<td>-56.17</td>
</tr>
<tr>
<td>Euro area</td>
<td>0.64</td>
<td>0.67</td>
<td>0.33</td>
<td>0.32</td>
<td>-22.14</td>
</tr>
<tr>
<td>Euro area ; natural rate hypothesis</td>
<td>0.65</td>
<td>0.67</td>
<td>0.34</td>
<td>0.32</td>
<td>-26.05</td>
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<tr>
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<td>0.60</td>
<td>0.41</td>
<td>0.38</td>
<td>-57.53</td>
</tr>
<tr>
<td>All countries; natural rate hypothesis</td>
<td>0.57</td>
<td>0.60</td>
<td>0.43</td>
<td>0.39</td>
<td>-58.13</td>
</tr>
</tbody>
</table>

*, ** and *** indicate the level of signification respectively at 10%, 5% and 1%.

The meta-analysis indicates a large variation of the mean of \(\beta_f\) and \(\beta_b\) between countries (columns 2 and 4). At one extreme, Sweden presents similar results to the mainstream view a) of a purely forward-looking NKPC. At the other extreme, the US seems to indicate that the NKPC is fifty-fifty, so nearly a perfect HNKPC.

The conclusion of the meta-analysis is that view b) seems to be dominant: the NKPC is hybrid, but mainly forward-looking. We see that for all inflation targeting and all countries, the mean is respectively \(\beta_b = 0.27\) and \(\beta_b = 0.41\); so the repartition of \(\beta_f\) and \(\beta_b\) is approximately two-third:one third.

This agrees with microeconomic surveys of firms in which the proportion of firms’ prices based on backward-looking inflation is also about one third. This appears to be a macro-level confirmation of micro-level results. The meta-analysis shows weak evidence for the mainstream view a) of a purely forward-looking NKPC.

Although indicative, these results must be received with caution, and cannot claim to provide a definitive answer to the question of the form of the HNKPC. Their lack of conformity with the mainstream view of the NKPC necessitate, to ensure good practice, an examination of potential implications for the conduct of inflation targeting strategy.
4. Implications for the conduct of monetary policy and the inflation targeting regime

4.1 The role of expectations: limits to expectations management

According to the baseline NKPC, inflation is mainly an expectations phenomenon: if the central bank controls future inflation expectations, it controls the present value of inflation. This explains why the expectations channel of transmission is central to monetary policy: ‘markets do the job’ instead of the central bank. It is also why the ‘expectations management’ is so crucial in the modern view of optimal monetary policy under the inflation targeting regime: the expectations management is the root of monetary policy efficiency. According to the ‘Divine Coincidence’ (Blanchard and Gali, 2007), the stabilisation of inflation coincide with the stabilisation of the output gap. This implies that the expectations management consists in anchoring inflation expectations to the medium term inflation target. Once anchored to the future, agents do not react to past or present values of inflation, and therefore do not react to the current shock. The expectations management is the New Keynesian version of the old ‘credibility bonus’ of the credibility literature of the 1980s. Nevertheless, this expectation management strategy is less efficient if the inflation process follows a HNKPC, as agents continue to take into account past values of inflation. Inflation is no longer a purely forward-looking phenomenon. It implies that the central bank cannot fully rely on agents to do the job: it has to act, and not only to talk. With a HNKPC, communication is not enough, and action has to be taken.

4.2 NKPC, inflation targeting and the reaction to shocks

For the standard NKPC, inflation is the jump variable, and there is no inflation persistence. This means that next to an inflationary shock there is an immediate response of inflation to
the new information. This shock is temporary, and only exists in the short-term. Disinflation
is quick, so that the inflation-output trade-off is weak, or inexistent: the fully credible
disinflation can be a ‘free lunch’\(^\text{33}\). \textit{A maxima}, the NKPC suggests a disinflationary boom
(Ball, 1994) that does not seem realistic. \textit{A minima}, the disinflation is quick and the sacrifice
ratio weak. The result is that the trade-off and the shock are very likely to disappear in the
medium term: that is to say the time horizon of the inflation target. Inflation targeters can
focus only on inflation. Above all, the canonical NKPC implies that the central bank can
practice a benign neglect regarding the first round effect of the shock because it is very
unlikely to face a second round. The shock does not affect inflation expectations, and thus
offers protection from a prices-wages spiral. As a consequence, the first round effect of the
shock can be accommodated, leading to a more flexible type of inflation targeting.

On the contrary, the HNKPC suggests that the shock is more permanent: the short term effect
can also exist in the longer term. The disinflation occurs over a longer period, and the trade-
off is less favourable. The lower rate of disinflation suggests that the second round effect of
the shock is more likely to lead the central bank to be more aggressive and to act sooner
against the shock\(^\text{34}\). The central bank has to be aggressive soon after the shock because the
HNKPC suggests that it would be a costly and slow process to bring inflation back to the
target after a shock: inflation is no longer a ‘jump’ variable, but, in part, a sluggish variable.

\textbf{4.3 The form of the NKPC and central bank credibility.}

If the central bank under inflation targeting is to be fully credible, inflation expectations
should be anchored to the medium term inflation target: inflation expectations should be
purely forward-looking. Agents should not be concerned about the present inflation shock, but
focus on the future inflation forecasts if, in the medium term, inflation is on target. In the
HNKPC this would be \(\beta_f = 1\).
The meta-analysis analysis is thus a rough indicator of the degree of central bank credibility. Since $\beta_b > 0$ in the meta-analysis, there is a rough indication that credibility is imperfect. If credibility is imperfect, it implies that the central bank does not fully benefit from the credibility bonus that emerges from the absence of immediate reactions of agents to the inflation shock. Therefore the central bank does not benefit from a time lag to offset the shock, because agents do not totally look beyond the shock. Once more, this lack of credibility implies that the central bank has to act sooner and more aggressively to avoid the risk of a second round effect.

4.4 An evolution towards a stricter type of inflation targeting?

The two previous points were oriented towards a more aggressive inflation targeting strategy in short term response to the shock. They indicate a shorter optimal horizon for monetary policy, so that more weight should be put on inflation in the central bank loss function, corresponding to a more conservative Rogoff’s central banker. Does it mean that a HNKPC calls for the end of a flexible and the return to a more ‘strict’ type of inflation targeting?

The answer could be negative for two reasons. The first is that a baseline NKPC calls for the central bank to accommodate the first round of the inflation shock, and to induce a deflation if a second round happens. In contrast, with a HNKPC, it seems more appropriate to respond sooner and more gradually to the first round effect: it does not necessarily mean being more aggressive. It simply indicates that the central bank leads a more gradual pre-emptive action in order to avoid possible large future contraction in output.

A second factor that casts doubts on an evolution towards a stricter version of inflation targeting is that the trade-off is less favourable with a HNKPC. If the inflation target should be respected at a shorter horizon, it could indicate that the sole final objective of price stability is too much of a straight jacket. The HNKPC actually indicates that the short-run trade-off between inflation and output can last a long time, so that that these two final
objectives do not necessarily coincide, even on the medium term horizon of the inflation target. The solution to this dilemma of the HNKPC could be either a stricter version or the collapse of the inflation targeting regime. In the case of the latter, the constraint of respecting the inflation target is relaxed, and the trade-off becomes more manageable (Friedman, 2006). The experience of Brazil in 2002 is that, in practice, central bankers are pragmatic and prefer changing the target instead of increasing conservativeness. This confirms that a HNKPC can be consistent with a form of dual mandate. It suggests that Greenspan (2004) could be right when he announced that inflation targeting was evolving towards the dual mandate of the Federal Reserve. Surprisingly, Mishkin (2004) claims that the Brazilian experience, with the renunciation of the commitment to the inflation target, is the best practice for inflation targeting. But once again, if, in the face of a large trade-off, the inflation target is abandoned, it is an implicit decision that the sacrifice ratio to return to the target is considered to be too large due to inflation persistence. The output objective instead of the inflation objective is accordingly favoured, and a dual mandate declared.

**4.5 The hybrid NKPC, the Divine Coincidence and the dual mandate**

In order to propose a more formal explanation of the evolution of inflation targeting towards a dual mandate as a result of a HNKPC, the concept of ‘Divine Coincidence’ can be used. According to advocates of the canonical NKPC, there is Divine Coincidence if, in the medium term the objectives of inflation and output coincide. This means that stabilising inflation at the inflation target is automatically equivalent to stabilising the output around its potential level. It can be demonstrated by rearranging the NKPC (equation 1) to obtain:

\[ \pi_t - \beta E_t \pi_{t+1} = \alpha x_t = \alpha (y_t - y^*) \]
If the so-called ‘expectations management’ of Woodford (2003) - the basic definition of inflation targeting - works, then agents are forward-looking and form their expectations on the inflation forecasts produced by the central bank to obtain:

$$E_t \pi_{t+1} = E_t \pi_{central \text{ban \; } k}$$

Then, if there is full credibility, then agents consider that at this future horizon inflation will be equal to the inflation target, so that:

$$E_t \pi_{t+1} = E_t \pi_{central \text{ban \; } k} = \pi$$

Finally, one has approximately:

$$\pi_t - \pi = (y_t - y^\ast)$$

This last relation describes the Divine Coincidence permitted by the purely forward-looking NKPC. Yet, if instead the NKPC is hybrid (2), the Divine Coincidence does not work. For convenience, it is recalled that the HNKPC (equation 2) is:

$$\pi_t = \pi_{central \text{ban \; } k} + (1 - \beta) \pi_{t-1} + \alpha x_t \quad \text{so that,} \quad \pi_t - \beta E_t \pi_{t+1} = (1 - \beta) \pi_{t-1} + \alpha x_t \cdot$$

If the NKPC is hybrid, since the Divine Coincidence does not hold, the central bank can hardly focus only on the sole objective of price stability ($\pi_t - \pi = 0$), as it is not enough. As a consequence, due to the persistence of inflation, the central bank should adopt a more flexible type of inflation targeting. In practice this consists of choosing a longer time horizon to return to the inflation target, in order to change the inflation target, to activate the escape clause, or to evolve to a dual mandate. Indeed, all these modifications are equivalent to an increase in the weight on output in central bank loss function. If this rise is large, it is possible that the weight of output becomes larger than the weight of inflation, thus constituting a dual mandate.

## 5. Conclusion

According to common wisdom, the purely forward looking NKPC is robustly based on microfoundations, and is capable of reproducing the empirical dynamics of inflation. A meta-
analysis tends to indicate that this perceived wisdom has to be taken carefully. It suggests that the NKPC is empirically more hybrid than pure, as it contains a backward looking fraction, of about one third. This result is roughly in agreement with microeconomic surveys of firms which indicate that about 30% of firms form their prices based on past inflation.

Even if the results of the meta-analysis should be received with caution, they propose a substantial modification of the optimal monetary policy derived from the purely forward looking NKPC. In particular the Divine Coincidence - the cornerstone of the inflation targeting regime – is not supported by a hybrid NKPC. This rejection casts doubts on the conduct, and eventually on the sustainability of a strict inflation targeting regime, and favours the adoption of a more flexible type of inflation targeting.

The usual theory is that inflation targeting evolves from a strict to a flexible type as soon as credibility is earned, i.e. when inflation expectations are anchored to the inflation target. Inflation then becomes a purely expectation phenomenon, without inertia, leading to a purely forward looking NKPC. The inflation targeting regime becomes more flexible because it exploits this credibility bonus given by agents. After nearly twenty years of inflation targeting, the meta-analysis should confirm this scenario of the evolution of this regime.

Nevertheless, the meta-analysis suggests that the evolution towards a flexible inflation targeting has been accompanied by a hybrid NKPC. As a result, the meta-analysis proposes a more complete scenario of the evolution whereby credibility is imperfect, so that the inflation targeting becomes more flexible also because it is necessary in order to take inflation inertia into account. Flexible inflation targeting is also partly an obligation. In light of the experience of inflation targeting in Brazil, the hypothesis of flexibility as a necessity, in addition to a bonus, seems valid.
Appendix

Table 1. A comparison of the number of estimates collected in meta-analysis.

<table>
<thead>
<tr>
<th>References</th>
<th>Number of estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card and Krueger (1995)</td>
<td>15</td>
</tr>
<tr>
<td>Knell and Stix (2003)</td>
<td>559</td>
</tr>
<tr>
<td>Nijkamp and Poot (2003)</td>
<td>208</td>
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<tr>
<td>Nijkamp and Poot (2004)</td>
<td>123</td>
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<tr>
<td>De Grauwe and Costa Storti</td>
<td>122</td>
</tr>
<tr>
<td>Rose and Stanley (2005)</td>
<td>34</td>
</tr>
<tr>
<td>Doucouliagos and Paldam (2008)</td>
<td>543</td>
</tr>
</tbody>
</table>

Notes

5. See also Cogley and Sbordone (2005), Sbordone (2005, p.1196) or Angeloni et al. (2006, p.572).
6. Another limit to the canonical NKPC is the lack of ‘cost push’ shock arising from wages or the exchange rate. It is a serious matter for emerging markets under inflation targeting such as Brazil or South Africa. This is not analysed because it is beyond the scope of this paper dedicated to inflation persistence. There are other limits to the NKPC, such as the proxy for the real marginal cost: labour income share or output gap.
   As shown in Kurmann (2007), the coefficients $\beta_f$ and $\beta_h$ vary considerably depending on the proxy chosen.
10. See Fuhrer and Moore (1995). There is an ongoing controversy on the evidence of a significant decrease of inflation persistence in the recent period. Some authors claim that the drop is effective (Kumar and Okimoto, 2007), while authors contest this drop of persistence and consider that inflation persistence has remained fairly stable and significant (O’Reilly and Whelan, 2004; Pivetta and Reis, 2007).
14. See also Fuhrer (2006, p.52) for the distinction between ‘intrinsic’ and ‘inherited’ persistence.


17. Paloviita (2005a, p.15).

18. For a recent overview of this technique in economics, see the 2005 special issue of the Journal of Economic Surveys, volume 19, issue 3.


20. See also Kurmann (2007), or Jondeau and Le Bihan (2008).

21. See also Fuhrer and Olivei (2004, p.2).


25. See Knell and Stix (2003, p.6).


27. See Rose (2004, p.6).

28. Data available upon request.

29. As in Rose and Stanley (2005, p.5).


32. See Carré and Le Heron (2006) for a presentation of the credibility literature.


34. See Fuhrer and Olivei (2004, p.16).

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