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Why Do They 'Overreact'?

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Abstract

The purpose of the present paper is to provide a simple model which explains how households (or non-experts) form their inflation forecasts. The paper contributes to the existing literature and the understanding of how inflation expectations are formed in two ways. Firstly, we present an integrated model of how non-experts form their inflation expectations. The paper initially outlines how professionals form inflation forecast. Subsequently, the model presents the non-expert's expectations formation incorporating the dynamics of the professional's forecast. Secondly, we explain the prevalent phenomena where non-experts tend to overreact, or overshoot, initially as they revise their inflation forecast.

I: Introduction:

The purpose of the present paper is to provide a simple model which explains how non-experts - primarily households - form their inflation forecasts. The paper contributes to the existing literature and the understanding of how inflation expectations are formed in two ways. Firstly, we present an integrated model of how non-experts form their inflation expectations. The paper initially outlines how professionals form inflation forecast. Subsequently, the model presents the non-expert's expectations formation incorporating the dynamics of the professional's forecast. Secondly, we explain the prevalent phenomena where non-experts tend to overreact, or overshoot, initially as they revise their inflation forecast. The model is based on a number of crucial recent empirical findings.

There has been a heighten interests in how both professional forecasters (experts) and non-experts form their inflation forecasts. Important innovative developments in the literature focus on the inattentiveness of agents. Agents are inattentive due to informational rigidities, or frictions. Their inflation forecasts deviate from full information rational expectations due to the informational rigidities, which limit their ability to revise their forecasts.

Reis (2006a and 2006b) argue that rationally inattentive agents update their information set sporadically. Subsequently, the slow diffusion of information among the population is due to the costs of acquiring information as well as the costs of reoptimization, resulting in the 'sticky-information expectations'. Distinguishing between experts and non-experts expectations, Carroll (2003 and 2006) put forward a specific form of 'sticky information' expectations that best explains how households form their

expectations about the macroeconomy. 'Epidemiological expectations' argues that households form their expectations by observing the professionals' forecasts which are reported in the news media. Such sticky information expectations have been used to explain not only inflation dynamics (Mankiw and Reis, 2002) but also aggregate outcomes in general (Mankiw and Reis, 2007) and the implications for monetary policy (Ball et al., 2005). The second type of informational friction models (Woodford (2002) and Sims (2003)) argue that agents update their information set continuously but can never fully observe the true state due to signal extraction problem. Crucially, as pointed out by recently by Coibion and Gorodnichenko (2015), both types of models predict quantitatively similar forecast errors.

More recently the literature has also examined the nature of professional forecasters inattentiveness. An important recent contribution to this literature Coibion and Gorodnichenko (2015) introduced a novel way to assess professionals' inattentiveness by focusing on the structure of their forecast error. Inevitably, the professionals' forecast error is no longer a random error but one that is persistent.

The empirical literature indicates three key findings with regards to households forming inflation expectations. Firstly, the non-experts form their inflation forecasts 'absorbing' the professionals' forecasts. Giving credence to the non-expert's 'epidemiological expectations', while professional forecasters tend to anchor on inflation targets, especially where targets are explicit such as the European Central Bank (see Easaw et al, 2013 and Beechy et al, 2011). Secondly, non-experts also tend to account for current actual inflation rates indicating a naïve 'rule-of-thumb' forecasts formation (see Lanne et al, 2009). The third important empirical finding is there is a clear evidence that

non-experts tend to overshoot, or over-react, in the short-run when forming their inflation forecasts (see Pfarfar and Santoro (2010), Georganas et al (2014) and Easaw et al (2013)).

This paper presents a simple model explaining the dynamics of non-expert inflation forecasts. In particular, how they over-react in the short-run as they revise their forecasts. In the model, non-experts' account for both professional's inflation forecast and current inflation rates when updating their own forecasts. Non-experts' are more likely to revise their forecasts when inflation is rising rather than falling (see Akerlof, 1996 and 2000). Non-expert's, or households, initially overshoot as they revise their inflation forecasts. This is attributed directly to the professional's persistent forecast error as a result of their inattentiveness which, in turn, is caused by informational rigidities.

In Section II and Section III we proceed to outline a simple model of both professionals and non-experts' inflation forecasts dynamics respectively. Summary and conclusions are drawn in the final section.

II: Inflation Dynamics and Professionals' Forecasts:

In a recent seminal paper, Stock and Watson (2007) put forward a general unobservable components (UC) representation of actual inflation rate, where observable inflation rates are composed of two components, a stochastic trend (τ_t) and a stationary factor, or inflation gap (ξ_t)[1]:

$$\pi_t = \tau_t + \xi_t \tag{1}$$

and $$\tau_t = \tau_{t-1} + \eta_t \tag{2}$$

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[1] Recent papers have investigated the nature of this stationary component, or inflation gap (see Cogley et al (2010) and Nason and Smith (2013)).

where η_t denotes a trend innovation. The inflation gap, assumed to be persistent, is modelled for simplicity as a stationary AR(1) process:

$$\xi_t = \rho_t \xi_{t-1} + \mu_t \tag{3}$$

where μ_t denotes the inflation gap shock and , similar to η_t, is a martingale difference series. Both τ_t and ξ_t may be correlated.

We first assume that professional forecasters' have rational expectations and form their long-run inflation forecasts by estimating the stochastic trend $F_t(\tau_t)$ based on information at time *t*. It follows since τ_t is a random walk (2):

$$F_t^P(\pi_{t+h}) = F_t^P(\tau_t) + (\rho_t \rho_{t+1}....\rho_{t+h-1})\xi_t \tag{4}$$

For large *h* and ρ_t bounded away from 1 we have the approximation and limit as the time horizon *h* tends to infinity:

$$(\rho_t \rho_{t+1}....\rho_{t+h-1})\xi_t \approx 0$$
$$\lim_{h\to\infty}(\rho_t \rho_{t+1}....\rho_{t+h-1})\xi_t \approx 0$$

Hence the long-term forecast (large *h*) can be seen as capturing the "trend" element:

$$F_t^P(\pi_{t+h}) \approx F_t^P(\pi_{t+\infty}) = F_t^P(\tau_t) \tag{5}$$

Forecasters form short-horizon inflation forecasts (small *h*) according to (4) as follows:

$$F_t^P(\pi_{t+h}) = F_t(\tau_t) + \rho_t \rho_{t+1...}\rho_{t+h-1}F_t(\xi_t) \tag{5}$$

The long horizon forecasts depend solely on $F_t^P(\tau_t)$, while any short horizon forecasts will depend on the estimates of both stochastic trend and inflation gap. Therefore, the multi-period forecasts made in *t* will be entirely shaped by the estimates, or forecasts, of

the inflation gap $F_t^P(\xi_t)$. The main purpose of the multi-period forecasts is to capture the persistent nature of the stationary component of inflation (the inflation gap), or the propagation of any stationary shock. Consequently, the professional updates their short horizon forecast as follows:

$$\Delta F_t^P(\pi_{t+1}) = F_t(\eta_{t+1}) + \rho_t(F_t(\mu_t)) \tag{6}$$

where $h=1$ and $\Delta F_t^P(\pi_{t+1}) = [F_t^P(\pi_{t+1}) - F_{t-1}^P(\pi_{t+1})]$. Also, $F_t(\tau_t) = F_{t-1}(\tau_t) + F_t(\eta_t)$ and

$F_t(\xi_t) = \rho_{t-1}F_{t-1}(\xi_t) + F_t(\mu_t)$. The professional updates their forecast when they expects change to the inflation's trend innovation and/or perceives shock to inflation gap.

So using the most recently available information they form full-information rational expectations (hereafter referred to as FIRE):

$$E_t^*(\pi_{t+1}) = F_t^P(\pi_{t+h}) = \pi_t + \varepsilon_t \tag{7}$$

However, due to informational rigidities, or frictions, professionals are inattentive and their actual forecasts ($F_t^P(\pi_{t+h})$) invariably deviate from FIRE:

$$F_t^P(\pi_{t+h}^P) = (1-\lambda)E_t^*(\pi_{t+h}) + \lambda F_{t-1}^P(\pi_{t+h}) \tag{8}$$

The professional forecaster tries in the current period (t) to form an inflation forecast for $t+1$ period ahead. Informational rigidity is captured by λ, that is it depicts the level of information imperfection or stickiness. When forecasters are unable to form FIRE, they resort to their previous inflation forecast for period $t+1$. As shown in Coibion and Gorodnichenko (2015) the forecast errors are derived accordingly:

$$\pi_{t+1} - F_t^P(\pi_{t+1}) = \frac{\lambda}{1-\lambda}\Delta F_t^P(\pi_{t+1}) + \varepsilon_{t+1} \tag{9}$$

or following equation (6):

$$\pi_{t+1} - F_t^P(\pi_{t+1}) = \frac{\lambda}{1-\lambda}[F_t(\eta_{t+1}) + \rho_t(F_t(\mu_t)] + \varepsilon_{t+1} \qquad (9')$$

where $\Delta F_t^P(\pi_{t+1}) = [F_t^P(\pi_{t+1}) - F_{t-1}^P(\pi_{t+1})]$. Hence, forecast errors persists due to informational frictions. The remainder of the paper will focus on the dynamics of non-expert inflation forecasts as they interact with the professionals' forecast.

III: The Dynamics of Non-Experts' Inflation Forecasts: The Model

As discussed in the introduction non-experts, such as firms and households, observe and, subsequently, absorb professionals' forecasts via the news media and social interaction with other non-experts. In addition, they may also include the current actual inflation rates as a 'rule-of-thumb'. We assume that non-expert's rate of revising their inflation forecast depends on the professional's forecast errors for the current period. So, for instances, if the professional under-forecasted current inflation the non-expert continues to revise their forecast upwards and updates their inflation forecast as follows:

$$\dot{F}^N = \gamma[\pi - F^P] \qquad (10)$$

where $\gamma > 0$, and F^N denotes the non-experts inflation forecast while F^P denotes the professional's inflation forecast for the current period. Specifically, the non-expert updates their inflation forecast as follows:

$$\dot{F}^N = \gamma\left[\frac{\lambda}{1-\lambda}\Delta F_{t-1}^P(\pi_t) + \varepsilon_t\right]$$

or $\qquad \dot{F}^N = \gamma\left[\frac{\lambda}{1-\lambda}[F_{t-1}(\eta_t) + \rho_{t-1}(F_{t-1}(\mu_t)] + \varepsilon_t\right] \qquad (10')$

Inflation expectations are one of the main causes of actual inflation due to its influence of current wage negotiations, price setting and financial contracting for

investment (see Cunningham et al (2010)). This can be depicted in a dynamic framework as follows:

$$\dot{\pi} - \beta\pi = \delta F^N \qquad (11)$$

where $\beta < 0, \delta > 0$. As non-experts' inflation forecasts increase so does actual inflation and vice versa. We also assume $\beta < 0$, so inflation rates are stable dynamically and converge to the long-run equilibrium. Hence, in the steady state, non-experts' inflation forecast are:

$$F^N = -\frac{\beta}{\delta}\pi \qquad (12)$$

Actual inflation rates affect the non-experts' forecasts positively. If $|\beta| = |\delta|$, an increase in the inflation rate will be matched equally by an increase in their inflation forecasts.

The dynamic behavior of household's expectations and actual inflation rates, depicted in equations (10) and (11), can be re-specified in matrix form:

$$\begin{bmatrix} \dot{F}^N \\ \dot{\pi} \end{bmatrix} = \begin{bmatrix} 0 & \gamma \\ \delta & \beta \end{bmatrix} \begin{bmatrix} F^N \\ \pi \end{bmatrix} + \begin{bmatrix} -\gamma F^P \\ 0 \end{bmatrix} \qquad (13)$$

Solving the system of differential equations simultaneously (see Appendix for detailed derivations), we obtain the following results: the eigenvalues (λ_1, λ_2) obtained are real roots and are of opposite sign as the determinant of the coefficient matrix is negative, implying the steady state is a saddle point equilibrium. The equilibrium or steady state values for non-expert forecasts and actual inflation rates are derived as follows:

$$\begin{bmatrix} \pi^* \\ F^{N*} \end{bmatrix} = \begin{bmatrix} F^P \\ -\dfrac{\beta F^P}{\delta} \end{bmatrix} \qquad (14)$$

The above results can be depicted in the following phase diagram:

Figure 1 [about here]

The phase plane for the bivariate system of differential equations is described in Figure 1. The π isocline is obtained by setting $\dot{\pi} = 0$, thereby plotting equation (12). The F^N isocline is also obtained by setting $\dot{F}^N = 0$, giving the horizontal isocline. This is essentially occurs when the professional's forecast errors is zero. The dynamics of π in the two isosectors are separated by the π isocline. So it follows that π is declining in the region above the $\dot{\pi} = 0$ line while increasing in the region below, and is confirmed by the negative partial derivative $\partial \dot{\pi} / \partial \pi$. On the other hand, F^N is increasing above the $\dot{F}^H = 0$ line and decreasing below it, which is confirmed by the partial derivative $\partial \dot{F}^N / \partial G$ which is positive. The ensuing arrows of motion and trajectories are illustrated in Figure 1.

In the phase diagram, the steady state conditions for non-expert's inflation forecasts and actual inflation are given by the equilibrium position at point A. Suppose there is an exogenous increase in the professionals' inflation forecast. When professional forecasters revise their forecast upwards, that is F^P increases to $F^{P'}$, causing a parallel shift of the F^N isocline upwards to $\dot{F}^{H'} = 0$. As a result the steady state values move from equilibrium point A to the new equilibrium point B, with new steady state values. Whether these values increase by the same amount would depend on whether $|\beta| = |\delta|$.

Interestingly, due to the underlying foundations of the model, the non-experts' inflation forecasts overreacts, or overshoots, in the short-run. Their forecasts do not move instantly from equilibrium point A to the new equilibrium point. The non-experts' forecasts adjust faster than the professionals'. Empirical evidence indicate that household

expectations adjust to current inflation. Indeed, there is evidence that they adjust to the difference between current inflation and the professional forecasts – effectively the professionals' forecast error.

What is clear is that the dynamics of the non-expert's forecast is driven by the exogenous professional's forecasts and actual inflation rates – more specifically the professional's forecast errors. First and foremost, there is sufficient evidence to indicate that non-experts' are more likely to adjust their forecast when actual inflation is rising rather than when it is falling (see Easaw et al, 2013). The loss aversion argument put forward in Akerloff (1996 and 2000) suggesting that non-experts stand to lose more by ignoring rising inflation than falling ones.

The crux of the explanation can really be found in the professionals' inattentiveness. As indicated by equation (9'), if the professional revises their forecast upwards ($\dot{F}^P > 0$) they expect a positive change to the inflation's trend innovation and/or perceive a positive shock to inflation gap. Nevertheless, any upward revision of their forecast is likely to leads to an under-forecast ($\pi - F^P > 0$) due to inattentiveness and is persistent. Consequently, as the non-expert too revise their forecast upwards ($\dot{F}^H > 0$) they over-shoot or overreact initially. The non-expert continues to revise their forecast upwards until $\pi - F^P = 0$.

If professionals are able to forecast inflation consistent with FIRE, the non-experts forecast will move to the new equilibrium accordingly instantly – baring stochastic errors. However, professionals' forecast are characterized by inattentiveness due to informational rigidities and, therefore, rational expectations due to informational friction. The ensuing persistent professionals' forecast error entail that the non-experts'

forecast will also rise persistently. This results in their inflation forecast overshooting initially before reaching the new equilibrium. The convergence of non-experts' forecast to its long-run value or equilibrium is non-monotonic.

III: Discussion and Concluding Remarks:

The purpose of the present paper is to provide a simple framework model outlining how non-experts' form their inflation forecasts. The model incorporates and explains recent empirical findings. There have been extensive empirical investigations focusing on how non-experts form their inflation forecasts. The availability of interesting and novel survey-based datasets from various sources and economies has largely facilitated this.

The analyses importantly allow for non-experts to incorporate and absorb, or learn observationally or socially, from professionals' forecasts. Non-experts' forecasts are also react to current inflation rates. Interestingly too, in the short-run, as they adjust their expectations they tend to over-react. The model outlined here shows that they over-react or over-shoot initially while converging to their long-run non-monotically. Crucially this is explained by the professionals' inattentiveness due to informational rigidities causing their forecasts errors to be persistent. This result in non-experts adjusting their forecast faster than professionals.

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Appendix

$$\begin{bmatrix} \dot{F}^N \\ \dot{\pi} \end{bmatrix} = \begin{bmatrix} 0 & \gamma \\ \delta & \beta \end{bmatrix} \begin{bmatrix} F^N \\ \pi \end{bmatrix} + \begin{bmatrix} -\gamma F^P \\ 0 \end{bmatrix}$$

The characteristic equation is given by $\det(A - \lambda I) = 0$, where $A = \begin{bmatrix} 0 & \gamma \\ \delta & \beta \end{bmatrix}$.

Solving the characteristic equation we get:

$$-\lambda(\beta - \lambda) - \delta\gamma = 0$$

Solving the characteristic equation we obtain the following eigenvalues:

$$\lambda_1 = \frac{1}{2}\left[\beta + \sqrt{\beta^2 + 4\delta\gamma}\right]$$

$$\lambda_2 = \frac{1}{2}\left[\beta - \sqrt{\beta^2 + 4\delta\gamma}\right]$$

Since the discriminant is positive the eigenvalues will be real numbers. From the above results we can deduce that:

$$\lambda_1 + \lambda_2 = \beta < 0$$

$$\lambda_1\lambda_2 = -\delta\gamma < 0$$

$$\det(A) < 0$$

This implies that both the eigenvalues are negative and real and therefore the equilibrium will be a saddle path.

Figure 1: Dynamic Relationship between Inflation Rates, Professional's and Non-Experts' Inflation Forecasts