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1339

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June 2007

This paper is part of the Kiel Working Paper Collection No. 2

"**The Phillips Curve and the Natural Rate of Unemployment"**
June 2007

http://www.ifw-kiel.de/pub/kap/kapcoll/kapcoll_02.htm

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Kiel Working Paper No. 1339

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Inflation Expectations, the Phillips Curve and Monetary Policy

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1 May 2007

Abstract

Conjectures about inflation expectations are inextricably linked to our understanding of the relationship between the real and monetary sides of the economy; yet, direct empirical research on the matter has been scarce at best. This paper therefore examines the empirical properties of inflation expectations data constructed on the basis of both qualitative and quantitative surveys of consumers for a set of eight European countries. The rational perceptions hypothesis is tested and rejected by the data, a finding which in turn leads us to reject the rational expectations hypothesis and casts doubt on the New Keynesian Phillips Curve model. The popular alternative of using "rule-of-thumb" expectations in such models empirically is also found to be unrobust. Similarly, the conjecture by Akerlof et al. (2000) of a non-vertical long-run Phillips curve arising from the presence of "near-rational" expectations cannot be supported. The Mankiw and Reis (2002) Phillips curve based on the idea of "sticky information" succeeds in its intuition of a gradual adjustment of expectations, but its assumption of rational updating is challenged by the data in the context of the natural experiment provided by the UK's ERM disinflation. Instead, the adjustment mechanism for expectations appears to display largely adaptive characteristics. Finally, the paper provides some insights into the nature of the interaction between monetary policy and inflation expectations.

JEL Classifications: D84, E31, E52, E58, E61, E65, C22, C42.

Keywords: Inflation expectations, inflation perceptions, survey data, rationality, Phillips curve, consumers, expectations distribution, inflation targeting.

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The views expressed in this paper are solely my own and do not necessarily reflect those of NERA Economic Consulting. I would like to thank especially Professor John Muellbauer for his extraordinary support and numerous insightful discussions over the years. I am also extremely grateful for comments from Dr. Mark Williams, Professor Peter Sinclair, Dr. Chris Bowdler, Dr. James Forder and Professor David Vines. Any remaining errors are my own.

1. Introduction

For the past half century, the Phillips curve has constituted one of the central paradigms of modern macroeconomics, in particular through its framing of the debate on the relationship between the real and monetary sides of the economy. It has done this in various shapes and incarnations: from the original relationship evidenced in Phillips (1958), through the expectations-augmented Phillips curve of Friedman (1968), the New Keynesian Phillips Curve (henceforth "NKPC") and more recent variations, such as the sticky information model of Mankiw and Reis (2002).

All the contributions on the matter since Friedman (1968) have at least one point in common, namely their incorporation of some conjecture relating to inflation expectations as a fundamental building block for the theory in question. Yet, despite the sensitivity of the conclusions reached on the particular expectations process assumed, critical and systematic empirical examinations of such conjectures have on the whole been scarce.

The present paper aims to address this situation by deploying direct data on inflation expectations and perceptions arising from four consumer surveys: the European Commission's Consumer Survey; the Gallup survey and the Bank of England/NOP surveys in the UK; and the HIP survey in Sweden. For purposes of exposition, the main text takes the availability of direct, quantitative, empirical data on these dimensions as a given, with some additional methodological detail relegated to the Appendix.

On this basis, the paper documents a triple failure which has clouded our understanding of the relationship between the real and monetary sides of the economy to date. Firstly, a failure of the rational expectations and perceptions hypotheses and consequently of the NKPC approach (Section 2). Secondly, a failure of "rule-of-thumb" expectations and their associated Phillips curves, introduced in light of the obvious shortcomings of rational expectations-based models (Section 3). And thirdly, a failure to preserve a role for rational expectations in more recent approaches rooted in information stickiness (Section 4) – which nonetheless will be shown to have obvious merits. Finally, Section 5 provides some insights on the relationship between monetary policy and inflation expectations. Section 6 concludes.

2. The failure of rational expectations and New Keynesian Phillips Curves

The idea of "rational expectations" is due to Muth (1961) who hypothesised that "*expectations, since they are informed predictions of future events are essentially the same as the predictions of the relevant economic theory*". In this view, agents' subjective expectations of economic variables coincide with the objective mathematical conditional expectations of those variables: agents know the true underlying model of the economy and use it to inform their expectations. The popularity of this method followed both from its simplicity and the appealing idea that it concerns economically "intelligent" agents that avoid systematic mistakes[1].

[1] How successful they are at this depends on how much information one includes in the model put in the agents' possession in the Muth (1961) definition; in particular, a weak definition of rationality would exclude knowledge of regime shifts from the model, which could lead to systematic prediction errors (Cukierman, 1986).

Unfortunately, the approach was rapidly found to be problematic from an empirical perspective. Tests of the rational expectations hypothesis can broadly be placed in two categories: direct and indirect tests.

2.1. Direct tests of rational expectations and the rational perceptions hypothesis

First, the rational expectations hypothesis has been tested directly, using survey data on inflation expectations of the type considered in this study. In fact, a whole testing "industry" developed in the literature, making this the quasi-exclusive use for survey data on expectations over the past thirty years. A variety of countries, surveys, types of data (qualitative and quantitative), quantification methodologies (where applicable) and econometric techniques were considered. Econometrically, not all the approaches commonly used in these papers are commendable (see Curto Millet, 2006, for a critique). Notwithstanding this, and although this is no place to survey such a vast literature, it can be said that the overwhelming majority of studies rejected one aspect or the other associated with rational expectations[2].

An implicit assumption in much of the literature is that when consumers think about prices, they conceptualise them in the same way as the statisticians compiling the consumer price index. That is, to reach their personal notion of "consumer prices", they weigh expenditure components in their heads in the same way as they are weighed in the CPI. In other words, the CPI is their reference index for inflation. We refer to this as the "rational perceptions hypothesis".

This assumption is debatable, at the very least. For instance, survey participants might respond to questions by thinking of retail price inflation rather than headline inflation. Their responses might be biased towards goods inflation, as many services are consumed less frequently; this matters given the differences between sectoral inflation rates due to technological progress differentials, for instance. One-off, administrative payments that influence the official index may also be excluded from their assessment.

The literature testing the rationality of expectations has therefore either: (1) implicitly assumed the validity of the rational perceptions hypothesis; or (2) tested a joint hypothesis of the rationality of both expectations and perceptions. This is potentially a grave concern. Indeed, differences between the actual reference index and CPI may lead to systematic deviations between inflation expectations and *ex post* observed inflation without this depending in any way on the ability of consumers to form predictions.

The exceptional availability of quantitative expectations data from the HIP survey in Sweden allows us to carry out a test of the rational perceptions hypothesis for the first time in the literature. In particular, we have sought to explain consumer inflation perceptions in terms of inflation in the underlying components of the HICP. We use monthly data on inflation perceptions for the period 1993m2-2005m7. The sub-components underlying the HICP are listed in Table 1.

[2] See *inter alia*: Roberts, 1997; Bakhshi and Yates, 1998; Łyziak, 2003; Nielsen (2003b); Forsells and Kenny (2006); Baghestani (1992); Hanssens and Vanden Abeele (1987); Figlewski and Wachtel (1981, 1983); Engsted (1991); Gerberding (2001, 2006); Thomas (1999); Papadia (1983); Kokoszczyński, Łyziak and Stanisławska (2006).

TABLE 1: HICP INFLATION COMPONENTS

Code	Concept	Retained in EqCM?
INF1	"Food and non-alcoholic beverages"	**YES**
INF2	"Alcoholic beverages and tobacco"	NO
INF3	"Clothing and footwear"	NO
INF4	"Housing, water, electricity, gas and other fuels"	**YES**
INF5	"Furnishings and household goods"	**YES**
INF6	"Health"	**YES**
INF7	"Transport"	**YES**
INF8	"Communication"	NO
INF9	"Recreation and culture"	NO
INF10	"Education"	NO
INF11	"Hotels, Cafés and Restaurants"	**YES**
INF12	"Miscellaneous goods and services"	**YES**

SOURCE: Eurostat

A possible modelling approach then consists in incorporating the official consumer price index weights (denoted by CP) directly into the explanatory variables:

$$PERCEPTIONS_t = a + b_1 * (CP01_t * INF1_t) + ... + b_n * (CPn_t * INFn_t) + e_t$$

The independent variables are therefore the inflation rates of the individual HICP components multiplied by their time-varying weights in the HICP index[3]. The null hypothesis of rational perceptions would imply a value of zero for α and values of one for all the β terms. Values either above or below one for the β terms would respectively imply an over- or underweighting of the component in question by consumers relative to what would be "rational". The results (reported in Curto Millet, 2007) show that some components are either under- (e.g. INF1) or overweighted (e.g. INF11) relative to what would have been expected from the HICP weights. Furthermore, the model performs very poorly in terms of specification diagnostics, notably with respect to residual autocorrelation and heteroscedasticity. In addition, Chow tests reveal the regression to be highly unstable.

In light of these failings, a more sophisticated modelling exercise was carried out through the development of alternative equilibrium correction specifications. This approach seems sensible, as there may well be timing errors in the data. Furthermore, it is easy to conceive that, on a sample of monthly data, lagged perceptions of inflation would be relevant. To address such concerns, a set of nested EqCM specifications was developed, presented below from the most to the least restrictive:

$$H1: \Delta PERCEPTIONS_t = a_1 * \Delta HICPINFLA_t + a_2 * (HICPINFLA - PERCEPTIONS)_{t-1} + e_t$$

$$H2: \Delta PERCEPTIONS_t = \sum_{i=1}^{12} a_{1i} * \Delta INFi_t + a_2 * (HICPINFLA - PERCEPTIONS)_{t-1} + u_t$$

$$H3: \Delta PERCEPTIONS_t = \sum_{i=1}^{12} a_{1i} * \Delta INFi_t + \sum_{i=1}^{12} a_{2i} * [w_i * (INFi - PERCEPTIONS)]_{t-1} + v_t$$

[3] Such a transformation might be hoped to lead to a better specification, in that some of the potential instability that could be experienced might now be subsumed within the independent variables (Hendry, 2004).

"INFi" denotes the inflation of the ith component of the HICP index, and w_i its associated index weight; "HICPINFLA" denotes overall HICP inflation; "PERCEPTIONS" denotes the quantitative inflation perceptions of Swedish consumers evidenced by the HIP survey.

Having estimated all three models in their most general form, we are able to carry out nested tests on the basis of the likelihood ratio statistic. The results of this exercise are presented in Table 2. As can be seen, the general H2 and H1 specifications are at the boundary of being rejected against the general H3 model. On the other hand, the restrictions implied by the parsimonious H3 specification are comfortably accepted.

TABLE 2: SWEDISH INFLATION PERCEPTIONS, NESTED TEST RESULTS

Case	No. Restrictions	LogLik. Statistic	Crit. value (5%)	Result
General H3 vs General H2	11	19.50	19.68	Marginal non-rejection
General H3 vs General H1	22	32.69	33.92	Marginal non-rejection
General H3 vs Specific H3	14	16.00	23.69	Do not reject

The non-rejection results for specifications H2 and H1 are so marginal that they hardly build much confidence in the implied restrictions. Thus, it would seem to be important to express both the dynamics and the long-run solution of the model in terms of the individual components of HICP inflation. We now present the selected parsimonious H3 specification in Table 3. The model appears to be congruent and quite stable overall, excepting some punctual traces of instability around the year 2000.

TABLE 3: PARSIMONIOUS EqCM MODEL, INFLATION PERCEPTIONS

Modelling DPERSCBEV; Estimation Sample: 1993m2-2005m7

	Coefficient	Std.Error	t-value	t-prob	Part.R^2
DINF6	0.0548654	0.01917	2.86	0.005	0.0549
DINF7	0.0454588	0.02045	2.22	0.028	0.0339
ECMHICP1_1	0.187491	0.06690	2.80	0.006	0.0528
ECMHICP4_1	0.106273	0.05452	1.95	0.053	0.0262
ECMHICP5_1	0.579224	0.2760	2.10	0.038	0.0303
ECMHICP7_1	0.113488	0.05861	1.94	0.055	0.0259
ECMHICP11_1	1.07929	0.4452	2.42	0.017	0.0400
ECMHICP12_1	0.744322	0.3026	2.46	0.015	0.0411
I1996:2	-1.27997	0.3298	-3.88	0.000	0.0965

sigma	0.314375	RSS	13.9352846
log-likelihood	-34.6249	DW	2.07
no. of observations	150	no. of parameters	9
mean(DPERSCBEV)	-0.0034	var(DPERSCBEV)	0.123302

NOTES: "DINF" variables denote differenced inflation terms; variables prefixed by ECM refer to the equilibrium correction terms; I1996:2 is a dummy variable capturing an outlier.

Specification Tests	
AR 1-7 test:	F(7,134) = 0.75318 [0.6274]
ARCH 1-7 test:	F(7,127) = 1.5047 [0.1714]
Normality test:	Chi^2(2) = 1.7453 [0.4178]
hetero test:	F(17,123)= 1.1647 [0.3033]
hetero-X test:	F(45,95) = 1.2410 [0.1891]
RESET test:	F(1,140) = 0.026845 [0.8701]

The model in Table 3 makes clear that not all HICP components seem to matter significantly in terms of shaping consumer inflation perceptions; furthermore, heterogeneity is also evident in the influence of the components that are retained (as summarised in Table 1). These results therefore question the validity of the rational perceptions hypothesis.

Curto Millet (2007) further argues and provides evidence to support the conjecture that the importance of a particular set of products in determining the inflation perceptions of consumers is increasing in the following four factors: (1) the frequency at which the prices in question are adjusted; (2) the weight of these products in the overall expenditure of consumers; (3) the level of inflation applicable to those products over the sample; and (4) the frequency at which the consumer purchases those products. Furthermore, it is shown that taking into account the biases in the consumers' perceptions of prices translates into only a marginal improvement in the forecasting performance of their expectations in RMSE terms, which are still outperformed by a naïve predictor based on extrapolation of the previous year's inflation.

For the present purposes these findings together with the cited literature surely can be said to provide a coup de grâce to the illusion of real world relevance of rational expectations, as generally understood in the mainstream literature.

2.2. Indirect tests of rational expectations and New Keynesian Phillips Curves

Second, the rational expectations hypothesis has been tested *indirectly*, by implication. For instance, the finding by Ericsson and Irons (1995) of the surprisingly limited relevance of the Lucas critique in key empirical applications is consistent with the formation of expectations that are not fully optimising, but may be highly appropriate when it comes to dealing with breaks in series (Hendry, 2002).

However, the most influential blow to the theory of rational expectations has perhaps come from its widely noted empirical failure when implemented in the context of the so-called New Keynesian Phillips Curve (NKPC) model. A standard derivation of the model is based on the Calvo (1983) pricing assumption, which – denoting the output gap by y_t and inflation by Π_t – yields the following equation:

$$\Pi_t = [a\, l^2/(1-l)]y_t + E_t\Pi_{t+1}$$

Multiple misgivings have been identified: the model predicts that announced, credible disinflations produce booms (Ball, 1994); it is incapable of generating inflation persistence (Fuhrer and Moore, 1995); and more generally, the restrictions it imposes across impulse response functions fail to match the evidence (Mankiw, 2000). Of course, the failure of the NKPC is that of a joint hypothesis – of expectations being rational, and of the NKPC model being appropriate. The evidence presented above certainly suggests that the first leg of this hypothesis in wrong.

In light of such findings, the literature concluded that more inertia needed to be introduced if the model was to shed its problems, and at least two ways related to expectations were explored to achieve this. They are considered in turn in the following two sections.

3. The failure of rule-of-thumb expectations and associated Phillips Curves

The first approach is based on the diagnosis that the problems the model faces arise from the assumption of rational expectations. It is precisely because firms are rational that the ones having an adjustment opportunity cut their prices immediately in the face of an announced credible disinflation ahead, thereby increasing the real money stock and causing a boom. This does not happen if firms' expectations are adaptive, which also introduces inflation persistence and more realistic impulse response cross-restrictions. The NKPC model then reduces to the traditional backward-looking model (Friedman, 1968), which is overall more successful in its data confrontation.

Given this requirement for empirical success, the unwillingness to fully abandon the rational expectations hypothesis led to attempts to strike an ad hoc compromise. A number of Phillips curves were fitted under the assumption that there is a fraction of forward-looking agents acting as above and a fraction of backward-looking ones, thus introducing the required inertia. Prominent among these studies has been Galí and Gertler (1999), whose authors estimate the following hybrid Phillips curve, with s_t being a measure of real marginal costs:

$$\Pi_t = l s_t + g_f E_t\{\Pi_{t+1}\} + g_b \Pi_{t-1}$$

One of their strongest results is that although backward-looking behaviour is statistically significant, their estimates suggest that forward-looking behaviour is followed by roughly sixty to eighty percent of firms. This is a tremendously forward-looking finding. However, it is plagued by a number of econometric difficulties. Ruud and Whelan (2001) show that conventional models can easily generate such results as a product of omitted variable bias. Mavroeidis (2002) argues that weak identification due to an AR(1) process for s_t can lead to upward biases in small samples for the forward-looking coefficient. Furthermore, when tested against a backward-looking EqCM specification on Norwegian data, this model is strongly rejected (Bardsen et al., 2002).

In any event, a major limitation of results in this area is that they again depend on a joint hypothesis – that of "rule-of-thumb" expectations and a given Phillips curve specification. Once again, the first leg of this joint hypothesis can be examined using survey data.

3.1. The chronic instability of rule-of-thumb expectations models

The "rule-of-thumb" hypothesis is based on the idea that there is a fraction of agents in the population acting rationally, with the remainder doing "something else" (typically, some form of adaptive expectations).

Direct measures of consumer inflation expectations permit the estimation of such relationships. For instance Gerberding (2001) estimates a quarterly model of partly rational and partly adaptive expectations for Germany, Italy and France with the following form:

$$E_t p_{t+4} = c_1 E_t^m p_{t+4} + (1-c_1)(E_{t-4} p_t + c_2 (p_t - E_{t-4} p_t))$$

$E_t^m p_{t+4}$ is the "mathematical" expectation of future inflation, whilst c_2 captures the speed at which agents revise their expectations. Gerberding argues that it is realistic to assume that only *lagged* inflation is known at the time of expectations formation. Furthermore, the rational expectation can be rewritten as the actual future inflation rate minus an expectation error u_{t+4}. Highlighting the use of survey data with the superscript S, this yields:

$$E_t^S p_{t+4} = c_1 p_{t+4} + (1-c_1)(E_{t-5}^S p_{t-1} + c_2 (p_{t-1} - E_{t-5}^S p_{t-1})) + e_t^S - c_1 u_{t+4}$$

To deal with the bias that would arise from the correlation between p_{t+4} and the error term, the author uses lagged values (up to 12 lags) of the inflation rate as instruments but refrains from using lagged values of the endogenous variable. This is due to the possibility of measurement error in the survey data introducing a correlation between the lagged endogenous variable and the disturbance. The estimation method used was two-stage least squares with Newey-West correction of standard errors. In no case can the tests of overidentifying restrictions reject the null. Gerberding reports the following coefficients:

TABLE 4: GERBERDING (2001) RULE-OF-THUMB MODEL; 1991q1-1999q4

	DEU	FRA	ITA
C_1	0.22*	0.30**	{0}
1-C_1	{0.78}	{0.70}	{1.00}
C_2	1.18**	1.01**	0.93**
Constant C_0	-	-0.45**	-

Note: * & ** denote significance at the 5% and 1% level, respectively; Brackets {} denote restricted variables.

Prima facie, it is especially striking that Italy can be restricted to an entirely backward-looking specification, which seems at odds both with its inflationary history and past empirical evidence (e.g. Barrell and Dury, 2001; Curto Millet, 2004, 2007). We note, however, that in the regression presented for Italy, the first order autocorrelation coefficient appears to be highly significant which may indicate misspecification.

We now reproduce where possible Gerberding's results over the same sample period ("S1") for these and five other countries. As a check on the robustness of the model and in particular its stability, we examined the sample sensitivity of the results, using the largest sample period available in each country ("S2")[4]. The results are reported in Table 5.

[4] In Germany, this was limited to post-1991 data, as earlier values would involve expectations referring to West Germany only, and the transition could potentially be an independent source of instability.

TABLE 5: RULE-OF-THUMB MODEL, FULL SAMPLE ESTIMATION

Country:	**DEU**		**FRA**		**ITA**		**GBR**	
Sample:	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
C_1	0.285** (0.054)	0.381** (0.067)	0.275** (0.044)	-0.070 (0.126)	{0}	{0}	0.368** (0.037)	0.226** (0.054)
$1-C_1$	{0.715}	{0.619}	{0.725}	{1.07}	{1.00}	{1.00}	{0.632}	{0.774}
C_2	1.11** (0.039)	1.00** (0.095)	1.04** (0.09)	0.832** (0.067)	0.943** (0.131)	1.29** (0.121)	1.17** (0.048)	1.13** (0.035)
Constant C_0	-	-	-0.005** (0.0003)	-0.006** (0.001)	-0.003** (0.001)	0.013* (0.0061)	-0.004** (0.001)	-0.004** (0.0012)
Period	1991q1-1999q4	1992q2-2004q2	1991q1-1999q4	1986q2-2004q2	1991q1-1999q4	1974q2-2005q2	1991q1-1999q4	1981q3-2004q2
Country:	**ESP**		**BEL**		**NLD**		**SWE**	
Sample:	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
C_1	0.468** (0.146)	0.04 (0.087)	0.256** (0.040)	0.228** (0.061)	{0}	{0}	-	0.011 (0.054)
$1-C_1$	{0.532}	{0.96}	{0.744}	{0.772}	{1.00}	{1.00}	-	{0.989}
C_2	0.584** (0.152)	0.933** (0.045)	0.971** (0.064)	1.00** (0.038)	1.04** (0.043)	1.20** (0.10)	-	0.753** (0.026)
Constant C_0	-0.010** (0.001)	-0.013** (0.001)	-0.004** (0.000)	-0.004** (0.000)	-0.002** (0.000)	-0.003* (0.0014)	-	-0.002** (0.00041)
Period	1991q1-1999q4	1987q4-2004q2	1991q1-1999q4	1986q2-2004q3	1991q1-1999q4	1975q1-2005q2	1991q1-1999q4	1997q2-2004q2

Note: S1 and S2 refer to the first and second sample used. * & ** denote significance at the 5% and 1% level, respectively. HAC-consistent standard errors. {} denote restricted variables.

It can be seen that when using the same sample, we obtain results which are insignificantly different from Gerberding's, except in respect of the significant constants in the models for France and Italy[5]. Looking across countries and samples in this respect, we note the significant presence of constants in all but the German specifications. This is already a potential sign of ill-health for – as Gerberding puts it – this could be "*indicating either that a measurement error has occurred with respect to the level of the expectations variable […] or that the formulated model does not entirely capture the expectation formation process of the polled households*"[6].

Now, contrasting samples S1 and S2 reveals a number of important differences in coefficients for all countries, except Belgium, the Netherlands and Germany (although in the latter case, C_1 has substantially increased). For both Spain and France, the coefficient C_1 – formerly significant at the 1% level – has collapsed and is now insignificant; C_2 is also significantly different (smaller for France, larger for Spain). For Italy, both C_2 and C_0 appear to be significantly higher in the full sample. The UK's coefficient C1 is significantly smaller here. Widespread autocorrelation is also detected, which may simply be a reflection of the overlapping data problem, or may equally be indicative of specification problems.

[5] This may be due to the use of different sources for CPI data, or to slightly different distributional assumptions when applying the Carlson-Parkin method (Curto Millet, 2007).

[6] See Gerberding (2001), p.31.

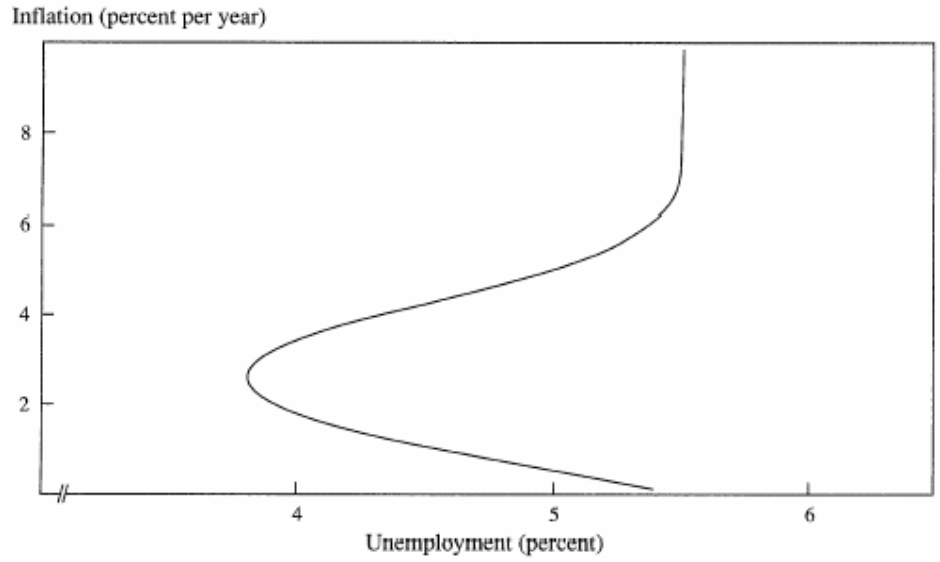
Curto Millet (2007) carries out a further exercise to check the robustness of the specification to minor changes. The stability of the equation was further examined by using a different but closely-related quantification methodology for inflation expectations to that used in Gerberding (2001). Significant differences in coefficients were then evidenced for all countries, yielding a greatly modified qualitative interpretation to that offered by the Gerberding regressions. Similar issues of sample-sensitivity and measure-dependence were apparent when considering quantitative expectations data from the UK Gallup survey and the Swedish HIP survey.

The obvious fragility of the model highlighted by these exercises therefore makes its use ill-advised, whether for the construction of Phillips curves or for drawing any form of policy conclusions. This outcome is hardly surprising given the ad hoc motivations behind the development of this approach. Here as elsewhere, the General-to-Specific modelling approach advocated by Hendry (1995) would appear to be invaluable.

3.2. Rule of thumb expectations and the verticality of the Phillips Curve

Akerlof, Dickens and Perry (2000) (henceforth ADP) put forward the hypothesis that the population of agents in the economy is divided into two groups: whilst some form fully rational expectations, others hold "nearly rational" expectations, in that they underweight or even ignore inflation. The proportion of such agents in the economy is a function of the prevailing inflation rate, as higher rates increase the incentive to gather information about inflation. This hypothesis implies the existence of a non-vertical Phillips curve in the long-run, as depicted in Figure 1.

FIGURE 1: ADP HYPOTHETICAL LONG-RUN PHILLIPS CURVE



SOURCE: Akerlof, Dickens and Perry (2000)

The rationale for this shape is that as inflation increases from zero, it is underestimated by the nearly-rational agents, leading them to overestimate their real wage increases and substitute work for leisure. Inflation increases however also make it worthwhile for some agents to start forming expectations rationally. In the limit, all agents form expectations rationally, and the economy is again operating at the natural rate of unemployment.

ADP presented estimates of expectations-augmented Phillips curves on the basis of US data consistent with their theory. A similar exercise was carried out for Sweden by Lundborg and Sacklén (2001). However, Bryan and Palmqvist (2005) have criticised those exercises as being unable to distinguish the ADP hypothesis from other competing possibilities. The authors carried out alternative empirical verifications in the context of Sweden and found that the data fails to reveal the correspondence between expectations errors and actual inflation implied by the near-rationality hypothesis, as advanced by ADP. The pattern predicted by ADP's theory is as follows: initially, the expectation error is close to zero for very low levels of inflation; as inflation rises, there is a period of increasing underprediction; this peaks at some level of inflation and subsequently underprediction diminishes back to zero as inflation rises further.

Curto Millet (2007) reproduces the results of Bryan and Palmqvist (2005) for Sweden, and applies their methodology to seven further European countries. Since it is unclear from ADP's paper whether the theory is intended to apply to all changes in inflation, or only to more persistent changes, a two-stage approach is adopted.

First, the ADP pattern for the expectation error is checked against the pattern found empirically across *regime changes* in inflation, identified by the test for multiple structural changes proposed by Bai and Perron (1998, 2003). No basis is found to support the ADP near-rationality hypothesis in this respect, despite the larger sample used in Curto Millet (2007).

Second, the ADP pattern is examined when considering *all changes in inflation* as being of relevance to the theory. This suggests using the following nonlinear regression for the expectations error and null hypothesis:

$$p^{e}_{t,t-12} - p_t = a + b_1 p_t + b_2 p_t^2 + e_t$$

$$H_0 : \begin{cases} a = 0 \\ b_1 < 0 \text{ and } b_2 > 0 \\ |b_1| > b_2 \end{cases}$$

As could be expected from a model of this sort, significant autocorrelation and heteroscedasticity are found to be present in the residual term. This would invalidate the standard errors and thus inferences drawn on their basis. We therefore proceed to a correction of the standard errors according to the Newey-West procedure; the maximum number of lags allowed was set to 12, consistent with the monthly nature of the data and an inspection of the resulting correlograms from the previous regressions. Expectations data was drawn from the EC Consumer Survey, from the Gallup Survey for the UK, and from the HIP Survey for Sweden. Table 6 presents the results.

The evidence makes clear that the null hypothesis performs poorly when contrasted with the data. Only in the case of three countries (the UK with EC data, France and Germany) do the signs of β_1 and β_2 match the null. This is hardly an endorsement of the theory, however. In no case is the β_2 coefficient significant; β_1 proves to be mostly insignificant or marginally significant for the most part; and several constants are found to be significant. Furthermore, many of the coefficients appear with the "wrong" sign.

TABLE 6: TESTING ADP NEAR-RATIONALITY, ALL FLUCTUATIONS

cty	Period	α	β_1	β_2	F
GBR [EC]	1981m11-2005m8	2.11 *** (0.659)	-0.578 * (0.340)	0.007 (0.030)	15.37 ***
GBR [GLP]	1983m1-1997m1	3.86 *** (0.822)	-0.413 (0.351)	-0.026 (0.030)	39.3 ***
ITA	1982m1-2005m9	-0.424 (0.676)	0.334 (0.279)	-0.019 (0.021)	1.05
FRA	1986m4-2005m8	0.464 ** (0.216)	-0.680 ** (0.314)	0.056 (0.082)	18.7 ***
NLD	1986m4-2005m8	0.746 *** (0.209)	-0.508 *** (0.171)	-0.041 (0.038)	49.2 ***
BEL	1985m10-2005m9	1.23 (0.747)	-0.705 (0.613)	-0.028 (0.116)	26.2 ***
ESP	1986m6-2005m8	-0.836 (1.11)	0.272 (0.658)	-0.086 (0.078)	14.5 ***
DEU	1980m10-2005m8	0.857 (0.303)	-0.492 * (0.272)	0.017 (0.044)	4.92 ***
SWE [SCB]	1979q1-2001m12	-0.302 (0.523)	0.239 (0.311)	-0.029 (0.028)	1.31

NOTES: *, **, *** respectively denotes significance at the 10%, 5% and 1% levels. Newey-West standard errors in parentheses, max lags 12. [GLP] refers to UK Gallup data; [SCB] refers to quantitative SCB data.

Our results therefore reinforce the robustness of those obtained by Bryan and Palmqvist (2005) and suggest that the behavioural basis claimed by ADP for their theory is invalid. More broadly, the hypothesis of a U-shaped relation exclusively involving underprediction of inflation is at odds with empirical expectations data. The data shows that overpredictions are a common occurrence; furthermore, the formation of beliefs regarding inflation seems to rely more heavily on some sectors of the economy than others[7], and the composition of this information set can change over time and depending on circumstances.

Again, the evidence leads us to reject a "rule-of-thumb" based explanation for inflation expectations. This reinforces the results of Roberts (1997), who – using US suvey data – had reached the empirical conclusion that the observed deviations from rationality could not be adequately captured by a simple weighted-average of rational and adaptive expectations. Furthermore, this has an immediate and important policy implication, namely that of removing support for the view that the long-run Phillips curve might not be vertical due to ADP-type expectations effects.

4. The failure to safeguard rational expectations through information stickiness in Phillips Curves

A second approach explored in light of the failings of the NKPC has been that of information stickiness. In a seminal paper, Mankiw and Reis (2002) introduced a model of "sticky information", managing to retain rational expectations whilst correcting for several counterfactual predictions of more traditional NKPCs.

[7] One particularly interesting aspect of this issue concerns the relationship between the forecasts of experts and consumer inflation expectations. See Carroll (2003), Curto Millet (2007).

They argued that costs of information acquisition or reoptimisation[8] implied a slow diffusion of information in the economy, a concept which the authors formalised through the Calvo (1983) geometric structure: at any period in time, only a fraction λ of the population updates its information set and computes economic plans on this basis; the rest continue to act on the basis of outdated information. Crucially, when updating does take place, it does so *according to rational expectations*. Mankiw, Reis and Wolfers (2003) (henceforth "MRW") implemented this idea in the context of inflation expectations, implying the following equation for the aggregate expectation $\bar{p}^{e}_{t+12}$:

$$\bar{p}^{e}_{t+12} = l\sum_{j=0}^{\infty}(1-l)^{j}\hat{p}_{j,t+12}$$

Where j denotes how many months ago the information set was last updated for a proportion $l(1-l)^{j}$ of agents and $\hat{p}_{j,t+12}$ is the rational forecast made j months ago for inflation between t and t+12. The latter is approximated by the forecast from a VAR model.

As a test of the sticky information model, MRW (2003) offered a case study of the "Volcker disinflation", which followed the appointment of Paul Volcker as chairman of the Board of Governors of the Federal Reserve Bank in August 1979. The period following his appointment is of particular interest as it witnessed a very sharp fall in inflation from 11% to around 4% in 1982; the empirical consensus is that there was a serious structural break towards a more conservative policy (e.g. Clarida et al., 1998). In such a context, the sticky information model makes clear predictions as to the changes that one should expect for the distribution of inflation expectations. The predictions of the model are presented in Figure 2. These were generated by approximating the "rational forecasts" required by the sticky information model as the output of a VAR including monthly CPI inflation, the interest rate on 3-month Treasury bills and a measure of the output gap. The parameter λ of the model was calibrated by maximising the correlation between the interquartile range of inflation expectations in the survey data with that predicted by the model, leading the authors to set λ=0.10.

A number of distributional predictions of the model for an episode of strong disinflation are clear from the figure:

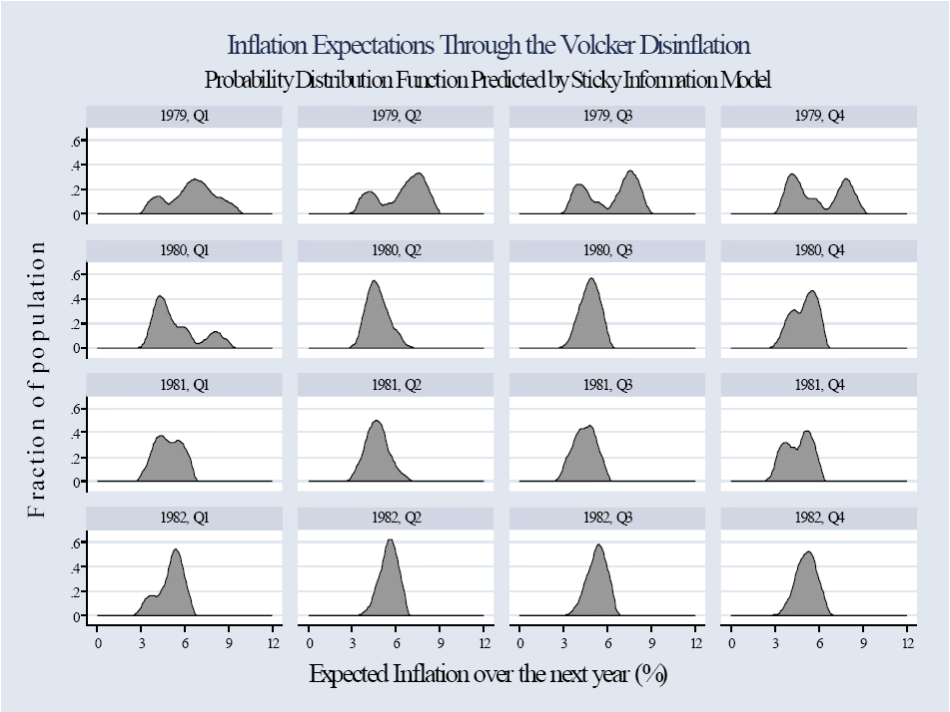
1. The shift towards the new distribution is gradual in nature;
2. The distribution of expectations flattens temporarily – its dispersion increases; and
3. In the process, the distribution becomes clearly bimodal, with a very visible trough between the two modes.

When contrasting these predictions with the actual developments in the data from the Michigan survey of consumers, the authors recognise that the model generates predictions that are "*too sharp*". However, this thought is taken no further and overall, MRW conclude that the model "*successfully accounts for broad features of the evolution of the distribution of inflation expectations during the Volcker disinflation*"[9].

[8] Reis (2005) has recently provided some microfoundations for this "inattentiveness".

[9] Mankiw, Reis and Wolfers (2003), p.48.

FIGURE 2: VOLCKER DISINFLATION, "STICKY INFORMATION" PREDICTIONS



SOURCE: Mankiw, Reis and Wolfers (2003), p.47.

Before examining these claims, we propose to throw new light on the issue through the consideration of an even sharper disinflation episode across the Atlantic – that associated with Britain's membership of the Exchange Rate Mechanism (ERM), starting on 8 October 1990 and ending with "Black Wednesday" on 16 September 1992. From a starting point of over 10% in August 1990, inflation fell to roughly 1.7% by January 1993. Most of the decline took place in 1991, with inflation being reduced to 4% by January 1992.

The data collected monthly by Gallup on samples of British employees contains some distributional information that allows us to study the evolution of disagreement through this historical episode. In particular, the *Gallup Political Index* and *Gallup Political and Economic Index* reports provide the proportions of respondents falling into a number of quantitative ranges. Table 7 lists these by providing the data for January 1991 as an example.

For the following exercise, we dropped the "don't know" category and only considered the answers of the respondents having addressed the question, re-weighting the proportions so that they would sum to 100. We propose to analyse the changes in the distribution of expectations from the start of the disinflation to the end in some detail. To provide some guidance as to the shape of the underlying distribution, we estimated univariate kernel densities and plotted them alongside the relevant histograms. We used the Epanechnikov kernel function to perform these particular calculations.

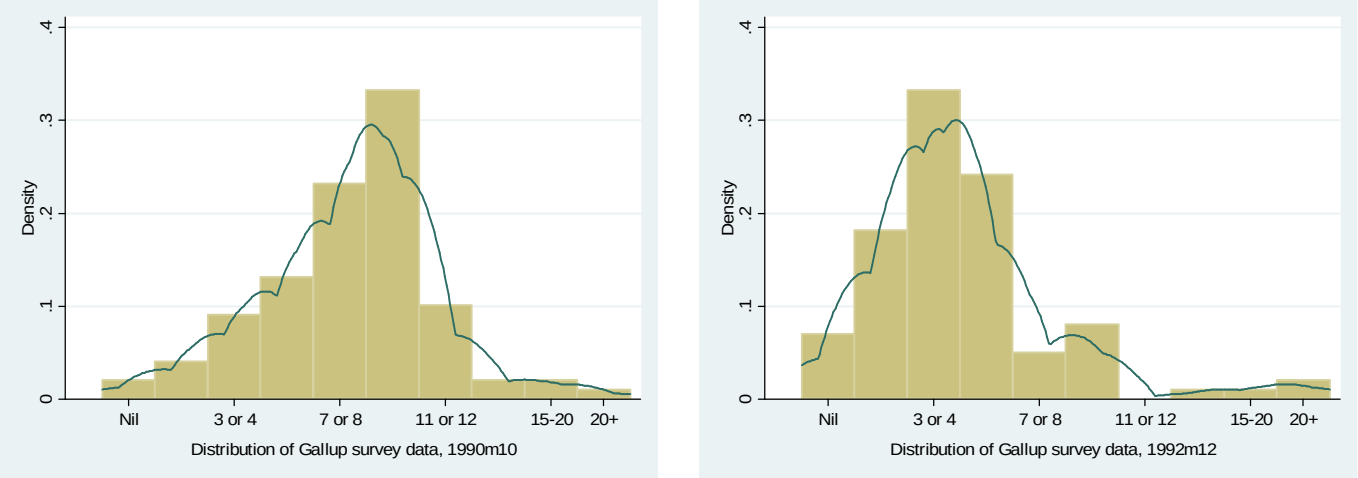
Figure 3 shows the distribution of expectations at the start (October 1990) and end (December 1992) of the disinflation process. Both distributions appear to be unimodal, but with very different modes; whereas at the start of the transition, the mode could be located around 9%, by the end this had shifted all the way down to between 3 and 4%. Figure 4 examines a number of key points between these two pictures that shed light on the issues at hand. We focus on the year 1991, as the sharpest part of the disinflation occurs during it, thereby yielding the clearest insights.

TABLE 7: UK INFLATION EXPECTATIONS, DISTRIBUTION DATA, 1991m1

Category	Proportion of Responses (%)	Category	Proportion of Responses (%)
Nil	2 %	**11 or 12 %**	6 %
1 or 2 %	3 %	**13 or 14 %**	2 %
3 or 4 %	4 %	**15-20 %**	4 %
5 or 6 %	14 %	**20+ %**	1 %
7 or 8 %	16 %	**Don't know**	20 %
9 or 10 %	28 %		

SOURCE: Gallup Political and Economic Index Report, January 1991

FIGURE 3: UK EXPECTATIONS, ERM DISINFLATION, ENDPOINTS



SOURCE: Gallup Political and Economic Index Reports, various issues, and own calculations

Contrasting the distributions for October and December 1990 in Figure 4, it appears that the mode at 9-10% inflation has increased despite the start of the disinflation, a phenomenon which could perhaps reflect some momentum in inflation expectations. We note however that the categories "5-6%" and "7-8%" are also attracting a significant share of responses, and that the former category has indeed increased noticeably between these two dates. The evolution over the following three plots – concerning January, April and May 1991 – is of particular interest. Indeed, there appears to be a very clear and gradual shift of responses from the "9-10%" category to the two categories immediately below it, in particular. As a result, the mode of the distribution is decreasing, a point reinforced by the plots relating to August and December of that year. Thus, by the end of 1991 the mode of the distribution was located at about 5%.

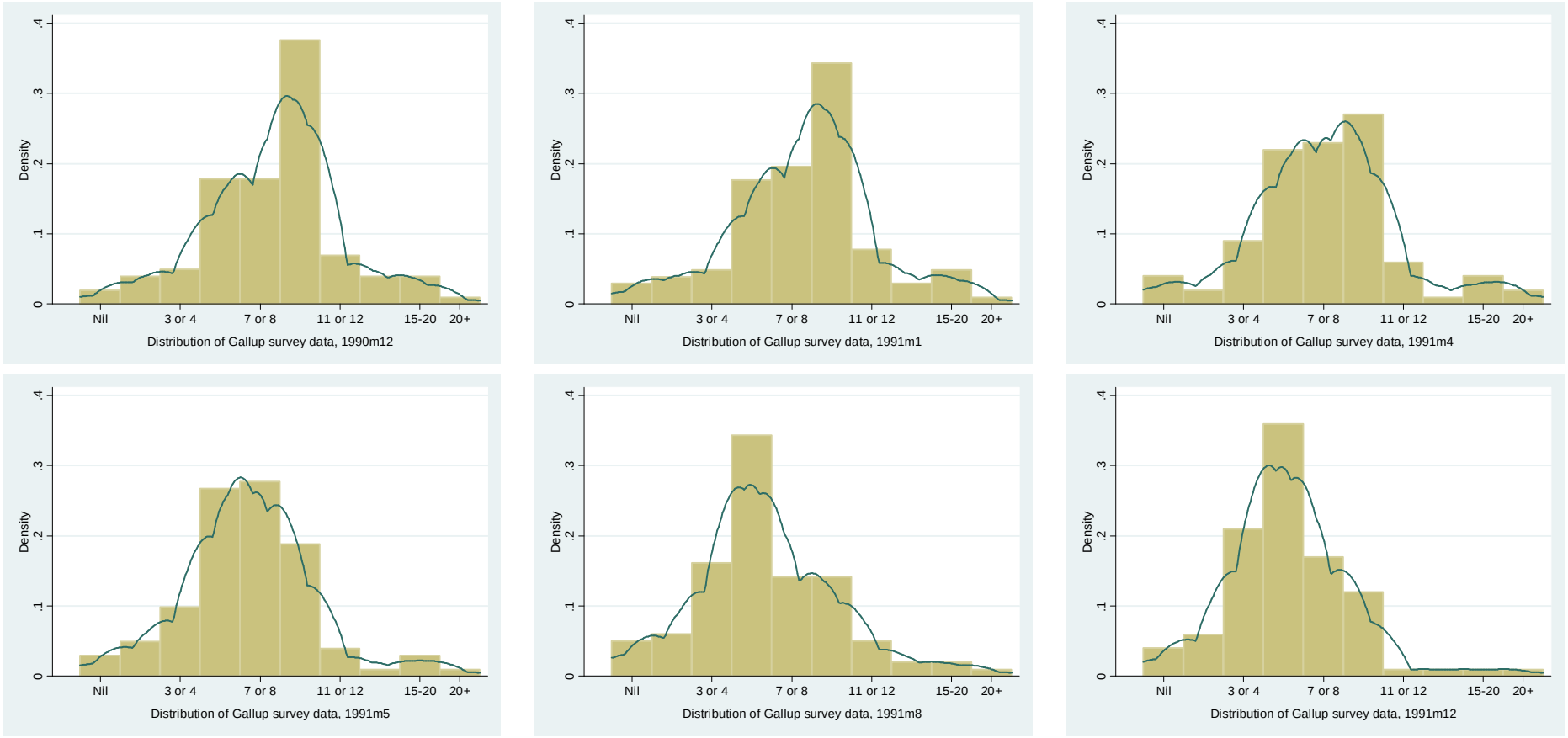
A number of comments can be drawn from this episode regarding the three predictions of the sticky information model:

1. The shift towards the new distribution does indeed appear to be gradual, in accordance with the model.

2. The distribution of expectations does flatten somewhat during the transition process, a development that is also in accordance with the theory.

3. However, there is no evidence for the strong bimodality developments that are so clearly predicted by the theory.

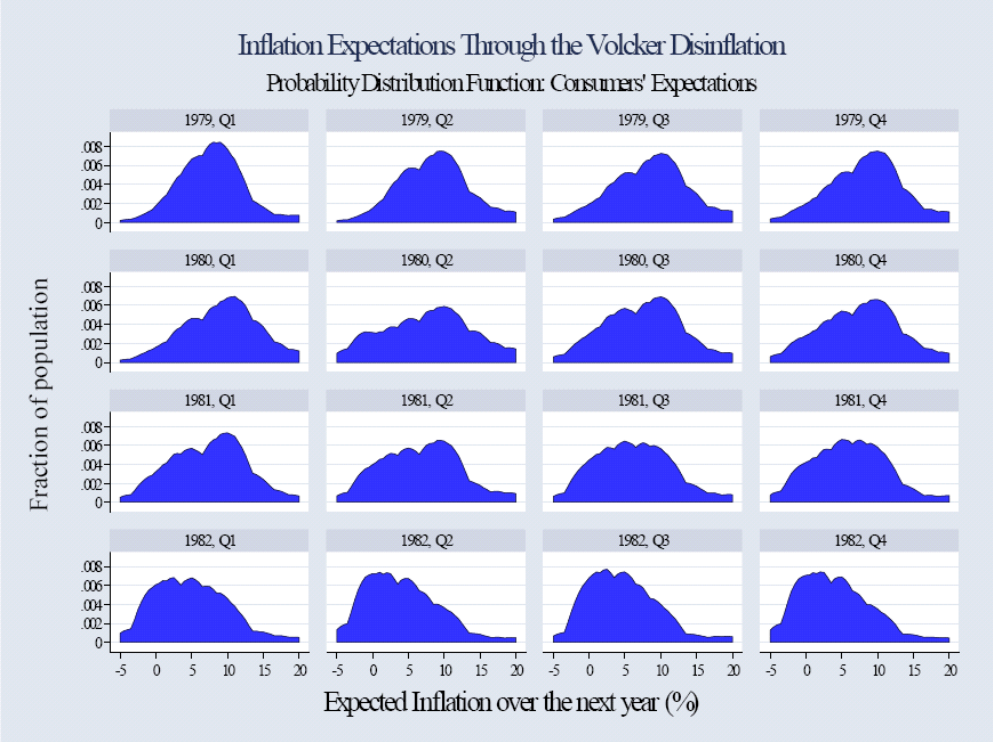
FIGURE 4: UK EXPECTATIONS DISTRIBUTION & THE ERM DISINFLATION, DETAIL



SOURCE: Gallup Political and Economic Index Reports, various issues, and own calculations

Exactly the same conclusions can in fact be drawn from a consideration of US consumer inflation expectations from the Michigan survey during the Volcker disinflation. This is clearly visible in Figure 5.

FIGURE 5: US INFLATION EXPECTATIONS, VOLCKER DISINFLATION



SOURCE: Mankiw, Reis and Wolfers (2003), p.46.

Thus, in both episodes the data appears to seriously contradict the bimodality implications of the model. As was noted earlier, MRW do recognise that the predictions of the model are "too sharp"; however, they do not consider that such findings actually imply a different shape for the process of expectations updating.

The reason behind the bimodality prediction of the model is essentially the assumption of updating to a "rational forecast" when an opportunity becomes available. Thus, at the beginning of a strong disinflation process, the fraction λ of agents that have an opportunity to update their expectations do so by dramatically reducing their forecast. This leads to the creation of a second, lower mode in the distribution. This new mode keeps gaining probability weight as more and more agents are able to update their forecasts, generating a very visible bimodal distribution with a clear trough between the modes. Eventually, when most agents have had a chance to accomplish an update, the distribution becomes unimodal once again, at the lower mode.

The actual distributional data is consistent with MRW's intuition that different agents hold different expectations, which appear to be based on information that is more or less recently updated; there does indeed seem to be a gradual adjustment process to new conditions. However, the process seems to be more *adaptive* than *rational*. The probability mass in the plots shifts downwards, *accompanying* rather than *anticipating* the fall in inflation.

This view is fully consistent with the behaviour of the inflation expectations data, documented more extensively in Curto Millet (2007), and would also address another criticism of Mankiw and Reis' (2002) work. Indeed, when considering their particular form of expectations updating in a Phillips curve framework the authors are forced to rely on serial correlation of money to explain inflation persistence (Mash, 2004), which is a somewhat ad hoc justification.

5. Insights for monetary policy

Expectations influence the decisions of economic agents, and as such are of consequence for the outcomes of interest targeted by monetary policy. For instance, inflation expectations have been found to have a significant influence in wage equations estimated for seven European countries (Curto Millet, 2007). Such an influence straightforwardly translates into consequences for inflation and unemployment. A sound understanding of the process through which these are generated is therefore of paramount importance.

Surveys providing distributional information yield several key insights for monetary policy. Such information is notably available for inflation expectations through the UK Gallup survey, as noted earlier, and for both inflation perceptions and expectations through the quarterly Bank of England / NOP survey (see Bank of England, 2001-2005 for details), which was initiated in November 1999[10]. On this basis, we wish to highlight two related findings.

First, Bank of England (2005) noted that the median series for perceptions and expectations moved closely together, and that indeed the *distributions* underlying both sets of data were themselves similar. This finding is developed in Curto Millet (2007), who also reaches an analogous result on the basis of historical data underlying the EC Consumer Survey[11]. This suggests a somewhat adaptive behaviour on the part of consumers – who seem to project perceptions into the future when forming expectations, to a large extent.

Second, we are unable to find any clear relationship between major changes in the monetary policymaking process and the behaviour of inflation expectations. The possibility that there might be such a relationship was explored by examining the British experience in some detail, given the status of the country as an early and notable inflation targeter. Key reforms have included: the introduction of a first annual RPIX inflation target of 1-4% in October 1992; the modification of the target to 2.5% RPIX or less in June 1995; the granting of operational independence to the Bank of England in May 1997, and the setting of a symmetric target around 2.5% in June of the same year; and finally, the announced switch to an inflation target of 2% on the basis of the HICP index in December 2003.

We will now consider whether there is any visible effect of these policy changes on the distribution of expectations. Figure 6 presents the distribution of expectations for the Gallup data for the month of January in the years 1992-1997; Figure 7 carries out the same exercise for the BOE/NOP responses in the first quarter of the years 2000-2005.

[10] The BOE/NOP survey offers respondents a set inflation ranges to choose from. In this respect, the survey is quite different from its Gallup counterpart, which used an open-ended question but reported distributional information in "range format".

[11] The period around the physical introduction of the Euro currency is subject to particular disturbances which are analysed in the work referenced.

FIGURE 6: UK INFLATION EXPECTATIONS, GALLUP DATA

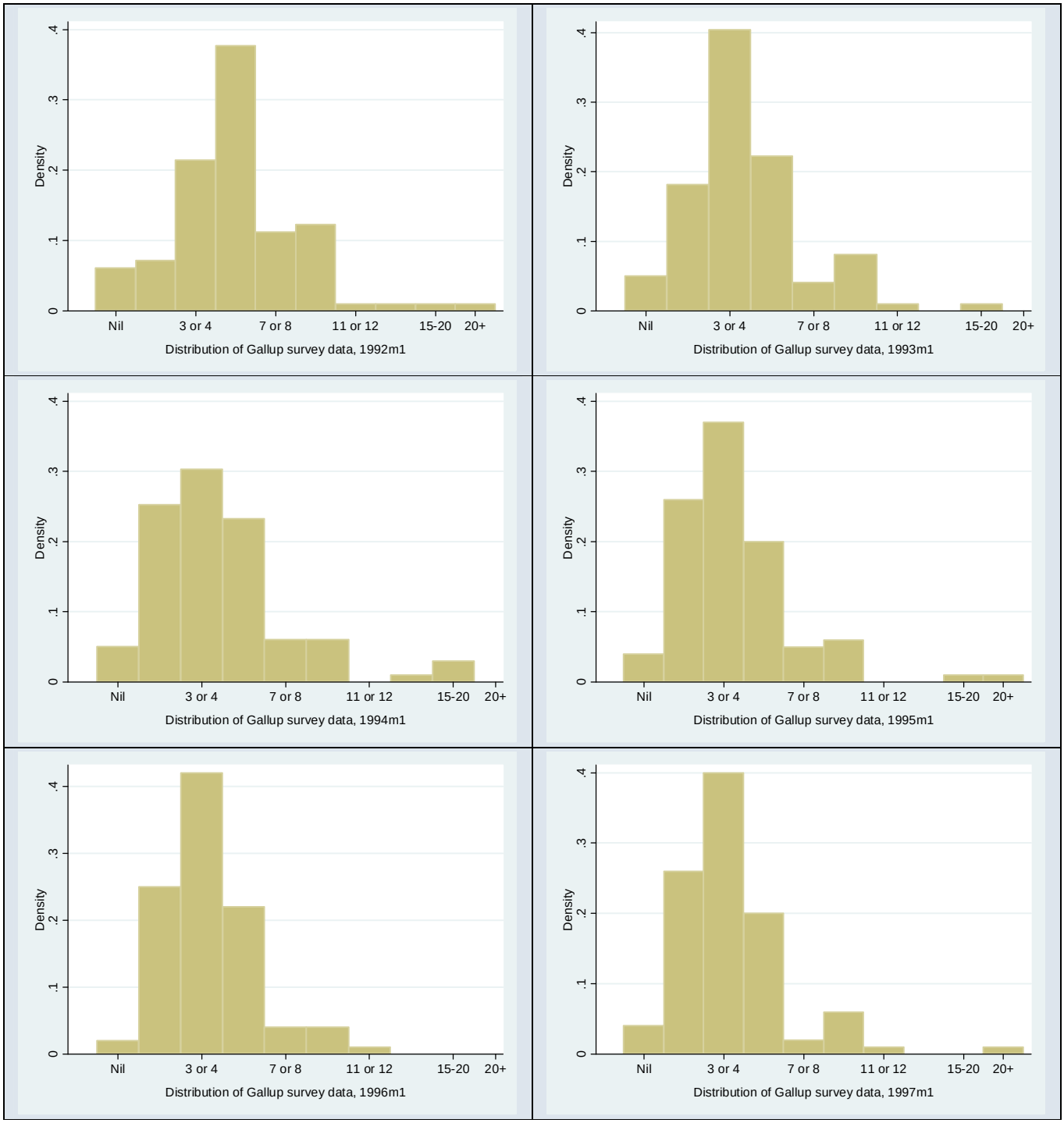
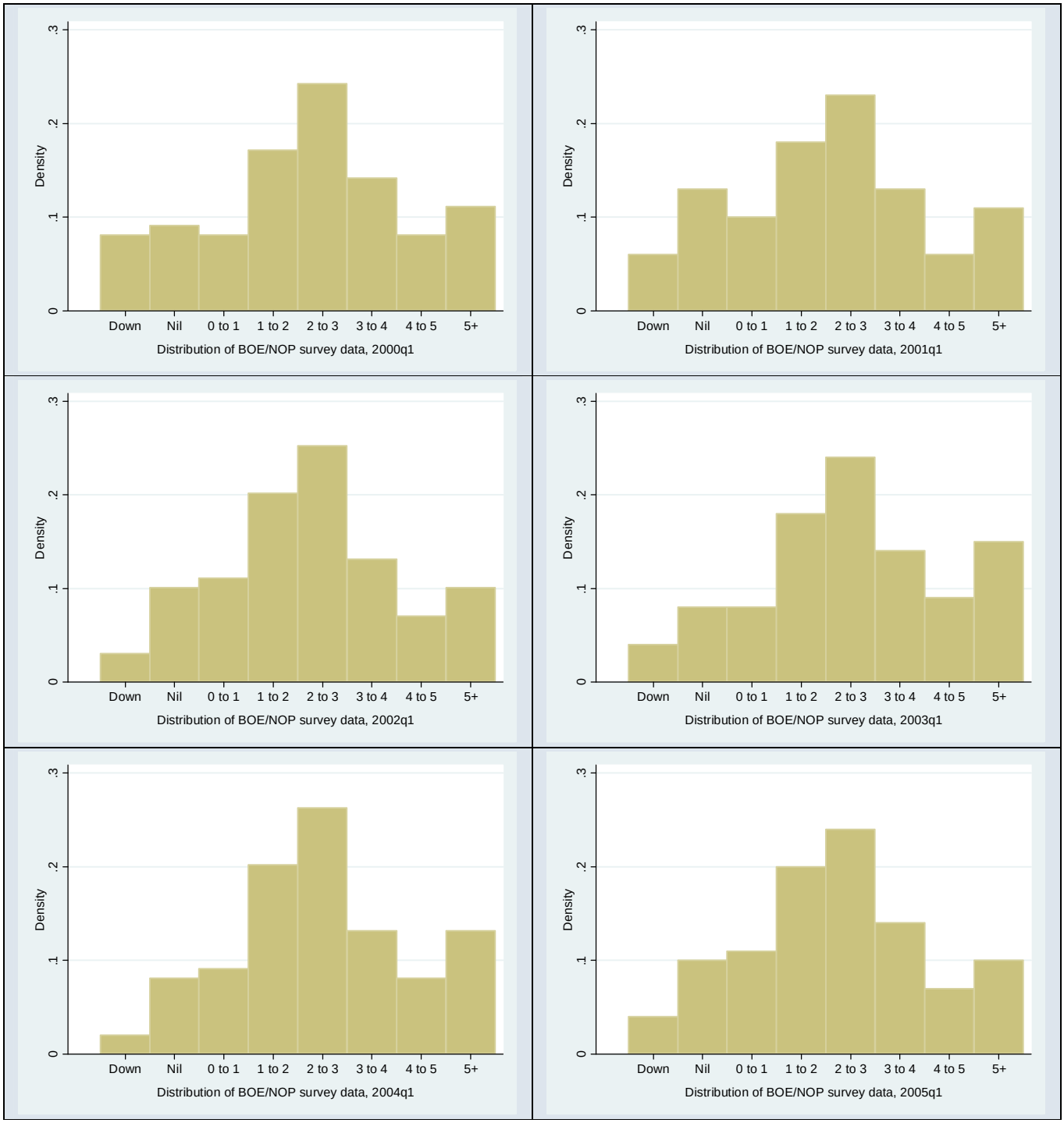


FIGURE 7: UK INFLATION EXPECTATIONS, BOE/NOP DATA



The only notable evolution in the expectations distributions presented in Figure 6 is the switch in the mode from "5 or 6%" to "3 or 4%" that takes place in the second half of 1992; the rest of the plots essentially show fluctuations in the salience of the mode but no major changes otherwise. In particular, there appears to be no significant reaction to the switchover from a range inflation target to a symmetrical point target of 2.5% in June 1995; indeed, the mode of the distribution overshoots this in both the 1996 and 1997 plots. Similar qualitative

findings apply for the expectations distributions shown in Figure 7 relating to the BOE/NOP survey. The mode is located at "2 to 3%" and the distribution appears to be stable around it over the period. This is consistent with the RPIX inflation target of 2.5%. However, there is no sign that the switch to a 2% HICP target had any effect on the distribution.

The UK data is therefore consistent with a situation in which the public has come to expect inflation to be in a relatively low range – about 80% of the views expressed fall in the 0-4% region. There does not seem to be any direct "magic" about the operation of the inflation targeting framework other than the fact that it creates low and stable inflation, to which the public "gets used to" in a predominantly adaptive manner.

This contradicts the conclusion reached by Bryan and Palmqvist (2005). These authors considered distributional data for inflation expectations in Sweden and the US, and noted an extremely significant jump in the response proportion corresponding to zero inflation expectations in Sweden over the period 1991-1999, a jump that was not mirrored in the US data (nor is in the UK data presented above). They noted that this difference arose "*despite the fact that the nations followed the same inflation trend over roughly the same period*"[12]. In their view, this would "*suggest that the findings are a consequence of a changed policy*"[13] and in particular that "*inflation targeting in Sweden has substantially increased the proportion of Swedes who ignore inflation*"[14] – thereby crediting the inflation targeting objective of the Riksbank centred at 2% for this significant development, and explaining the popularity of the "zero" response relative to the "2%" option as a consequence of a greater understanding by the public of the objective of "price stability" than of the specific inflation target.

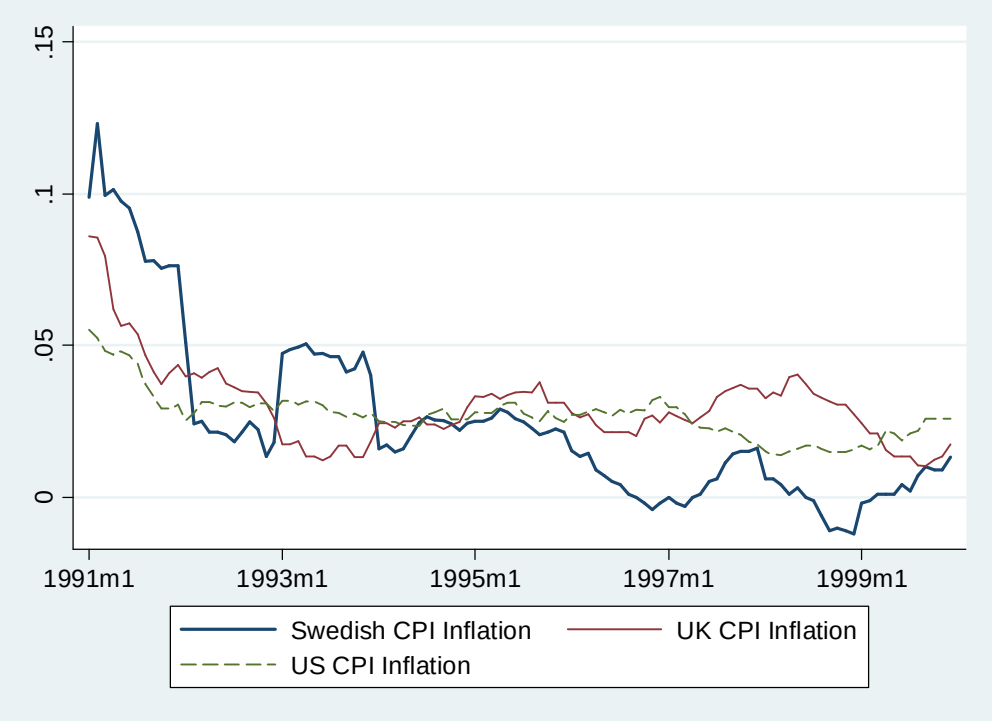
This important discrepancy across countries may however have a more straightforward explanation. Indeed, the claim that the countries followed the same inflation trend over the relevant period masks an important divergence in this respect. Figure 8 plots CPI inflation (all items) in Sweden, the US and the UK over the period of concern (1991-1999). As is clear from the plot, Swedish CPI inflation has been inferior to that in the other two countries from the end of 1994 onwards. It has taken values close to zero and has even moved into the area of deflation at several points. Such a period of extremely low inflation/deflation is an important development; indeed, actual deflation is a rather unusual event, and leads to the suspicion that expectations should be affected proportionately. This is not highlighted in Bryan and Palmqvist (2005), as the authors are instead considering core CPI inflation for Sweden, which shows broadly the same qualitative characteristics but does not actually move into negative territory. The core CPI measure in Sweden (UND1X) excludes mortgage rates, as well as the direct effects of changes in indirect taxes and subsidies. However, an important reason for the behaviour of actual CPI at the end of 1998 and the beginning of 1999 was an easing of monetary policy, with the consequence of lower interest expenditure for households; this situation was even accompanied by a number of "eye-catching media headlines on the threat of deflation" (Sveriges Riksbank, 2003). This could well be the reason for the dramatic increase in "zero inflation" responses observed, rather than any direct linkage to the policy regime. Such an interpretation would then make the US, Swedish and British findings consistent.

[12] Bryan and Palmqvist (2005), p.29.

[13] Bryan and Palmqvist (2005), p.29.

[14] Bryan and Palmqvist (2005), p.31.

FIGURE 8: US, SWEDEN AND UK, 1991-1999 CPI INFLATION



The results presented here emphasise the importance of neither over- nor underestimating the influence of policy on the minds of the general public. Indeed, the British evidence does not reveal the image of a nation of consumers paying daily attention to the evolution of its inflation targeting system or institutions. On the other hand, the distribution of expectations does evidently respond to inflation regimes. Thus, consumers certainly acknowledge good policy in their own way – gradually.

6. Conclusion

Several key ideas have been put forward in this paper.

First, it is clear from the evidence that the concept of rational expectations is empirically bankrupt, and that any additional constructions relying on its support – such as New Keynesian Phillips Curves – are bound to be unreliable. Importantly, the rational perceptions hypothesis – which had to date only been tested in conjunction with the rational expectations hypothesis – has been found to be rejected by the data, with consumers routinely over- or underweighting inflation components, and altogether ignoring some. This evidence calls for a fundamental rethink of the level of rationality economic theory has endowed upon the agents that are the object of its study.

Second, ad hoc fixes aiming to describe expectations as a simple composite of rational expectations and some other process (described above as “rule-of-thumb” expectations) are found to be unstable and inadequate descriptions of the data. This in turn questions the validity of Phillips curves relying on such an assumption, and in particular the argument made by Akerlof et al. (2000) in favour of a non-vertical long-run Phillips curve.

Third, the modern remedy proposed by Mankiw and Reis (2002) to the ailments of rational expectations macroeconomics through the introduction of "information stickiness" is found to be inadequate due to an updating process that still maintains rational expectations at its core. However, the idea of agents going through a process of *gradual* adjustment is very much in tune with both the data and intuition.

Finally, we emphasised some insights for monetary policy that can gained from an examination of distributional data on inflation perceptions and expectations. This data reveals the importance of *adaptive* and *gradual* behaviour on the part of agents, implying an eventual sensitivity to regime changes but no drastic or immediate response as a rule – not even to important innovations to the monetary policymaking process, such as the introduction of inflation targeting.

Inflation expectations are generated through complex processes, and it is admittedly not straightforward to specify satisfactory conditional density functions to model them – especially given the possibility of their displaying "animal spirits" movements. Perhaps as a consequence, the last few decades have been marked by a considerable amount of "theory-mining". The time is ripe for an equilibration of the situation; indeed, theory dependence can easily be as dangerous as data dependence.

APPENDIX

The problem of measuring inflation expectations

The measurement of inflation expectations in this paper is based on data from four consumer surveys. Survey evidence presents clear advantages over alternative methods for measuring expectations, including a firm grounding on data rather than ad hoc assumptions and coverage of the population of interest[15].

First, we use the European Commission's Consumer Survey to derive numerical measures of inflation perceptions and expectations. Participants in the survey are asked the questions listed in Table A, which yield data that is qualitative in nature. In order to quantify it, we use a variation of the Carlson Parkin methodology (Carlson and Parkin, 1975; Batchelor and Orr, 1988; Berk, 1999) proposed in Curto Millet (2004). In broad terms, the Carlson Parkin approach relies on making an assumption regarding the shapes of the aggregate distributions of expectations and perceptions. In our case, the assumption of normality was retained due to theoretical justifications through central limit theory and satisfactory performance in previous empirical work (Berk, 1999; Nielsen, 2003a).

TABLE A: EC CONSUMER SURVEY, QUESTIONS 5 AND 6

Q5. How do you think that consumer prices have developed over the last 12 months? They have…	**Q6. By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months? They will …**
1 risen a lot	1 increase more rapidly
2 risen moderately	2 increase at the same rate
3 risen slightly	3 increase at a slower rate
4 stayed about the same	4 stay about the same
5 fallen	5 fall
9 don't know.	9 don't know.

The shares of responses falling in each answer category in Table A are then interpreted as maximum likelihood estimates of areas under the aggregate density function of inflation expectations, that is, as probabilities. An estimate of mean expectations and perceptions can then be derived by exploiting the linkage between both questions, and using a measure of actual inflation as a scaling factor for mean inflation perceptions[16].

Second, we use data from three quantitative surveys on inflation expectations: monthly surveys on inflation expectations covering the period 1983-1997 for the UK ("the Gallup Survey"); Swedish data on both inflation perceptions and expectations from the Households' Purchasing Plans Survey ("the HIP Survey") – collected quarterly from 1979 and monthly from 1993; and data from the quarterly Bank of England / NOP survey, initiated in November 1999. These surveys directly ask consumers for quantitative estimates, thereby obviating the need for prior quantification before use.

[15] For a discussion of alternative approaches, please refer to Curto Millet (2007).

[16] Please refer to Curto Millet (2007) for details.

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