Relative Price Shocks, Inflation Expectations, and the Role of Monetary Policy

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Abstract

The aim of this paper is to rely on a wide variety of forecasts and survey-based estimates of inflationary expectations since the early 1990s for a group of nine economies, five of which explicitly target inflation, and ask: to what extent are disagreements over forecasts of inflation driven by movements in relative prices? The empirical evidence leads to the following conclusions. First, there is little doubt that inflation targeting has contributed to narrowing the forecast differences *vis-à-vis* inflation forecasts for the United States. Second, there is some evidence that, at least since 1990, inflation forecasts in the economies considered that had deviated substantially from US forecasts show signs of converging towards US expectations. Third, examining the mean of the distribution of forecasts potentially omits important insights about what drives inflation expectations. Finally, commodity and asset prices clearly move inflation forecasts, although this is a phenomenon of the second half of the sample. Prior to around 1999 relative price effects on expectations are insignificant.

1. Introduction

The last two decades have seen a remarkable convergence in inflation rates around the world. The role that monetary policy plays in achieving this outcome continues to be debated. There is, of course, a long tradition in the profession linking inflation performance to monetary policy. For example, during the depths of the Great Depression, in a landmark 1932 study of commodity prices covering two centuries of data, Warren and Pearson (1932) remarked: 'Any price level that is out

of adjustment with the monetary situation should not be expected to be maintained permanently' (p 67). A look at any of the recent inflation reports published by several central banks would doubtlessly produce very similar sentiments about the behaviour of inflation. Yet, there is also a case to be made that economists have yet to fully grasp the dynamics of inflation (for example, Bernanke 2008). This state of affairs also carries over to our understanding of what moves inflation forecasts. Adding to the mix, sharp movements in both commodity and asset prices in recent years (see Section 3 below) raise a host of questions about what factors drive expectations of inflation (see also Reis and Watson 2009).

The financial and economic crisis that began in July–August 2007 only deepens the mystery about what influences inflation rates around the world since aggregate price level movements have been relatively benign over the past two years, at least in the industrialised world. There has been no shortage, however, of commentary by central banking officials and other analysts over prospects of a spiralling inflation or deflation.[2] As Trichet (2009) remarked concerning the conduct of monetary policy in turbulent times: '… the evidence supports the view that a central bank's ability to ease monetary conditions – and thereby support the stabilisation of inflation and output – is significantly enhanced by its ability to anchor private expectations'. However, what explains this ability to anchor expectations, and the role played by the monetary policy regime in place, remains open to debate and more research. Therefore, studying the determinants of inflation and, in particular, how relative price shocks interact with inflationary expectations remains an important task.

Adding to the difficulties in our understanding of the inflationary process is the fact that observers of inflation forecasts normally have very little information about the model, or models, that were used to generate a forecast, or the extent to which certain economic variables (for example, commodity prices), as opposed to informed judgment, drive changes in forecasts over time. The problem of identifying the signal from the noise is, of course, an old one.

This paper relies on a wide variety of forecasts and survey-based estimates of inflationary expectations since the early 1990s for a group of nine economies, five of which explicitly target inflation, and asks: to what extent are disagreements over forecasts of inflation driven by movements in relative prices? As there has been considerable interest about whether inflation has been driven by global factors, it is equally important to examine to what extent inflationary expectations are idiosyncratic or driven by factors common to all the economies considered. A variety of subsidiary issues also emerge from the questions that this paper sets out to explore. For example, while small changes in commodity prices may have no significant effect on inflation forecasts, larger changes could have a substantial influence on inflation forecasts. As we shall see, this asymmetric effect appears plausible. In this regard, it is also of interest to examine the extent to which large shocks have permanent or transitory effects on inflationary expectations. Moreover,

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2. Worries over whether the fiscal stimuli in place in many parts of the world will work has led to suggestions that a 'little' inflation (for example, 2 to 3 per cent) is preferable to near-zero current levels. Others worry that inflation, once unleashed, cannot be controlled with such precision.

it is also natural to consider whether these sorts of effects are influenced by the adoption of inflation targeting.

Disagreements about inflationary expectations are almost always defined in terms of a distribution of forecasts prepared in individual countries and are presumably focused on the determinants of the domestic inflationary experience.[3] In the present study I depart from this norm to consider disagreement relative to a different benchmark, namely the US experience. This is done for at least three reasons. First, on both historical and economic grounds, the US experience with inflation remains a useful benchmark, particularly over my sample periods given the earlier success in controlling inflation in the United States. Needless to say, there is considerable debate about the role played by the US Federal Reserve (Fed). While Fed officials have long defended their dual mandate, the recent fashion in central banking and policy-making circles has been to adopt a form of inflation targeting (for example, see Siklos 2009a and references therein). The extent to which this distinction matters is an ongoing research topic. Finally, the decade of the 1990s and early 2000s was a period of substantial globalisation, for both finance and trade. Hence, it is reasonable to posit that inflationary expectations also contain a global element. Consequently, if US inflation and inflation expectations represent a global benchmark, then it is sensible for forecasters, businesses and households to take this information into account perhaps in a more explicit fashion than has heretofore been the case.

An additional contribution of the present study is to generate evidence about the behaviour of inflation expectations by exploiting as broad a sample in terms of the number of forecasts or forecasters as I was able to collect for each economy. Thus, for example, for the United States, Japan, and the euro area, inflation expectations from almost a dozen sources are considered. This comprehensive dataset provides us with some new insights into the behaviour of inflation expectations over time.

The rest of the paper is organised as follows. In the following section I provide a brief overview of the literature linking relative price shocks and central bank strategies to inflation and expectations of inflation. Section 3 introduces the data and provides a bird's eye view of the stylised facts. Section 4 presents some econometric evidence which relies on a variety of techniques, each of which is aimed at providing evidence about the various questions raised in this study. Section 5 concludes. Appendix A documents the inflation forecasts used in this paper and the sources of those forecasts.

2.   Relative Price Shocks, Inflation and Monetary Policy

It is perhaps surprising that some prominent economists claim we do not sufficiently understand the dynamics of inflation. Nevertheless, we have learned a great deal about the determinants of inflation over the past decade or so, no doubt assisted by

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3.   In related work, I am investigating disagreement in inflation expectations across a wider set of economies than considered here relying on this more conventional benchmark. In addition, I am considering whether there are cross-country divergences that depend on whether or not the economy in question is an emerging market.

the spread of inflation targeting around the world.[4] What follows then is a concise summary of the existing consensus about some stylised facts.

First, while inflation is persistent, it appears to have fallen substantially in many parts of the world (Benati 2008), possibly more so in inflation-targeting (IT) economies than elsewhere (for example, Siklos 1999a). Whether the combination of lower and more stable inflation has led to expectations of inflation becoming better anchored remains unsettled (for example, Bernanke 2007, Mishkin 2007a, and references therein). Two sets of questions arise here. Can we say whether certain monetary policy regimes (for example, inflation targeting) are better able to hold down inflation expectations than others? If this is the case, what are the sources of disagreements in expectations? It may be that an unstable economic environment leads to persistent deviations in inflation expectations from a path to which the monetary authority plans to adhere. It is also possible that inflation expectations react excessively to relative price shocks, particularly ones that are large and believed to contain a significant permanent component. A relevant consideration here is that the literature has not come to a definitive understanding over how such disagreements are to be measured (for example, see Lahiri and Sheng 2008, and references therein).[5] It should be emphasised at this stage that data limitations pose a serious constraint on the information that can be extracted from inflation forecast and survey data.[6] It is typically the case that point forecasts are used. However, other than for a very few economies (for example, the United States and the United Kingdom), researchers generally do not have access to the distribution of forecasts. This consideration can be crucial since, as shown by Mankiw, Reis and Wolfers (2004), the information content of mean or median forecasts can mask considerable underlying forecast disagreements.[7]

Second, the notion that expectations are rational, which leads to the testable implication that they are both correct, on average, and efficient and unbiased, does imply that there is little additional information that could have been brought to bear to improve on them. It can be said, rather charitably, that this view has

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4. Cecchetti *et al* (2007) provide a comprehensive overview of what drives inflation in a cross-section of countries.

5. In what follows, this paper uses the concept of 'forecast disagreement', defined by what is essentially one of the moments in the distribution of inflation forecasts.

6. There is another important type of data limitation that is the subject of ongoing research with the dataset used in the present study, namely the difficulties posed in forecasting inflation because of disagreement over the measurement of the output gap and the resort to revised data, as opposed to the real-time data that is more germane to the information set that would be used by forecasters in preparing forecasts over time. Clearly, these are important considerations but space limitations prevent further discussion here.

7. In recent years there has been a burgeoning interest in so-called density forecasts, namely an estimate of the probability distribution of possible future values of the variable in question. For a recent survey, see Tay and Wallis (2000). An example of a distribution of forecasts is the Survey of Professional Forecasters in the United States. Part of the appeal of density forecasts is that they can capture asymmetries that could be of considerable interest to policy-makers. In particular, if short-run expectations of inflation are higher than the mean inflation rate, forecasts are generally negatively skewed while the opposite holds when inflation is below its historical mean.

received mixed support.[8] In any event, the view that forecasts are rational and/or unbiased contradicts the increased emphasis placed by central banks on improving and intensifying their communication function (for example, Blinder *et al* 2008). Then there is the literature that points out fairly convincingly not only that learning takes place in any economic environment but that the policy regime itself can assist in the learning process (for example, Sargent 1999 and Orphanides and Williams 2007).

Third, contrary to what one might believe *a priori*, the low and stable inflationary environment of the past 15 years or so has not necessarily made inflation easier to forecast. Indeed, arguably the most widely used inflation model in the profession, namely a New Keynesian-style Phillips curve, performs rather poorly (for example, Rudd and Whelan 2007 and Stock and Watson 2007) in spite of its strong micro-foundations (for example, Kiley 2008). There continues to be a wide-ranging debate about the links between inflation and inflation expectations, and the relative weight that ought to be placed on certain factors over others. For example, for a time, there was increasingly prominent discussion devoted to the influence of price developments in China as a source for global disinflation (for example, Rogoff 2003, Ball 2006, Borio and Filardo 2007, Ihrig *et al* 2007 and Côté and de Resende 2008). However, it proves to be extremely difficult to identify a separate role for China from the impact of the global consensus in favour of lower inflation or, for that matter, the role played by institutional mechanisms that ensure that low inflation remains in place (for example, Acemoglu *et al* 2008, and Bohl, Mayes and Siklos, forthcoming). Beyond these considerations, there is the apparent tenuous connection between expectations and actual inflation rates (for example, Blinder 1999) which must be contrasted with the view that the public does care very much about inflation (for example, Shiller 1997). The relationship between these two crucial variables is further complicated by the evidence that pass-through effects, either via the exchange rate, or through the influence of changes in commodity prices, have diminished considerably in recent years (for example, Hooker 2002 and Gagnon and Ihrig 2004). Interestingly, investigations of the behaviour of commodity prices, for example, and how their movements are linked to ones in aggregate price levels, generally fail to exploit the possibility that the appropriate relationship is asymmetric

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8. Testing such hypotheses requires estimation of the following specification: $a_t = \alpha_0 + \alpha_1 f_{1,t-1} + e_{t|t-1}$, where a is the realised value of the variable of interest, here inflation, and $f_{1,t-1}$ is, say, the one-year-ahead inflation forecast, conditional on information available at time t–1. Unbiasedness requires the non-rejection of the null $\alpha_0 = 0, \alpha_1 = 1$. Efficiency also requires that no additional useful information can be used to improve upon existing forecasts. This implies that, if $\mathbf{X}_t$ represents a vector of omitted variables, this could not statistically explain $a_{t+1} - f_{1|t}$, that is, the forecast error. Given the form in which most forecasts are presented (see below), there are potentially additional econometric problems stemming from serial correlation in the errors to name just one hurdle with this testing framework.

in nature.[9] Hence, a rise in oil prices might feed into inflation rates more quickly, and remain more persistent, than a reduction in the price of oil.[10]

Brief mention also ought to be made about the horizon over which expectations are evaluated and how these are constructed. Only a handful of industrial countries have developed inflation-indexed bond markets which provide researchers with a source of data on long-run inflationary expectations. Moreover, the extent to which these markets are liquid, and the length of time they have been in place, also pose additional constraints for a cross-country study of the kind undertaken here. It is also the case that there is a paucity of survey or other longer-horizon forecasts for a large cross-section of countries.[11] This is unfortunate since this information directly pertains to the role of the monetary policy regime.[12] Accordingly, the empirical evidence that follows focuses on short-term forecasts. If there is a significant probability that any existing regime will change – a likelihood that may well have risen in some cases in light of the Global Financial Crisis, even though there are few outward signs that policy-makers are contemplating changing their monetary policy regime – then one factor that explains what drives inflation expectations will have been omitted. Otherwise, the empirical evidence below provides some evidence about the role of central banks, their policies, as well as the influence of relative prices, on the evolution of inflationary expectations.

Most studies rely on forecast or expectations data from one or a very small number of sources. For example, an analysis of the properties of inflation forecast errors is usually conducted on a single forecast from a public institution (such as the IMF or the OECD), a private firm (such as Consensus Economics), or a formal survey of forecasters (such as the Survey of Professional Forecasters). It is interesting to consider, however, whether the source provides any additional clues about what drives the forecasts and this study is an attempt to do so.[13]

Finally, there has been considerable debate about the desirability of the central bank publishing its own forecasts. There is no consensus about this question and it is inappropriate here to delve into the relevant issues (see, however, Mishkin 2007b, Ch 5). Nevertheless, it is worth considering such forecasts as well. They, together with forecasts from other sources, provide indirect clues about whether, *ex post*, prior beliefs about differences in information sets that go into producing such forecasts explain how well expectations are anchored. They also provide clues about how

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9. Of course, asymmetries, for example, in the movement of oil prices are well known (see Hamilton 2009, and references therein). What is less well understood is whether changes in commodity prices also feed into the aggregate price level in an asymmetric fashion.

10. This type of asymmetry may not, however, always have operated in this fashion. For example, in a well-known study (Warren and Pearson 1932), the asymmetry went in the other direction in the period over which commodity prices were examined (1814–1931).

11. Consensus forecasts do exist for the 10-year horizon for a relatively small number of countries.

12. There is some evidence that inflation contains a long memory component (for example, see Hassler and Wolters 1995; Baillie, Chung and Tieslau 1996; and Siklos 1999b).

13. Alternatively, one might examine forecast dispersion among the forecasters surveyed by a particular firm, such as Consensus Economics. A recent example is Dovern, Fritsche and Slacalek (2009).

sensitive forecasts may be to the different pressures on inflation over time, including those stemming from relative price changes, the monetary regime in place, as well as some of the other factors noted above.

3.   A Bird's Eye View of the Data

Appendix A provides details of the data sources and definitions used in this study. All tests and estimates are based on data converted to a quarterly frequency. Original forecasts are monthly (M), quarterly (Q) or half-yearly (H). Generally, the sample covers the period 1990 to 2008. Inflation is defined in terms of the headline rate for the CPI for all the economies considered, expressed in annualised terms. The empirical evidence shown below examines the experience of five IT economies – Australia, Canada, New Zealand, Sweden and the United Kingdom – and four non-IT economies – the euro area, Japan, Switzerland and the United States. The expectations data are time series of current-year and one-year-ahead forecasts. Three types of forecast data are used: professional forecasts; forecasts derived from survey data; and any available central bank forecasts.

There are several difficult issues that arise when resorting to these data. First, most of the forecasts are for the calendar year. For example, each month (usually around the third week of the month) *The Economist* publishes private-sector forecasts of inflation (and real GDP growth) for the current and following calendar years (one-year-ahead forecasts). Other forecasts are presented in a similar manner (for example, Consensus forecasts). Some forecasts (those of the OECD, for instance) are published semi-annually while others (for example, the RBNZ) release forecasts on a quarterly basis.[14] As a result, there is both an issue of timing and the horizon to which the forecast pertains. Studies that rely on these data are aware of this, but adjustments to correct for such problems are often *ad hoc* or are said to have little influence on the outcome of empirical tests. Given the persistence properties of inflation, it is conceivable that calendar-year forecasts pose little difficulty. In what follows, no special adjustments are made to the data. While some experiments were conducted to determine how large the resulting biases might be, it appears (in line with other studies) that they do not appear to be large.[15]

In the case of survey data, the researcher faces the additional difficulty that the data are not always presented in the form of an inflation rate. Instead, many surveys (for example, those of the European Commission and the Centre for European Economic Research (ZEW)) report an index. Generally, the literature has adopted two approaches to convert the data into usable form. Smith and McAleer (1995) provide a nice survey of the methodologies originally due to Carlson and Parkin (1975) and Pesaran (1985, 1987). The former is generally referred to as the probability approach, whereas the latter is a regression-based technique used to convert an index into an estimate of inflation expectations. Both techniques were implemented in this study and readers are referred to the relevant papers for additional details.

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14. The RBNZ, for one, does publish one-quarter-ahead forecasts, so there are some forecasts that are not presented on a calendar-year basis.

15. Put differently, the issue concerns the implications of relying on fixed-event versus fixed-horizon forecasts. In the present application, as will be explained below, the averaging used to investigate cross-country differences in inflation forecasts may also contribute to mitigating any biases from the timing and horizon problem.

A final comment concerning forecasts is also in order. While the measurement of forecast disagreement used in this study treats all forecasts on an equal footing, the researcher does not observe the objective function implicit in the construction of these forecasts, that is, whether the aim of the forecaster is to find the best forecast of inflation or one that might attract the greatest public attention. The implications are not formally explored in this study but should be borne in mind in future extensions of the present research.

Consider first overall inflation performance, as shown in Figure 1. The top and bottom panels show CPI inflation in the IT and non-IT economies, respectively. There is little evidence of notable differences between IT and non-IT economies' inflation rates in the period since inflation targeting was adopted. Prior to 1994, however, one does clearly see the rapid disinflation that took place in the IT camp.[16] As will be seen below, appearances can be deceiving as some persistent differences in overall inflation performance between the IT and non-IT economies can be observed. The figure also highlights why there is continuing debate not only about the relative superiority of an IT regime but also whether forces more global in nature, including commodity price movements, are driving inflation rates around the world.

Figure 1: Inflation Rates – Selected Economies
Year-ended headline CPI
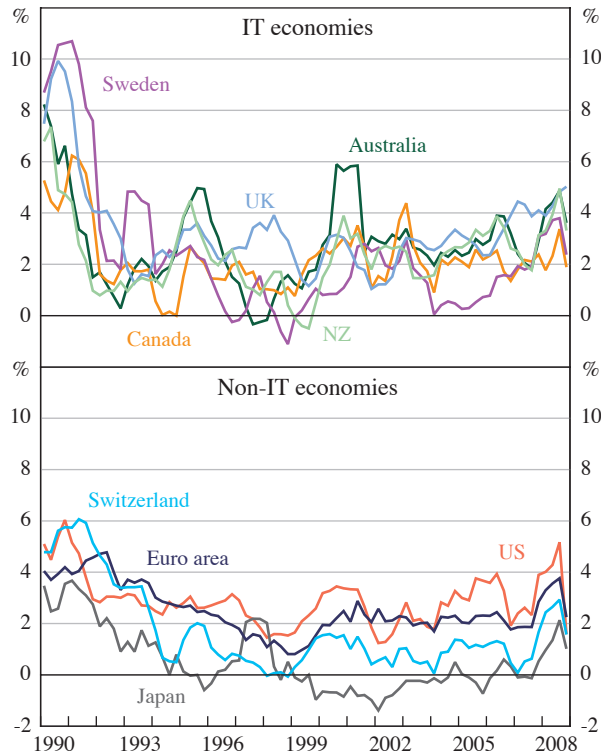
Sources: See Appendix A

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16. The dating of the IT period as beginning in 1994 is adopted purely for visual purposes. In some of the tests that follow, actual adoption dates are used (see Bernanke *et al* 1999, Siklos 2002 or Rose 2007 for the exact dates).

Figures 2 and 3 plot a number of commodity and asset prices.[17] These do not exhaust the set of relevant commodity prices that may have affected inflation expectations over time in each of the economies considered. Nevertheless, the various series shown are fairly representative of the data that various authors in the relevant literature have used to investigate the macroeconomic role of commodity and asset prices.[18] The series displayed in the figures consist of individual commodity price indices as well as aggregate commodity price indices that some of the central banks in our sample publish and monitor on a regular basis. The variability of commodity prices (Figure 2) is quite apparent. Nevertheless, it is usually the case that broader indices of commodity prices are relatively less volatile than many of the individual commodity prices sampled. In addition, most of the series appear to be mean-reverting and there is also a visual hint at least of some asymmetry in commodity price movements (somewhat steadier increases and more rapid decreases). Formal testing of the statistical properties of these series follows below.

Figure 3 plots the rate of change in the BIS's aggregate asset price index (Borio and Lowe 2004) for the IT and non-IT group of economies in our example. One can interpret fluctuations in these indices as a relative price of sorts – that is, for current versus future consumption. Alternatively, movements in these indices may provide clues about imbalances in the economy to which monetary policy and,

Figure 2: Selected Measures of Commodity Prices
Year-ended percentage change
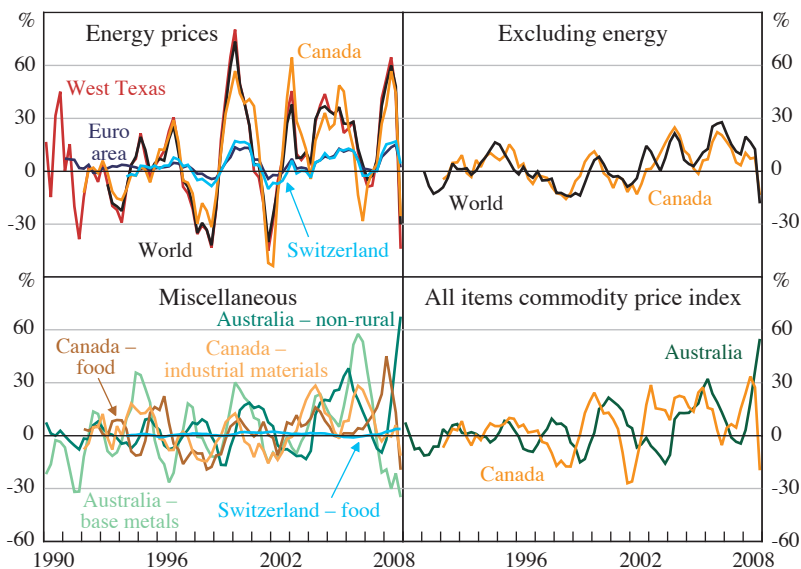
Sources: Australia, Canada and Switzerland – central bank websites; other – IMF

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17. Commodity prices are expressed in US dollars before transforming them into growth rates. All asset prices (also in US dollars) are in index form, again prior to computing rates of change.

18. Whether these are the 'right' prices to consider is another matter entirely. For example, Reis and Watson (2009) find that conventional relative price indicators are less informative than a linear combination of them (obtained via principal components analysis).

Figure 3: Asset Prices
Year-ended percentage change
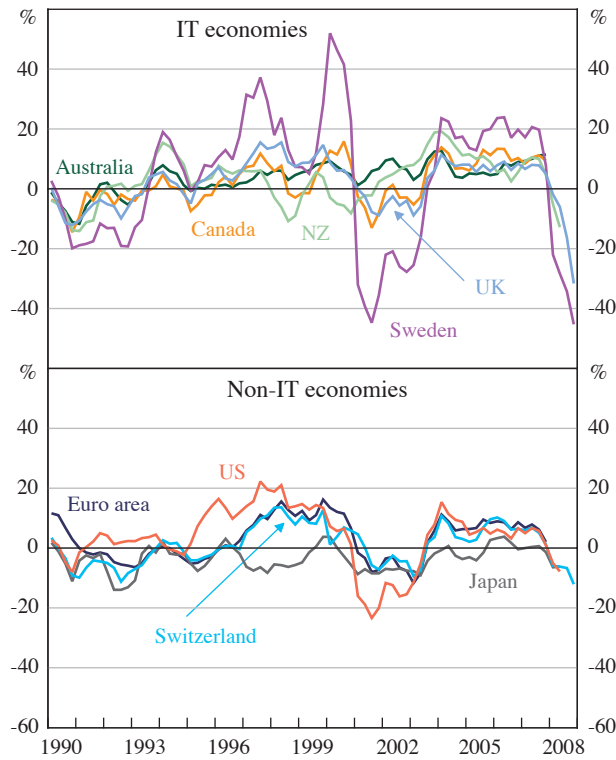
Note: The data are the BIS's aggregate asset price indices
Sources: BIS; Borio and Lowe (2004); author's calculations and Appendix A

presumably, inflation expectations, might react. The plots suggest considerable variability in asset prices in all the economies considered, although, on balance, volatility appears relatively larger in the IT economies. Also notable is asymmetry in growth rates of asset prices, with the exception of the Japanese experience.[19]

Figure 4 plots an estimate of the real interest rate based on the difference between the nominal long-term government bond yield and a three-year moving average of inflation. Needless to say, there is considerable debate about the proper measurement of real interest rates, let alone how to proxy longer-term expectations of inflation. Nevertheless, while estimates of the real interest rate may vary depending on the details of the calculations, it is likely that the series shown in Figure 4 offer a fair portrayal of how the stance of monetary policy has evolved across the economies

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19. The apparent differences in variability between IT and non-IT economies and the asymmetrical behaviour of commodity and asset price movements also seems to be reflected in real exchange rate and output gap data (not shown).

considered since 1990.[20] During the first half of the 1990s, real interest rates were relatively higher in the IT group of countries. As several authors have suggested, this stylised fact captures both the adjustment towards a lower inflation rate the newly IT countries were aiming for at the time, as well as an expression of the attempt by these central banks, given their historical experience with inflation, to establish *bona fides* in delivering inflation control. However, by the late 1990s it generally becomes difficult to distinguish the stance of monetary policy in IT economies from that in non-IT economies. This feature of the data also captures the stalemate in the debate between supporters of inflation targeting and others who have found it difficult to see, or are sceptical of, the superiority of one type of policy regime over another.

Figure 4: Real (*Ex Post*) Interest Rates
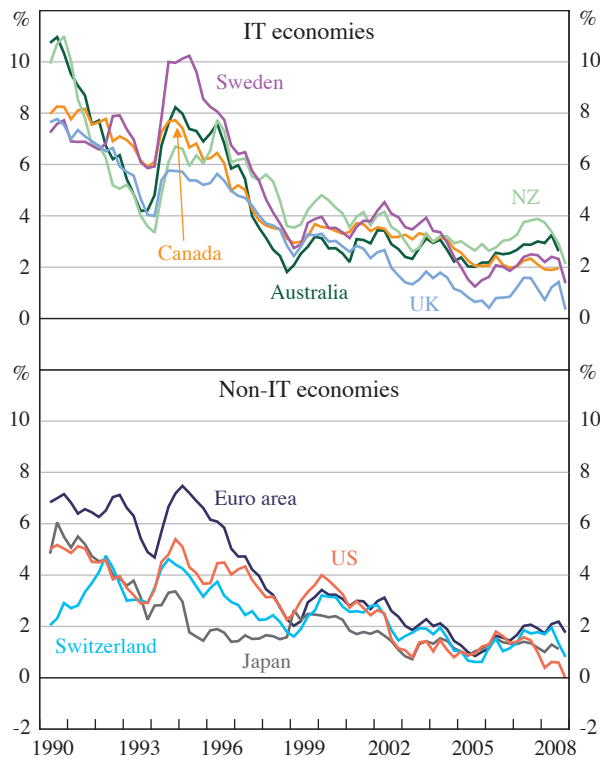
Note: Nominal interest rate (long-term government bond yield) less three-year moving average of inflation

Sources: See Appendix A

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20. An obvious alternative, other than using surveys of long-term expectations or index-linked bonds (though not a feasible option for the collection of economies examined here) is to estimate a policy rule, such as a Taylor rule. It is unlikely, however, that the conclusions drawn from such an exercise would yield substantively different results. It is now becoming widely accepted that monetary policy in recent years had become looser over time (see Siklos 2009a, Taylor 2010 and references therein).

I now turn to some stylised facts about inflation expectations. Figure 5 plots CPI inflation in the IT economies on the horizontal axis against various available measures of one-year-ahead inflation expectations (see Appendix A for details).[21] The same plots are generated for the non-IT economies in Figure 6. As noted previously, it is useful to distinguish between a general disinflationary phase versus a period when inflation remained relatively low and stable. Clearly, it is not straightforward to identify any such 'break' over the period examined. Moreover, it is likely to be difficult to pinpoint a common break across the nine economies considered in this study. Hence, I compare the full sample (1990–2008) to a sub-sample consisting of observations for the 1999–2008 period.[22] Most observers would agree that by that time all IT regimes were in place long enough to avoid problems arising from initial conditions biasing the results in favour of inflation targeting. Accordingly, the left-hand-side panels display the evidence for the full sample while sub-sample results are summarised in the right-hand-side panels. There are three notable features about the simple relationship between inflation and inflation expectations displayed here. First, with the possible exception of New Zealand, the country that first adopted inflation targeting in 1990, higher current inflation is generally associated with a rise in one-year-ahead inflation. The same relationship is apparent for Switzerland and Japan, but somewhat less so for the other non-IT economies. Second, the relationship between inflation and one-year-ahead expectations is considerably tighter after 1999 in the IT group of countries. This phenomenon is less apparent among the non-IT economies, except for Switzerland, who is not an inflation targeter but does target a forecast for inflation. The apparent clustering of inflation and inflation forecasts is suggestive of an anchoring of inflation expectations and the change is most visible among the IT group of countries. Whether inflation targeting alone, or in combination with other factors, can explain the difference is, of course, an empirical question. Finally, regardless of the nature of the monetary policy regime, there are fewer 'outliers' after 1999 in the various scatter plots shown. This suggests that the era since 1999 is, broadly speaking, characterised by fewer inflation surprises.

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21. The plots for current-year inflation expectations (not shown) reveal broadly similar patterns. There are too few series for forecasts two years ahead, or more, to conduct the same experiment as shown in Figures 5 and 6.

22. Later in the empirical section I also consider the 2001–2008 sub-sample as this may also represent a useful dividing line between the period of disinflation and stable inflation.

Figure 5: Inflation versus Inflation Expectations – IT Economies

(*continued next page*)

Figure 5: Inflation versus Inflation Expectations – IT Economies
(*continued*)

Notes: See Table A5 for the forecast codes. Inflation expectations are one-year-ahead forecasts as
          defined in the text. Inflation is as defined in Figure 1.
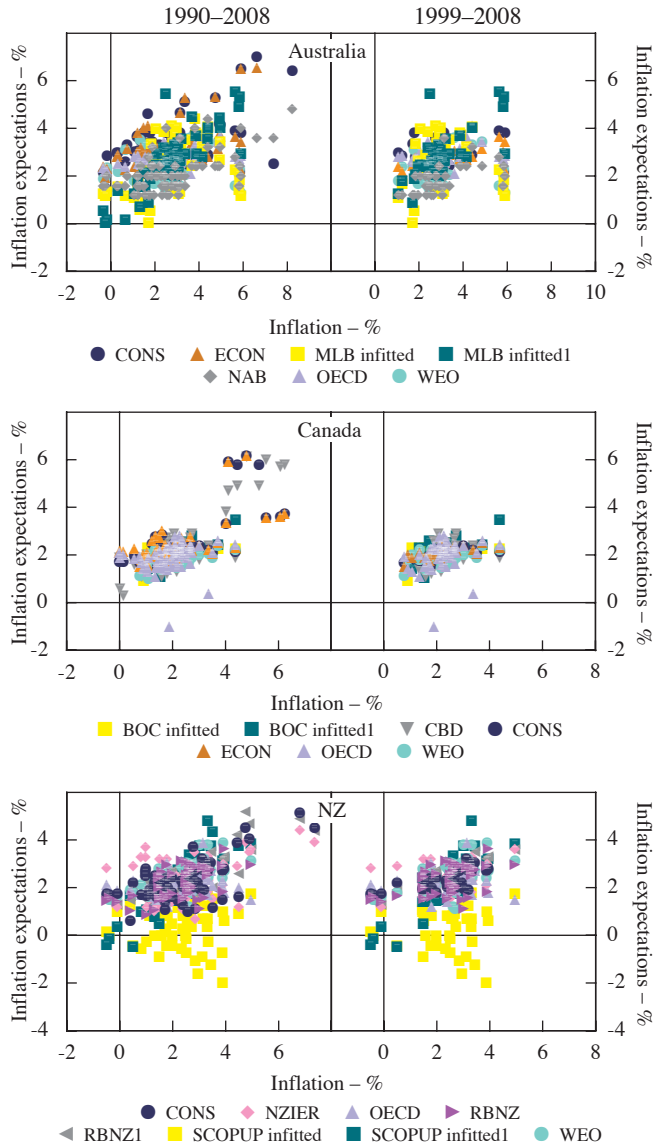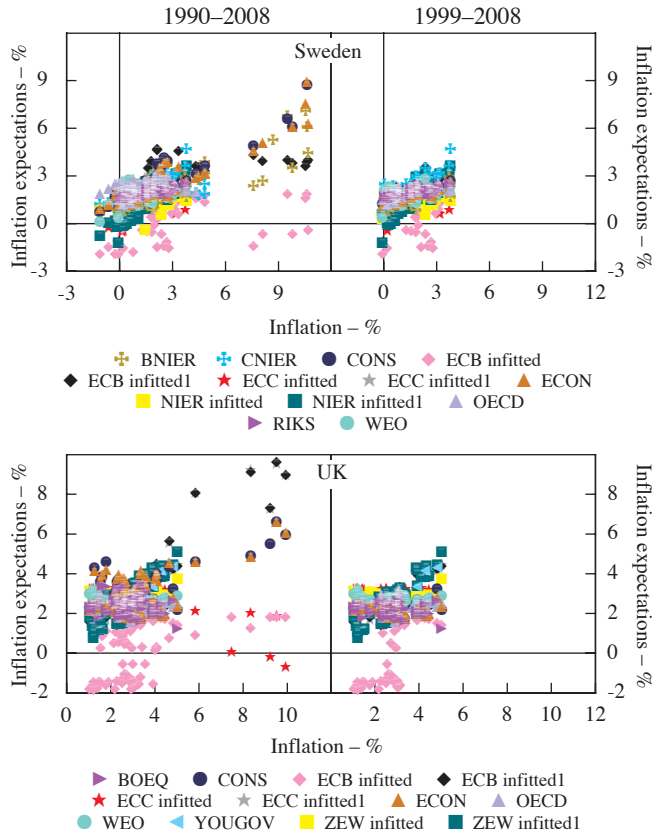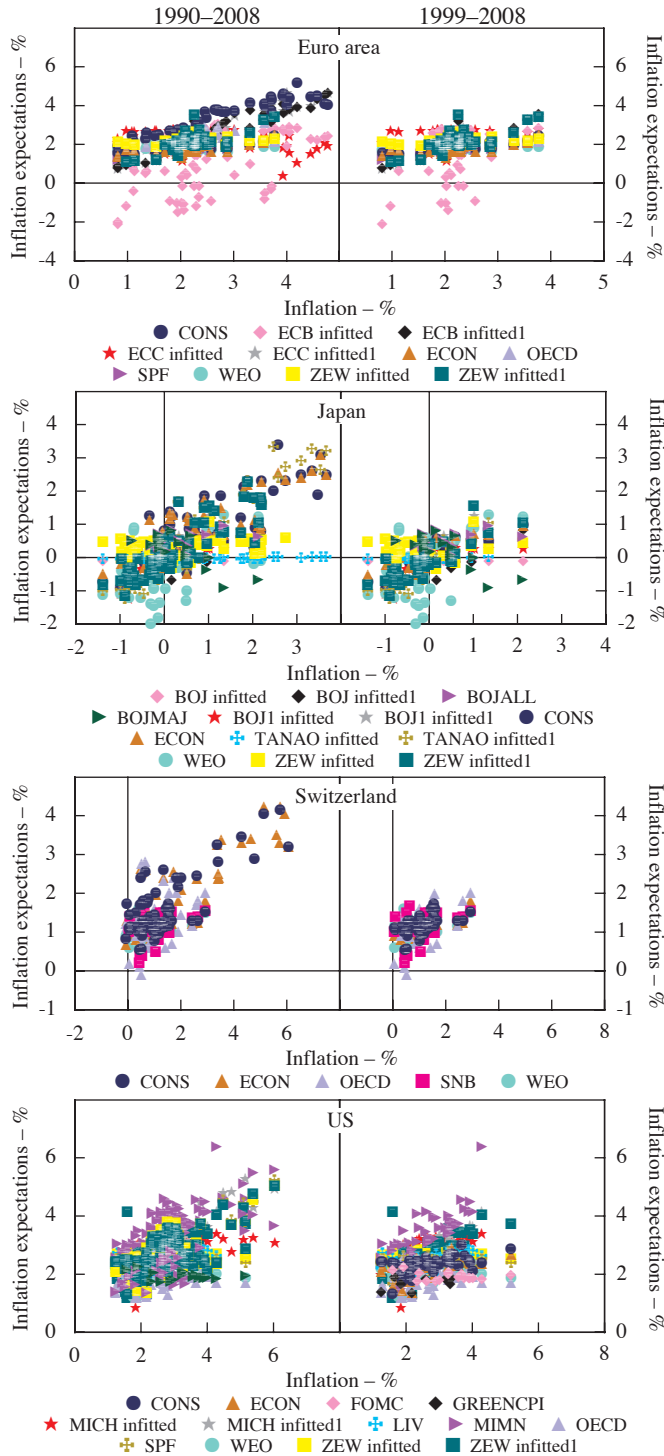Sources: See Appendix A

Figure 6: **Inflation versus Inflation Expectations – Non-IT Economies**

Notes: See Table A5 for the forecast codes. Inflation expectations are one-year-ahead forecasts as
          defined in the text. Inflation is as defined in Figure 1.

Sources: See Appendix A

Figure 7 displays evidence of the range of inflation expectations across economies and sources of data. As noted previously, it is customary to examine inflation forecasts or surveys relative to some domestic benchmark. However, since this study partly aims to assess the role of global forces on inflation, as proxied by the US experience, the figure shows differences in expectations relative to a US benchmark.[23] Examination of the data in Figure 7 suggests that in at least three of the five IT economies (Australia, Canada and Sweden), the differences *vis-à-vis* one-year-ahead US inflation forecasts have diminished somewhat over time while a similar pattern is less apparent for New Zealand and the United Kingdom. Equally interesting is the fact that inflation expectations are persistently below those of the United States, especially beginning in the mid 1990s, except possibly for the United Kingdom. It seems then that there is both a global element to the determination of inflation expectations (what one might loosely call a trend component) and a domestic component suggestive of the decoupling of these expectations relative to the United States, perhaps due to the adoption of inflation targeting. As seen in Figure 7, no such interpretation is evident for the non-IT economies in the sample. The idiosyncratic experience of Japan is evident, while there is seemingly little change in the behaviour of expectations in Switzerland relative to the United States. Only the euro area begins to resemble the US experience and this may point toward the success of the fledgling central bank in anchoring expectations to levels comparable to ones exhibited in the United States.

Finally, Figure 8 plots our measure of forecast disagreement for each of the nine economies in this study. The shaded areas highlight, where relevant, the period before inflation targets were introduced.[24] As noted previously, there is no universally agreed-upon measure of forecast disagreement. However, some researchers typically resort to the following definition

$$d_{th} = \frac{1}{N-1} \sum_{i=1}^{N} \left(F_{ith} - \bar{F}_{\bullet th} \right)^2 \tag{1}$$

where: d is the measure of disagreement for a particular country; F_{ith} is the i-th forecast for horizon h at time t; and $\bar{F}_{\bullet th}$ is the mean across the N available forecasts for that country.[25] To highlight the evolution of disagreement over time, Equation (1) is evaluated in a five-year rolling sample.[26] In what follows, h is always set to 1 to

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23. Namely, the US one-year-ahead inflation forecast from the Survey of Professional Forecasters, often thought to be the most accurate of the forecasts over time. Clearly, other US benchmarks could have been used and it is possible that the results may be sensitive to this choice.

24. There is no shaded area shown for New Zealand which introduced inflation targeting at the very start of the available sample.

25. Alternatively, forecast disagreement can be expressed in terms of forecast errors, as in $\frac{1}{N-1} \sum_{i=1}^{N} \left(\varepsilon_{ith} - \frac{1}{N} \sum_{i=1}^{N} \varepsilon_{ith} \right)^2$, where ε is the forecast error. Other definitions of forecast disagreement also exist. See, for example, Dovern *et al* (2009).

26. This explains why levels cease changing in the last few years of the sample. It was thought to be preferable to show the results in this manner rather than, say, reduce the span of the sample over which d was estimated.

Figure 7: Differential of Inflation Expectations
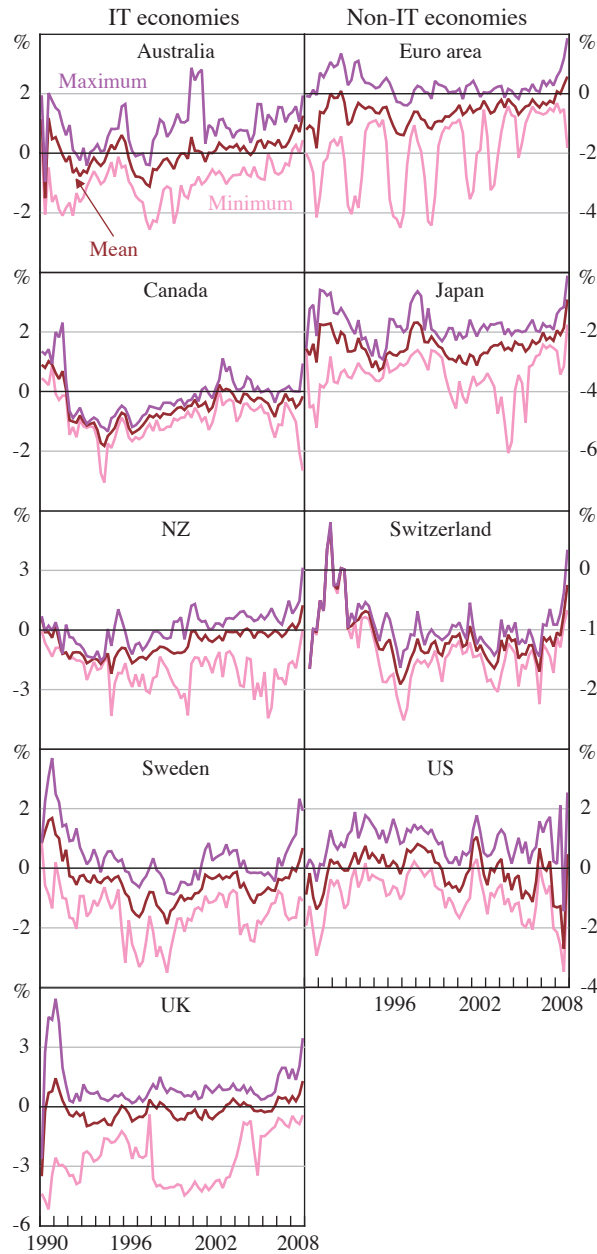
Notes: Inflation expectations are one-year-ahead forecasts less the benchmark US forecast (from the
           Survey of Professional Forecasters), except for the US, which is against the actual inflation
           outcome
Sources: See Appendix A

Figure 8: Disagreements in Inflation Expectations

Notes: The shaded areas represent the period before IT is introduced, where relevant. These
           are the one-year-ahead forecast disagreements based on the forecasts underlying
           Figure 7 (see Equation (1)). Quarterly disagreement was averaged to form an annual series.
           All subsequent econometric tests rely on disagreements measured at the quarterly
           frequency.
Sources: See Appendix A

indicate that the focus is on one-year-ahead forecasts. The results indicate that in all IT economies, disagreement tended to rise in the early phases of the new monetary policy regime. Nevertheless, the rise is typically very brief in duration with the possible exception of New Zealand where disagreement increased over a six-year period. In contrast, disagreement rose over five years in Australia, two years in the United Kingdom, and one year in Canada. Arguably, the 'shock' associated with the change in monetary policy regime was greatest for New Zealand. It is notable as well that disagreement tends to fall sharply in some cases following the adoption and adjustment to the IT regime.

Comparisons with the record of forecast disagreement in non-IT economies are particularly instructive. Disagreement in the euro area rises over a three-year period then permanently falls, but what is most notable is that disagreement falls around the start of European Monetary Union (EMU). Contrast this with the Japanese experience, which shows a period of elevated disagreement essentially covering the so-called 'lost decade' before falling since the turn of the century. The experience of Switzerland reveals a sharp rise in forecast disagreement during the first half of the 1990s and, in spite of a small dip in the second half of that decade, disagreement remains permanently higher than at the beginning of the sample. There is a less dramatic but equally pronounced rise in forecast disagreement in the United States, with estimates of disagreement for the most part increasing steadily until 2002. Clearly, there is considerable diversity in the forecasting experience across this sample of economies, but one should not exaggerate the differences. After all, every single economy in the sample experiences a rise in forecast disagreement sometime during the 1990s precisely when central banks in the industrial world, whether they formally targeted inflation or not, emphasised the desirability of low and stable inflation. It is likely that changes in monetary policy credibility, the actual design and implementation of inflation control strategies, as well as the international environment, have each played a role in the emergence and subsequent reversal of these forecast disagreements. I now turn to some preliminary evidence estimating the significance of some of these factors.

4. Empirical Evidence

Table 1 provides some summary statistics about the stationarity, or otherwise, of the key series under investigation. The top portion of the tables presents panel unit root tests. The two most widely used tests, namely those of Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS), are reported.[27]

Both panel tests are essentially versions of the well-known Augmented Dickey-Fuller (ADF) test that would be applied to time-series data for individual countries. The test equation in a panel setting (omitting constants and deterministic components) is written

$$\Delta y_{jt} = \alpha_j y_{jt-1} + \sum_{j=1}^{k} \sum_{i=1}^{p} \beta_{ij} \Delta y_{jt-1} + \varepsilon_{it} \qquad (2)$$

where: j identifies the particular economy in the sample; and y is the differential between domestic forecasts and the US benchmark forecast. The unit root test statistic then consists of the sample mean of the ADF t-statistics. IPS (2003) provide the critical values. The ADF tests tend to have a downward bias, which is corrected for when a panel test is used. Generally, if all independent parameter estimates are unbiased, then the mean of these estimates is also unbiased (Enders 2004, p 225). Notice that the test based on Equation (2) estimates a unit root test statistic for each cross-section, as well as a country-specific lag augmentation term. In contrast, if the hypothesis that $\alpha_j \neq \alpha_{j'}$, where $j \neq j'$, cannot be rejected, then an alternative specification of Equation (2), where α and β are fixed across all countries, results in the so-called LLC (2002) panel unit root test.[28] Since the panels considered refer to the differential between domestic forecasts and a US forecast, the test also amounts to asking whether cointegration holds between the various individual forecasts and the representative US forecast. Panels are also subdivided according to whether the forecast is survey-based or not.

In the case of the threshold cointegration test, attention focuses on the stationarity of the individual series of mean domestic forecasts versus the benchmark US forecast. While the benefits of panel estimation are lost, it is possible to determine whether cointegration is a feature of the data once we permit the error correction term to adjust in an asymmetric fashion.[29] The remainder of the table presents various unit

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27. There are other panel unit root tests that have been shown to be more powerful in a statistical sense. Siklos (2009b) and references therein consider some of these. Given the results reported below, it is unlikely that the conclusions will be much changed. Moreover, the extant literature is more familiar with the tests reported here.

28. LLC advocate removing the overall mean of the series (that is, $\bar{y}$) prior to running the test. It is not immediately obvious that this is necessary when the series under investigation is a differential between two existing series.

29. Enders and Siklos (2001) propose a strategy to test for threshold cointegration. The test relies on the ADF form for the test equation where the error correction term is replaced with two error corrections terms that switch depending on whether the series in question is above or below some estimated threshold, resulting in the threshold autoregressive (TAR) formulation. For reasons having to do with the statistical power of such tests, the so-called momentum TAR (M-TAR) is preferred. In this version, it is the change in the error correction term *vis-à-vis* some threshold that switches from a positive to a negative state that adds asymmetry to the conventional ADF-type specification.

**Table 1: Panel Unit Roots, Cointegration and Threshold Cointegration,
Unit Roots** (*continued next page*)

A. Panel unit root test: cointegration of domestic and US forecasts			
	LLC	IPS	Observations
Australia I	–2.44 (0.01)	–3.47 (0.00)	425
Australia II	–2.55 (0.01)	–3.77 (0.00)	192
Combined	–2.83 (0.00)	–3.72 (0.00)	
Canada I	–4.09 (0.00)	–5.84 (0.00)	375
Canada II	–3.33 (0.00)	–4.72 (0.00)	188
Combined	–4.10 (0.00)	–5.84 (0.00)	
New Zealand I	*0.52 (0.70)*	*–0.70 (0.24)*	454
New Zealand II	–3.81 (0.00)	–4.70 (0.00)	157
Combined	*0.53 (0.70)*	*–0.70 (0.24)*	
Sweden I	*–1.36 (0.09)*	–3.49 (0.00)	621
Sweden II	–3.10 (0.00)	–3.62 (0.00)	174
Combined	*–1.36 (0.09)*	–3.49 (0.00)	
United Kingdom I	–2.97 (0.00)	–4.94 (0.00)	746
United Kingdom II	–4.35 (0.00)	–4.53 (0.00)	299
Combined	–2.97 (0.00)	–4.94 (0.00)	
Euro area I	*0.28 (0.61)*	*–1.32 (0.09)*	629
Euro area II	–3.87 (0.00)	–4.03 (0.00)	200
Combined	*0.28 (0.61)*	–1.32 (0.10)	
Japan I	*0.49 (0.69)*	*–1.47 (0.07)*	593
Japan II	–4.51 (0.00)	–4.25 (0.00)	283
Combined	*0.49 (0.69)*	–1.47 (0.07)	
Switzerland I	*–0.04 (0.49)*	–2.82 (0.00)	257
Switzerland II	–3.94 (0.00)	–5.35 (0.00)	213
Combined	*–0.04 (0.49)*	–2.82 (0.00)	
United States I	*1.24 (0.89)*	–7.62 (0.00)	756
United States II	–2.70 (0.00)	–7.05 (0.00)	504
Combined	*1.24 (0.89)*	*–7.62 (0.90)*	

B. Threshold cointegration tests					
	ρ_1	ρ_2	F_1	F_2	τ
Australia	–0.02 (0.05)	–1.74 (0.17)	49.55*	89.25*	–0.30
Canada	–0.09* (0.04)	–0.28 (0.13)	4.45*	2.02	–0.62
New Zealand	–0.02 (0.06)	–0.53* (0.24)	9.47*	6.02	–0.84
Sweden	–0.11* (0.04)	0.28 (0.14)	5.24*	7.03*	–0.65
United Kingdom	–0.04 (0.05)	–1.14* (0.10)	60.75*	89.52*	–0.64
Euro area	–0.05 (0.08)	–0.82 (0.17)	12.43*	17.89*	–0.64
Japan	–0.19* (0.08)	1.06 (1.42)	2.91*	0.77	–2.35
Switzerland	–0.16* (0.07)	–1.10 (0.45)	5.84*	4.35	–1.05
United States	–0.09 (0.06)	–1.63* (0.15)	24.06*	38.94*	–0.85

**Table 1: Panel Unit Roots, Cointegration and Threshold Cointegration,
Unit Roots** (*continued next page*)

C. Unit root tests: commodity and asset prices			
	ERS (ADF)	LLC	IPS
Energy		*3.13 (0.99)*	*1.06 (0.86)*
Brent	−1.56 (5)		
West Texas	−1.50 (5)		
Canada	−1.68 (4)		
New Zealand	−1.06 (3)		
Switzerland	−1.43 (6)		
World	−1.47 (5)		
Other commodities		*4.37 (1.00)*	*2.79 (0.99)*
Metals	−2.45 (2)		
Non-rural	−0.79 (1)		
Canada – food	−2.70 (1)		
Switzerland – food	−2.17 (3)		
Australia – total	−0.69 (1)		
Canada – total	−1.77 (2)		
Canada – non-energy	−2.32 (4)		
World – non-fuel	−2.50 (7)		
Asset prices		*0.001(0.50)*	*−0.09 (0.47)*
Aggregate		*2.61 (0.99)*	*3.50 (0.99)*
Australia	−0.14 (2)		
Canada	−1.74 (1)		
New Zealand	−2.69 (8)		
Sweden	−2.34 (2)		
United Kingdom	−2.42 (1)		
Euro area	−2.02 (12)	*−1.12 (0.13)*	*−1.41 (0.08)*
Japan	−1.25 (4)	*−1.49 (0.13)*	*0.29 (0.62)*
Switzerland	−3.17 (4)		
United States	−2.32 (4)		
Equities		*−1.43 (0.08)*	*−2.84 (0.00)*
Australia	−1.50 (1)	*−0.87 (0.19)*	*−1.16 (0.12)*
Canada	−2.23 (1)		
New Zealand	−2.51 (11)		
Sweden	−1.83 (5)		
United Kingdom	−1.72 (1)		
Euro area	−1.75 (3)	*−0.18 (0.43)*	*0.36 (0.64)*
Japan	−2.01 (3)	*−1.52 (0.07)*	*−1.14 (0.13)*
Switzerland	−1.26 (1)		
United States	−1.40 (1)		

**Table 1: Unit Roots, Panel Unit Roots, Cointegration and
Threshold Cointegration** (*continued*)

C. Unit root tests: commodity and asset prices			
	ERS (ADF)	LLC	IPS
Housing		*–3.26 (0.00)*	–0.49 (0.31)
Australia	–1.35 (1)		
Canada	–1.83 (8)		
New Zealand	–2.35 (1)		
Sweden	–1.49 (3)		
United Kingdom	–1.31 (1)		
Euro area	–2.30 (4)		
Japan	–1.77 (4)		
Switzerland	–0.72 (2)		
United States	–4.04 (4)		

Notes:　In Part A, the test statistic is shown with *p*-values in parentheses; italicised numbers are those with *p*-values that are larger than 0.05 to identify cases where the null is rejected. I refers to non-survey-based forecasts while II refers to the group of survey-based forecasts. Part B gives the estimates of the error correction terms, the test for asymmetry (F_1) and the test for whether both error correction terms are jointly equal to zero (F_2). The test specification is from Enders and Siklos (2001). * indicates rejection at the 5 per cent significance level. In Part C, the column labelled ERS (ADF) gives the lag length used in the lag augmentation portion of the test equation, chosen according to the Schwarz information criterion (ERS = Elliot-Rothenberg-Stock test). Otherwise, *p*-values are shown in parentheses in the remaining columns along with the test statistic. A trend was not included in the test specifications.

root and panel unit root tests for commodity and asset prices. Asymmetric unit root tests are omitted, as the discussion in the previous section made clear the presence of asymmetric behaviour in these time series.

The null of no cointegration is rejected in most cases. In the case of IT regimes, the only exception is for New Zealand forecasts that are not survey-based. The results are mixed for non-survey-based forecasts for Sweden with the LLC test leading to a non-rejection, unless of course one wishes to adopt a 5 per cent critical value, in which case Sweden's non-survey-based forecasts are cointegrated with US forecasts. Turning to the non-IT economies, there are many more rejections of the no cointegration null. This is the case, regardless of the testing procedure employed, for non-survey-based forecasts for the euro area and Japan. The results are more mixed for non-survey-based forecasts for Switzerland and the United States. Therefore, there is some evidence that forecast dispersion behaviour is not the same in IT versus non-IT regimes. It is also interesting to note that the null of no cointegration is never rejected for survey-based forecasts. When the panel stacks together both survey- and non-survey-based one-year-ahead forecasts, the null of no cointegration is almost always rejected. The only exception is New Zealand, although once again the results for the non-IT economies are sensitive to the assumption of a common unit root in the test specification.

If we permit asymmetric adjustment of the momentum-threshold variety, the bivariate cointegration tests suggest that the cointegration property tends to hold. This result holds in five of the nine economies considered, but for this type of cointegration there is no obvious evidence of a distinction between IT and non-IT economies. Further, in absolute value, the attractor toward cointegration is always stronger from below the threshold than from above. This implies that a negative change in the error correction term, explained either by a rise in US inflationary expectations or a fall in the forecast for domestic inflation, exerts a relatively stronger pull than changes in the other direction. Of course, not all cases are statistically significant and, indeed, there are four cases (Canada, Sweden, Japan and Switzerland) where the attractor in the other direction exerts a stronger pull back to equilibrium. It is important to underscore that these results are based on mean forecasts. Consequently, some information is lost and, as shall be seen below, the interpretation of what moves inflationary expectations may be affected by this choice.

Turning to commodity and asset prices, it is not surprising that individually these series exhibit the unit root property. This much should have been apparent from the earlier discussion. Stacking all commodity prices in a panel does not change the conclusions. The same conclusion is reached for the BIS's aggregate asset price indices, although the results are somewhat sensitive in the case of non-IT economies, assuming a 10 per cent critical value is adopted.

Since a fairly large number of individual forecasts were retained for each economy,[30] a natural question to ask is how important is the relative information content of the individual forecasts. While there are many ways of addressing the issue, Table 2 provides summary information of a principal components analysis of the various available forecasts on an economy-by-economy basis.[31] The second and third columns of Table 2 shows the most important forecasts based on the estimated eigenvalues, measured on the basis of explanatory power (as a proportion of the total value). The second column lists the forecasts that would have the greatest weight if a linear combination of forecasts were used instead of, say, a simple mean of available forecasts. There are at least two notable features in the results. First, in practically all cases, either Consensus, *The Economist* forecasts, or both, are among the first or second principal components of the forecasts. Second, most forecasts contribute a relatively small fraction of the total variation. Consequently, there is no such thing as a dominant forecast. Indeed, it is often the case that at least four to five forecasts are needed to explain close to two-thirds of the variation in one-year-ahead inflation forecasts.

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30. For Australia, a total of 7 forecasts were retained. For the other countries the numbers are provided in parentheses: Canada (7), New Zealand (8), Sweden (11), the United Kingdom (10), euro area (11), Japan (8), Switzerland (5) and the United States (11).

31. Space constraints prevent a full discussion. However, the object of the exercise is to find the highest eigenvalues from the eigenvectors estimated from the covariance matrix that describes the relationship between the series of interest. Additional details can be found in, among other sources, Maddala (1977, pp 193–194) and Jolliffe (1986).

Table 2: Principal Components of Inflation Forecasts

Economy	Principal component (PC)	Proportion of total variation (%)[a]
Australia	ECON, OECD, CONS, NAB	0.37, 0.18, 0.16, 0.09
Canada	PC1: ECON, CONS, BOC, WEO PC2: CBD, BOC, OECD	0.39, 0.20, 0.14, 0.12, 0.07
Euro area	ECB(2), SPF, OECD, ECC(2), CONS, ECON	0.41, 0.20, 0.09, 0.09, 0.06, 0.05
Japan	TANAO(2), ZEW(2), CONS, ECON	0.36, 0.21, 0.12, 0.09
New Zealand	RBNZ, CONS, RBNZ-Survey	0.47, 0.16, 0.14
Sweden	NIER(2), CONS, ECON, RIKS	0.52, 0.15, 0.10, 0.07
Switzerland	CONS, ECON, SNB, OECD	0.55, 0.17, 0.14, 0.10
United Kingdom	PC1: ECC(2), ECB(2), ZEW(2), YOUGOV PC2: ECON, BOE, CONS	0.29, 0.20, 0.13, 0.08
United States	ECON, CONS, SPF, LIV	0.40, 0.15, 0.13, 0.07, 0.07

Notes: PC: (1) = probability approach; (2) = regression approach. See Table A5 for the forecast codes.
(a) Eigenvalues

Finally, we turn to some regression estimates of the determinants of the forecast differential. Once again, to conserve space, only a selection of the results are displayed in Table 3.

The estimated specification is a straightforward one and, as such, imposes restrictions that future research will need to consider. I am interested in the determinants of the differences between forecasts of one-year-ahead inflation in economy i, at time t, generated by forecaster j, and the US forecast (SPF). The resulting relationship can be expressed as

$$fd_{jit} = A_i + B_t + \kappa \mathbf{X}_{jit} + \delta \mathbf{I}_{it} + \xi_{jii} \tag{3}$$

where: *fd* represents the difference between forecaster j's one-year-ahead forecast for economy i at time t and the benchmark US forecast (SPF); A and B are fixed effects; $\mathbf{X}$ is a vector of control variables; and, since we are interested in, among other questions, the impact of inflation targeting, $\mathbf{I}$ is a dummy variable for this policy regime. One immediate difficulty, noted earlier, is that we are unlikely to have ample information on controls for each country. Moreover, as discussed in Bertrand, Duflo and Mullainathan (2004), standard errors from OLS estimation of Equation (3) can be distorted. Among the possible solutions is to estimate Equation (3) at the economy-wide level, in which case many more covariates are available. This is the strategy adopted below. In addition, as pointed out previously, there is potentially a loss of information when focusing only on the mean value of

Table 3: The Determinants of Inflation Forecast Differentials
Coefficient (standard error)

Variable	Mean: Full 1990–2008	Mean: 2001–2008	Mean: 1999–2008	MIN: Full	MAX: Full
	Dependent variable: Mean fd_{it}			$a_t = \alpha_0 + \alpha_1 f_{1,t-1} + e_{t\mid t-1}$	$f_{1,t-1}$
Brent	−0.05 (0.07)	−0.37 (0.10)*	−0.12 (0.07)*	−0.16 (0.13)	0.02 (0.10)
Non-fuel	0.21 (0.22)	0.20 (0.27)	−0.28 (0.26)	−0.06 (0.43)	0.23 (0.10)
Housing	0.01 (0.01)	0.01 (0.005)	0.01 (0.004)*	0.01 (0.01)	0.005 (0.008)
Equities	−0.001 (0.001)	−0.001 (0.001)	−0.001 (0.0008)*	−0.001 (0.002)	−0.0004 (0.001)
$\Delta fd_{it-1}*H$	−0.30 (0.06)*	−0.06 (0.09)	0.03 (0.08)	0.11 (0.11)	−0.31 (0.09)*
$\Delta fd_{it-1}*(1-H)$	−0.05 (0.05)	−0.05 (0.10)	−0.01 (0.08)	−0.05 (0.10)	0.02 (0.07)
KURT	−0.01 (0.01)	−0.01 (0.008)*	−0.01 (0.007)*	−0.20 (0.02)*	−0.006 (0.01)
DIS	−0.02 (0.01)*	−0.12 (0.04)*	−0.07 (0.02)*	−0.05 (0.02)*	−0.02 (0.01)*
ITDUR	0.003 (0.001)*	0.007 (0.002)	0.007 (0.002)*	0.01 (0.002)*	0.004 (0.002)*
IT	−0.07 (0.05)	na	na	−0.17 (0.10)*	−0.17 (0.08)*
fd_{it-1}	0.82 (0.03)*	0.60 (0.07)*	0.66 (0.05)*	0.59 (0.03)*	0.75 (0.03)*
Inflation – news			−0.01 (0.01)		
Interest rate – news			0.004 (0.004)		
Recession – news			0.02 (0.003)		
US dollar – news			−0.04 (0.02)		
Constant	−0.05 (0.05)	−0.02 (0.13)	−0.14 (0.10)*	−0.13 (0.10)	0.10 (0.10)*
$a_{t+1} - f_{1t}$	0.91	0.95	0.95	0.80	0.87

Notes: Variables are defined in the text. Cross-section fixed effects are not shown. * indicates statistical significance at least at the 10 per cent level. OLS estimation is used. Standard errors are shown in parentheses. H is the Heaviside indicator used to discriminate between positive (H) and negative ($1-H$) changes in fd.

fd. Hence, three set of results are shown in Table 3. Estimates of Equation (3) for the mean, the lowest (MIN) and highest (MAX) forecast differential are presented. One may view the MIN estimates as proxying the reactions of those who are most optimistic about future domestic inflation while the MAX estimates capture the most pessimistic forecasts.[32] In addition, two sets of sub-sample estimates are provided as it is likely, based on the stylised facts, that the behaviour of inflation and inflation expectations may well have undergone a change around 1999 to 2001.[33] Sub-sample estimation also permits the addition of another variable that is labelled 'news'. Various dummy variables are constructed (see Appendix A for details) that are set to 1, and are otherwise set to 0, when headlines, primarily in the financial press, highlight a rising fear of *future* inflation, *future* rises in the policy interest rate, a *future* recession or a depreciation of the US dollar – that is, there are separate dummy variables for each of these types of news events.

The vector **X** consists of the following variables. Oil and commodity prices are proxied by the world price of Brent crude and a world index of non-fuel prices. Both series are in HP-filtered form.[34] Asset prices, namely housing and equity prices that exceed or fall below some HP-filtered trend, are also included. Next, for reasons discussed above, I allow for asymmetric type of adjustment by creating a variable that is set to 1 when the *change* in the mean differential is greater than zero and is zero otherwise. This gives the opportunity to ascertain whether large positive or negative movements in domestic inflation forecasts relative to the US benchmark measure have a separate impact on *fd*. The specification also allows for uncertainty, proxied here by the kurtosis (KURT) in the distribution of forecast differential, as well as disagreement in the forecasts (DIS), to influence *fd*.[35] These variables not only capture the role of second and third moments but, in so doing, include some distributional information, omitted in the process of aggregation. Finally, other than a lagged dependent variable, included to measure persistence in *fd*, a variable that measures how long a country has been in an IT environment is also included (ITDUR).

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32. An alternative approach, currently the subject of ongoing work, consists of estimating a version of Equation (3) via quantile regressions in order to better exploit the information contained in the distribution of forecasts.

33. A Hausman test (results not shown) does suggest that the full-sample model may be mis-specified. What is unclear is the form of the mis-specification. It could be that the null that $\varkappa$ is constant across cross-sections is incorrect or it could be the case that it is inappropriate to pool all the economies in our sample together. For example, one might consider a separate pool of IT economies and non-IT economies. This extension is left for future research.

34. Using rates of change in these series does not appear to make much difference. However, in line with the earlier discussion, it seems preferable to think in terms of a measure of disequilibrium in relative prices. Needless to say, there are well-known drawbacks in using the HP filter but it is so widely applied that whatever it loses in terms of precision, it makes up for by remaining comparable with the relevant literature. The default smoothing parameter of 1 600 is used in all HP-filtered estimates.

35. The variance of *fd* was also considered but was generally found to be statistically insignificant. Hence, it was omitted from the final specification.

It is clear from the estimated coefficients that our suspicion that something changed around 1999 to 2001 is borne out.[36] For example, the asymmetry found for the 1990–2008 sample, where a rise in the inflation forecast differential is reversed (but not vice versa), is not apparent in the most recent period. Second, uncertainty about future inflationary expectations are statistically significant in the sub-samples but not in the full sample. Finally, and perhaps most interestingly, relative prices, as proxied by oil, housing and equity prices, are not statistically significant in the full sample but have a clear impact in the sub-sample estimates shown.

The results for the lowest (MIN) and highest (MAX) imply some rather interesting and important differences *vis-à-vis* the panel estimate based on the mean. First, notice that the IT dummy is statistically significant in both cases. In addition, at both ends of the distribution, as it were, we find that the introduction of inflation targeting reduces the differences in one-year-ahead inflation forecasts by 0.17 per cent. This is only trivially offset by the length of time the country in question has been targeting inflation (ITDUR). Next, it is clearly the case that the high level of persistence found for the mean-based estimates is more a feature of the 'pessimists' among the group of forecasters than for the 'optimists', with the latter specification yielding significantly lower persistence in the forecast differential (0.59 versus 0.75). In contrast, optimistic forecasters are relatively more worried about future uncertainty, which tends to narrow inflation forecast differentials. Similarly, disagreement among forecasters has twice as large an effect on the forecast differential when the forecast is a relatively optimistic one.

Before concluding, it is worth delving into the changing persistence properties of the forecast differential and the role of inflation targeting in the individual economies in the sample. To do this, a version of Equation (3) is estimated for each economy separately (not shown) and Table 4 summarises what happens to the estimates of persistence as well as the IT dummy. It is rather striking that the full sample sees all coefficients highly significant while every single coefficient in both sub-samples shown are statistically insignificant at the 5 per cent level. This result is to be expected since, as noted previously, much of the disinflation was achieved by the mid 1990s.[37] Just as with headline inflation, there is effectively much less persistence in inflation forecasts in the more recent sample period. While it is plausible to suppose that forecasters are now less backward-looking, the robustness of this result has yet to be properly tested. To be sure, there are differences in the estimates and clearly one can imagine specifications similar to Equation (3) that are equally plausible. However, some of the results in Table 4 do not seem to be greatly at variance with the summary estimates provided in Table 3. Of the five IT economies, separate estimates of δ (the coefficient on the IT dummy variable) can be provided for in only four cases. The results suggest that the reduction in the forecast differential due to inflation targeting is primarily a feature of the Canadian and Swedish experiences but not of Australia and the United Kingdom.

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36. All specifications include fixed effects A_i and this version of Equation (3) could not be rejected.

37. The somewhat arbitrary choice of sub-samples does not address the question of whether the reduction in inflation persistence was achieved faster in IT or non-IT economies, nor is the precise year when persistence became statistically significant identified for each economy.

**Table 4: Inflation Persistence and the Role of Inflation Targeting –
Summary of Individual Economy Estimates**

Economy	Full: 1990–2008	1999–2008	2001–2008	Inflation targeting
		Dependent variable: Mean fd_t		
Australia	0.46*	0.05	–0.12	0.03 (0.86)
Canada	0.70*	–0.09	0.22	–0.28 (0.07)
New Zealand	0.54*	–0.35	0.02	na[b]
Sweden	0.84*	0.29	0.63	–0.18 (0.10)
United Kingdom	0.46*	0.17	0.15	0.15 (0.29)
Euro area	0.55*	–0.26	–0.27	na
Japan	0.78*	0.47[a]	0.44	na
Switzerland	0.88*	0.18	0.25	na
United States	0.39*	0.29	0.36	na

Notes: The first three columns give the coefficient estimates and * indicates statistically significant at the 5 per cent level. The last column gives the estimate of the response to the IT dummy (see Equation (3) for the panel version of the same specification). *p*-values in parentheses.
(a)   *p*-value is 0.10.
(b)   New Zealand introduced inflation targeting in 1990:Q1.

5.   Conclusions

This paper began by noting that there is still much to be learned from analysing the behaviour of inflation expectations. In contrast with most studies of this kind, the strategy followed here is to extract information contained in the reasonably large variety of inflation forecasts. I then considered how forecasts in five IT and four non-IT economies have evolved since the early 1990s. What can we make of the results? First, there is little doubt that inflation targeting has contributed to narrowing the forecast differences *vis-à-vis* US inflation forecasts. Second, there is some evidence that, at least since 1990, inflation forecasts in the economies considered that deviate considerably from US forecasts show signs of converging towards US expectations. Third, examining the mean of the distribution of forecasts potentially omits important insights about what drives inflation expectations. Finally, commodity and asset prices clearly move inflation forecasts, although this is a phenomenon of the second half of the sample. Prior to around 1999, relative price effects on expectations are insignificant.

There is clearly scope for more research. It is unclear whether the specification used is the best one for extracting all of the useful information contained in the dataset. In addition, one may wish to examine the behaviour of forecasts using a different metric than the one employed here. Finally, one may consider some interaction effects and add some other omitted variables in Equation (3). For example, inflation targeting may operate jointly to reduce inflation forecast uncertainty and disagreement among inflation forecasts. In addition, central banking in the 1990s has been marked by a trend towards greater transparency. Explicit accounting for this characteristic would be useful. These are only a few of the many avenues open for future research.

Appendix A

Table A1: Inflation Surveys/Forecasts (*continued next page*)

Economy	Forecast	Horizons[a]	Start	Survey	Horizons[a]	Start
Australia	ECON	cy, 1y	1990:M8	MLB	ya–balance[b]	1993:Q2
	CONS	cy, 1y	1990:M1			
	WEO	cy, 1y	1993:H1			
	OECD	ya	1990:H1			
Canada	ECON	cy, 1y	1990:M8	BOC	2y–bins[b]	2001:Q2
	CONS	cy, 1y	1989:M10			
	WEO	cy, 1y	1993:H1			
	CBD	cy, 1y	1990:Q1			
	OECD	ya	1990:H1			
Euro area	ECON	cy, 1y	1998:M11	SPF	cy, 1y, 2y, 5y	1999:Q1
	CONS	cy, 1y	1989:M10	ECB/ECC	ya–balance[b]	1985:M1
	OECD	ya	1990:H1	ZEW	ya–bins[b]	1991:M12
Japan	ECON	cy, 1y	1990:M8	ZEW	ya–bins[b]	1991:M12
	CONS	cy, 1y	1989:M10	BOJ	ya, 5y–bins[b]	2001:Q2
	WEO	cy, 1y	1993:H1			(2004:
	OECD	ya	1990:H1	TANAO	Diffusion index	Q2/5y) 1985:Q1
New Zealand	CONS	cy, 1y	1990:M1	RBNZ	qa, 1y, 2y	1987:Q3
	WEO	cy, 1y	1993:H1	SCOPE	ya–bins[b]	1987:Q4/
	NZIER	cy, ya, 2, 3, 4 ya	1988:Q1			1995:Q1
	OECD	ya	1990:H1			
Sweden	ECON	cy, 1y	1990:M8	ECB/ECC	ya–balance[b]	1995:M1
	CONS	cy, 1y	1989:M11			1990:M1
	WEO	cy, 1y	1993:H1			
	OECD	ya	1990:H1			
Switzerland	ECON	cy, 1y	1990:M8	ZEW	ya–bins[b]	1991:M12
	CONS	cy, 1y	1989:M11			
	WEO	cy, 1y	1997:H2			
	OECD	ya	1990:H1			
United Kingdom	ECON	cy, 1y	1990:M8	ECB/ECC	ya–balance[b]	1985:M1
	CONS	cy, 1y	1989:M11	YOUGOV	ya	2005:M12
	WEO	cy, 1y	1993:H1	BOE/NOP	1y–bins[b]	2000:Q1
	BOEMPC	1y	1993:Q1			
	OECD	ya	1990:H1			

Table A1: Inflation Surveys/Forecasts (*continued*)

Economy	Forecast	Horizons[a]	Start	Survey	Horizons[a]	Start
United States	ECON	cy, 1yr	1990:M8	SPF	cq, qb, cy, ya, 1qa, 2qa, 3qa, 4qa, 10y	1981:Q3 (1991:Q4 for 10y)
	CONS	cy, 1y	1989:M11			
	GREEN	cy, 1q, 2q, 3q, 4q, 5q, 6q, 7q, 8q, 9q	1965:Q4, 1966:Q1, 1968:Q1, 1969:Q4, 1972:Q3, 1979:Q1, 1981:Q4, 1989:Q4, 1990:Q3	MIMN	ya	1978:Q1
				LIV	cm, cy, 6m, 12m, 1y, 2y, 10y	1985:H1
				ZEW	ya–bins[b]	1991:M12
	WEO	cy, 1y	1993:H1			
	OECD	ya	1990:H1			
	Wall Street Journal	cy	2003:H1			

(a)   'cy', '1y' and 'ya' represent current year, one-year-ahead and year ahead, respectively. There is little substantive difference between '1y' and 'ya' other than different sources use different language to refer to forecasts that pertain to the year following the publication of the forecast. In some cases, however, the forecast can refer to the calendar year ahead, or to a forecast for a calendar year ahead from the time of publication, in which case the forecast horizon may overlap the current and following calendar year. '#m', '#q' or '#y' refer to forecasts # months, quarters or years ahead. 'qb' is the quarter before the quarter for the particular observation.

(b)   'Balance' refers to the horizon stated applicable to the remainder (i.e. balance) of the year; 'bins' refers to the fact that forecasts are arranged in the form of a distribution of responses.

Table A2: Central Bank Forecasts

Country	Frequency	Horizons	Start
Japan	Half-yearly	Current and 1 year ahead	2000
New Zealand	Quarterly	Up to 12 quarters ahead	1997
Sweden	Quarterly	Up to 8 quarters	2000
Switzerland	Quarterly	Up to 2 years ahead	2003
United Kingdom	Quarterly	Up to 8 quarters ahead	1993, 1998 (conditional on market interest rates)
United States	Half-yearly	Up to 9 quarters	2000

Table A3: Internet Sources for Forecasts and Surveys (*continued next page*)

Economy	Sources
Australia	http://www.melbourneinstitute.com/ http://www.consensuseconomics.com/ http://www.imf.org/external/ns/cs.aspx?id=29 http://www.economist.com/ http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html
Canada	http://www.consensuseconomics.com/ http://www.imf.org/external/ns/cs.aspx?id=29 http://www.conferenceboard.ca/ http://www.economist.com/ http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html http://www.bankofcanada.ca/en/
Euro area	http://www.consensuseconomics.com/ http://www.economist.com/ http://ec.europa.eu/economy_finance/db_indicators/db_indicators8650_en.htm http://www.ecb.int http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html
Japan	http://www.consensuseconomics.com/ http://www.economist.com/ http://www.imf.org/external/ns/cs.aspx?id=29 http://www.zew.de/en/daszew/daszew.php3 http://www.boj.or.jp/en/ http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html
New Zealand	http://www.consensuseconomics.com/ http://www.rbnz.govt.nz/ http://www.nzier.org.nz/ http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html

Table A3: Internet Sources for Forecasts and Surveys (*continued*)

Economy	Sources
Sweden	http://www.consensuseconomics.com/
	http://www.economist.com/
	http://ec.europa.eu/economy_finance/db_indicators/db_indicators8650_en.htm
	http://www.imf.org/external/ns/cs.aspx?id=29
	http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html
	http://www.riksbank.com/
Switzerland	http://www.consensuseconomics.com/
	http://www.economist.com/
	http://www.imf.org/external/ns/cs.aspx?id=29
	http://www.zew.de/en/daszew/daszew.php3
	http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html
	http://www.snb.ch/
United Kingdom	http://www.consensuseconomics.com/
	http://www.economist.com/
	http://ec.europa.eu/economy_finance/db_indicators/db_indicators8650_en.htm
	http://www.imf.org/external/ns/cs.aspx?id=29
	http://www.bankofengland.co.uk/
	http://www.yougov.com/frontpage/home
	http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html
United States	http://www.consensuseconomics.com/
	http://www.economist.com/
	http://www.imf.org/external/ns/cs.aspx?id=29
	http://www.philadelphiafed.org/research-and-data/real-time-center/
	http://www.src.isr.umich.edu/http://www.src.isr.umich.edu/
	http://www.oecd.org/document/59/0,3343,en_2649_34109_42234619_1_1_1_37443,00.html
	http://online.wsj.com/home-page
	http://www.zew.de/en/daszew/daszew.php3

Table A4: Basic Data Series Information

Economy	Series	Sources
Australia	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, housing prices, central bank policy rate	Reserve Bank of Australia, BIS, IMF, www.econstats.com, Australian Bureau of Statistics
Canada	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, housing prices, central bank policy rate	Bank of Canada, BIS, IMF, www.econstats.com, Statistics Canada
Euro area	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, housing prices, central bank policy rate	European Central Bank, BIS, IMF, www.econstats.com
Japan	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, central bank policy rate	Bank of Japan, BIS, IMF, www.econstats.com, Cabinet Office
New Zealand	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, housing prices, central bank policy rate	Reserve Bank of New Zealand, BIS, IMF, www.econstats.com
Sweden	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, housing prices, central bank policy rate	Sveriges Riksbank, BIS, IMF, www.econstats.com
Switzerland	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, central bank policy rate	Swiss National Bank, BIS, IMF, www.econstats.com
United Kingdom	Real GDP, CPI, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, housing prices, central bank policy rate	Bank of England, BIS, IMF, www.econstats.com, Nationwide
United States	Real GDP, CPI, commodity prices, real and nominal exchange rates, stock price index, money market rate, LIBOR rates, long-term government bond yields, housing prices, central bank policy rate	Federal Reserve, BIS, IMF, www.econstats.com, Office of Federal Housing Enterprise Oversight (OFHEO), Bureau of Labor Statistics

Table A5: Descriptors Used for Forecasts in Tables and Figures
(*continued next page*)

Code	
BNIER	National Institute of Economic Research Business Tendency Survey
BOC	Bank of Canada Business Outlook Survey
BOE	Bank of England
BOEMPC	Bank of England Monetary Policy Committee
BOEQ	Bank of England quarterly forecasts (unconditional)
BOJ	Bank of Japan – Forecast of Monetary Policy Committee (all members)
BOJ1	Bank of Japan – Survey of Inflation Perceptions
BOJALL	Bank of Japan Monetary Policy Board – All members
BOJMAJ	Bank of Japan Monetary Policy Board – Majority of members
CBD	Conference Board of Canada
CNIER	National Institute of Economic Research Consumer Tendency Survey
CONS	Consensus Economics
ECB	European Commission Business Survey (Economic Sentiment Indicator)
ECC	European Commission Consumer Survey (Economic Sentiment Indicator)
ECON	*The Economist*
FOMC	Federal Open Market Committee
GREEN	Greenbook (Federal Reserve Board)
LIV	Livingston Survey (Federal Reserve Bank of Philadelphia)
MICH	University of Michigan Survey – median
MIMN	University of Michigan Survey – mean estimate
MLB	Melbourne Institute of Applied Economic and Social Research, University of Melbourne
NAB	National Australia Bank
NIER	National Institute of Economic Research
NOP	National Opinion Poll (UK)
NZIER	New Zealand Institute of Economic Research
OECD	Organisation for Economic Cooperation and Development (*Economic Outlook*)
RBNZ	Reserve Bank of New Zealand – 1-year-ahead inflation forecast
RBNZ1	Reserve Bank of New Zealand – average of quarterly forecasts over a 1-year-ahead period
RIKS	Riksbank Forecast
SCOPE	Market Scope (New Zealand)
SCOPUP	Bankscope
SNB	Swiss National Bank
SPF	Survey of Professional Forecasters (US, euro area)
TANAO	Tankan Survey

Table A.5: Descriptors Used for Forecasts in Tables and Figures (*continued*)

Code	
YOUGOV	YouGov Survey (UK)
WEO	*World Economic Outlook* (IMF)
ZEW	Centre for European Economic Research – Financial Market Surveys and Indicators of Economic Sentiment
infitted	Regression method conversion (see Section 3)
infitted1	Probability approach conversion method (see Section 3)

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