Inflation Forecasts in Asia and the Pacific: Performance, Disagreement, and Spillovers

Pierre L. Siklos†
Department of Economics, Wilfrid Laurier University
Balsillie School of International Affairs

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ABSTRACT

Until the so-called 'global financial crisis' of 2008-9 central banks celebrated the achievement of lower and more stable inflation rates. With a few exceptions, this accomplishment was a global one. Motivated by concerns over whether the relentless easing of policy in economies most stricken by the US and euro zone financial crises may lead to higher future inflation, this paper examines inflation forecast performance along several dimensions. The focus is on 12 economies in Asia and the Pacific as well as inflation performance in the United States and the euro zone. The principal findings of the paper are as follows. Whether forecasts portend an un-anchoring of expectations depends crucially on whether central banks convince the optimists or the pessimists amongst forecasters. The two types of forecasts are driven by different sets of fundamentals. Second, crisis times are precisely when central banks have the greatest flexibility to exploit deviations from some inflation objective. Third, forecasters can express large disagreement with central banks over one year inflation forecasts especially during stressful economic times. The notion that forecasters essentially adopt or mimic central bank forecasts does not hold at all times, and especially not during stressful economic times.

Pierre L. Siklos, WLU and BSIA, psiklos@wlu.ca

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1. Introduction

Until the so-called 'global financial crisis' of 2008-9 central banks celebrated the achievement of lower and more stable inflation rates. With some exception, this accomplishment was a global one. There was, it seems, no need to convince policy makers, or the public, that excessively high inflation rates are economically harmful. In spite of the turbulent events of the past few years the monetary authorities have not revised their view that low inflation is a desirable state. Indeed, there seems to be no desire, even on the part of most governments, to turn back the clock on the decades old efforts to enshrine inflation control as the primary mission of monetary policy. There is, however, pressure to relegate inflationary concerns to the back burner. This development stems in no small part from the almost complete absence of any imminent surge in the inflation outlook practically around the world.

Nevertheless, there is a nagging feeling that inflation may yet make a comeback in spite of weak global economic conditions. Some has called inflation "….the most capricious of economic variables." (Harding 2013). Why do some policy makers insist on keeping alive concerns over the possibility of a return to excessively high inflation rates? In part, it is because inflation remains incompletely understood. Even Milton Friedman's celebrated quote, namely that "… *substantial inflation is always and everywhere a monetary phenomenon*…" comes with the proviso that such recognition "…is only the beginning of an understanding of the cause and cure of inflation "(Friedman 1992, p. 193). In spite of the widespread reliance on the Phillips curve trade-off, more than 50 years after it made its appearance in the profession, economists continue to grapple with the need to understand inflation, its evolution over time, across countries, and how expectations of inflation respond to observed inflationary developments.

There are good reasons, of course, to believe that "good policies", as opposed to the "good luck" which may well have characterized business cycle movements during the Great Moderation, can explain the lion's share of global inflation performance over the past decade or so (inter alia, see Stock and Watson 2002, 2003, Bohl, Mayes, and Siklos 2011).

However, exactly what items the 'menu' of good policies consists of continues to be debated even as, in many parts of the world, central banks have turned their attention towards dealing with financial stability issues.

Complicating matters is that success at reaching price stability rests crucially on monetary policy being forward-looking. As a result, "[F]orecasting and controlling inflation are, of course, central to the process of making monetary policy (Bernanke 2008). Unfortunately, in the same speech, Bernanke also points out, "…there is much we do not understand about inflation expectations, their determination, and their implications." Also contributing to the unease over future inflation prospects is the unprecedented level of monetary policy ease, especially in the industrial world. Understanding inflation forecasts, their accuracy, and the degree to which forecasters disagree and why, represent essential ingredients in the successful anchoring of inflation expectations.

Not to be forgotten is the potential or risk of deflation. At least twice in the past decade or so, central banks in the world's largest economies (viz., U.S., Japan, China, and the euro zone) faced the prospect or lived with bouts of deflation. As this is written several central banks are once again seeing inflation rates fall to very low levels as the much hoped for global economic recovery struggles to reach 'escape velocity'. To be sure, continued economic slack contributes to moderating inflationary pressures even as the output gap seems to have become a less reliable indicator than it was in the decades before the global financial crisis struck the world economy. As is the case with inflation, deflation is equally capable of destabilizing expectations. The long history of low and mildly negative inflation in Japan reveals that forecasters find it even more difficult to forecast negative inflation rates suggesting that there exists an asymmetry in forecasting ability as between inflationary and deflationary episodes (e.g., see Siklos 2013).

Motivated by concerns over whether the relentless easing of policy in economies most stricken by the US and euro zone financial crises may lead to higher future inflation,[1] the

[1] It did not take long after the global financial crisis erupted for inflation worriers to make their case. See, for example, Crook (2009), and Napier (2009).

present paper examines inflation forecast performance along several dimensions. The focus is on 12 economies in Asia and the Pacific as well as inflation performance in the United States and the euro zone. Inclusion of the globe's two largest economic blocks is partly motivated by the possibility that monetary actions in one part of the world (viz., the U.S.) can and do spillover into other regions (e.g., Taylor 2013) and that this may be reflected in forecasters' views about the inflation outlook. Indeed, some have argued that the rapid expansion of central bank balance sheets among major central banks threatens low and stable inflation rates and will eventually usher in a new era of higher and more volatile inflation. When linked to slow economic growth the combination could conceivably recreate the stagflationary era of the 1970s (e.g., Meltzer 2008). Such fears have since subsided. Nevertheless, concerns have been raised about the unintended consequences of unconventional monetary policies (e.g., see White 2012). Similarly, there is the possibility that the unpredictable effects of financial crises also impacts forecast performance. Hence, examining the evolution of forecast accuracy across time may well provide additional insights about factors that underpin the stability of inflation expectations.

The notion that inflation shocks can be transmitted globally is not a new concern. It even pre-dates the idea that part of the international experience with low inflation in the 2000s is due to China's ability to export falling goods prices (e.g., Côté and De Resende 2008). Indeed, during the 1980s, analysts concluded that higher U.S. inflation was a source of global inflationary trends (e.g., see Darby et. al. 1983). These concerns have come full circle as some policy makers fear a return of higher U.S. inflation as inflation rates in several emerging markets have begun to rise over the past year.

Relying on previous evidence that univariate models easily out-perform multivariate ones (e.g., Stock and Watson 2007) much of the analysis that follows relies on a simple framework to explain the behavior and performance of inflation forecasts in the 14 economies examined. Nevertheless, in view of the continuing interest in the role of policy regimes (e.g., inflation versus non-inflation targeting economies) and their transparency as determinants of inflation performance, the impact of changing global capital flows, the

accumulation of foreign exchange reserves and the relative ability of the policy authorities to sterilize them, the present study also considers whether such factors might also impinge on the accuracy of inflation forecasts in Asia and the Pacific.

In light of the global spillovers argument (e.g., see Taylor 2013), the paper also considers the degree to which inflation forecasts are possibly subject to contagion type effects. If policy authorities rely on floating exchange rates then foreign shocks ought largely to be reflected in exchange rate movements. Even when managed floating is the chosen exchange rate regime there may be other instruments available to blunt the inflationary impact of foreign shocks (e.g., taxes, capital controls). Additionally, unless there are strong trade links between all of the economies in question it is unclear why inflation in one part of the world needs to spillover into other parts of the globe unless the explanation lies in a role played by non-fundamental factors. Finally, if for purely domestic reasons, industrial countries increasingly deviate from the rules like behavior that characterized monetary policy until 2008, then any spillovers in inflation forecasts within the Asia and Pacific regions to and from the rest of the world originate from sources that are even more difficult to identify. In other words, the study considers the possibility whether there are non-fundamental reasons for inflation and inflation forecasts to be transmitted globally. One can think of this as the empirical characterization of the 'bad luck' story of global inflationary developments as it pertains to the Asia and Pacific regions.

An insufficiently recognized aspect of the analysis of forecasts is that these can differ greatly across forecasters. To the extent that disagreement in forecasts stem from changes in inflationary developments, reflect unclear or non-transparent signals emanating from policy makers, these can be far more informative about forecast performance and the consequences of policy actions. Forecast disagreement (e.g., see Siklos 2012, 2012a, 2013) provides a window into our understanding of the likelihood that expectations can become unanchored. This ranks as one of the biggest fears of monetary authorities as they eventually face the removal of ultra-easy credit conditions. A related concern, raised so far primarily at a theoretical level, is that the long period of quiescent inflation, thanks to a

combination of autonomous and transparent central banks, has prompted forecasters and the public to set their inflation expectations according to the tune played by central bank forecasts. The coordination of forecasts is believed to expose a dark side of central bank transparency (Morris and Shin 2002). Yet, there has been almost no attempt to quantify the seriousness of the problem. The present paper offers some empirical evidence which contradicts the negative implications of central bank transparency, at least during periods of economic stress.

The rest of the paper is organized as follows. The next section briefly asks why, in spite of reasonably good inflation performance, some analysts and many policy makers continue to publicly express concerns over a possible resurgence of the high inflation rates of the 1980s. Next, the data are described and the methodological approaches to studying inflation and inflationary expectations are outlined. Section 4 is devoted to a description of the main empirical results, including the conclusion that it is important to examine varieties of forecasts and not solely point forecasts, as well as the finding that forecasters tend to express large disagreement with central banks over one year inflation forecasts during crisis times. The paper concludes with a summary and some policy implications are drawn.

2. Why Inflation (and Deflation) Haunts Us Still

The stagflation of the 1980s and early 1990s left a lasting impression on policy makers inside and outside central banks. Improvements in the 'contract' between governments and the central bank since that time contributed to reducing average inflation rates to levels not seen since the 1960s. Carney (2013), in one of his last speeches as Governor of the Bank of Canada, argues that this sufficed in the era of the Great Moderation.

While the events since late 2007 have apparently led to a reallocation of tasks a central bank must carry out worries about the future course of inflation (or deflation) remain at the forefront of central bank concerns in spite of mounting evidence that economic slack at the

global level remains high, principally in the industrial world.[2] The potential global impact of stimulating economies worldwide prompted fears of a looming inflation or, at least, the de-stabilization of inflationary impulses that characterized pre-central bank independence stop-go monetary policy regimes (e.g., see Goodfriend and King 2013). These factors, when combined, can easily lead to conditions that can un-anchor inflationary expectations.

The IMF (2013) recently concluded that inflation is "The Dog That Didn't Bark", largely thanks to the benefits of central bank independence and an improved capacity of the part of policy makers to control an economy's inflation impulses. However, as central banks have increasingly been called upon to support fiscal policy and finance sovereign debt, considered unsustainable by some (e.g., Schoder 2013), there is the worry that central banks are losing their independence. Even if an inflationary surge is not imminent, any un-anchoring of inflation expectations, given its persistence properties (e.g., Fuhrer 2009, also see below), will exacerbate inflation rates if the monetary authorities find it difficult to shift the stance of monetary policy in the direction associated with normal economic conditions. Others have chimed in that we can ignore, while not turning a blind eye to, inflation for the time being and shift priorities almost exclusively toward promoting economic growth (e.g., Brittan 2013, Wadhwani 2013). As noted previously, however, such a realignment of objectives may well require policy makers to revisit the existing central bank – government 'contract'.

Other than the fact that the IMF's study focuses only on the inflation record in advanced economies, that underlying economic uncertainty is ignored, as is the role of the exchange rate regime and central bank transparency, the remarkably stable inflation performance of the past few years may also be a reflection of the increasing reliance, if not coordination, of inflation expectations with those of the central bank. Morris and Shin's (2002) analysis warns us of this possibility. Even if some of the parameters of their model are considered implausible (Svensson 2002), a potential source of the un-anchoring of inflation expectations

[2] Apart from the usual challenges in measuring the level of slack in the economy is the uncertainty over whether allowances should be made for a significant structural shift in potential economic activity, not to mention the distribution of slack as between domestic and global sources. See, inter alia, Borio and Filardo (2007), and IMF (2013).

might be a loss of credibility in central banks' outlook, possibly reflected in a rise in forecasters' disagreement vis-à-vis the forward-looking scenarios of the central bank.

Rules like behavior, of which the Taylor rule is the embodiment of modern monetary policy making, ensures that a shock that led inflation and economic output to deviate from their respective notional or capacity levels, would eventually (and optimally) be eliminated via manipulation of the instrument of monetary policy, ordinarily an interest rate. However, following the crisis, the sphere of influence and authority of the central bank has become somewhat blurred not only because, in what is now called 'macro-prudential' policy, governments and central banks have shared responsibilities but perhaps more importantly because economic 'headwinds' in unusual times may well justify a looser policy for an extended period of time. Under such conditions, a tightening would be delayed only *after* inflation returns to target. As a result, policy-making in this environment requires a form of flexibility that differs from the 'constrained discretion' that characterizes central bank behavior in normal times.[3] More generally, the implication is that central banks may be required to act 'irresponsibly' for a time until normal economic conditions return.[4] To quote Carney (2013):

"In the tranquil macroeconomic environment of the "Great Moderation," this ambiguity didn't matter. Central banks generally sought to return inflation to target over a standard medium-term monetary policy horizon of six to eight quarters. They were largely successful. This created a virtuous cycle of credibility and well-anchored inflation expectations.

With the scale and the persistence of the shocks now present, such ambiguity can be unhelpful.

[3] For example, the Bank of Canada's take on how monetary policy reacts to headwinds (or tailwinds) is articulated in its July 2011 *Monetary Policy Report*, p. 28-29. Headwinds include the continued appreciation of the currency while tailwinds arise from the persistent effects of financial shocks. While this description serves to explain, in part, the Bank of Canada's reaction in crisis times, these phenomena are just as applicable for the economies in Asia and the Pacific.

[4] This view is attributed to Woodford (2012) who argues that, where relevant, policy rates may be required to remain at the zero lower bound beyond the time suggested by application of the Taylor rule.

The flexibility that central banks may require, both to address the consequences of the crisis and to reduce the risk of a repeat, raises a fundamental question about the appropriate constraints on central banks' delegated authority."

The implication then is that the virtuous circle the former Bank of Canada Governor refers to could well be broken at any time in response to a recurrence of tailwinds or headwinds. Notice that these are treated as external shocks. To the extent that some Asian economies intervene in the market for foreign exchange, to take one example, also raises the possibility that developments in some economies may well spillover into the other economies in the region. This suggests, therefore, that differences in forecast performance across the economies of Asia and the Pacific considered in this study may well provide an indirect indication of how well inflation expectations are anchored. Indeed, to the extent that shifts in inflation forecasts can be detected these can provide useful indications about the types of 'wake-up' calls that lurk in the data which may signal an un-anchoring of inflation expectations.

If the prospect of future inflation worries some central bankers others are equally concerned about the prospect of a renewed threat of deflation. In spite of the fact that there is little evidence that mild deflation is economically harmful[5] some central banks are determined to avoid a prolonged deflation at all costs. However, there has been less effort devoted to determining whether inflation forecasts behave relatively differently when inflation is low or negative. In view of the current fragile economic environment it is worth considering whether there are asymmetries in forecast performance and disagreement between bouts of (high) inflation and deflation. Japan is the obvious example of the latter phenomenon although China, Hong Kong, and Singapore have also known deflationary episodes.

3. Data and Empirical Methods

[5] The fear of deflation is dominated by the experience of the Great Depression of the late 1920s and early 1930s. For relevant empirical evidence that explores the consequences of different episodes of deflation, see Burdekin and Siklos (2004, Chapter 1), and Borio and Filardo (2004).

3.1 Data

Our principal focus is on inflation and inflation forecast performance in 12 economies of Asia and the Pacific. They are: Australia, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Thailand, and Singapore. In addition, because of their significance to the global economy and, in view of the discussion in the previous section, I also include evidence from the United States and the euro zone. Inflation is evaluated as 100 times the fourth-order log difference of a Consumer Price Index.

While most economies in the data set (Australia and New Zealand are exceptions) provide price level data at the monthly frequency many of the published inflation forecasts are only available at coarser frequencies, namely the quarterly and semi-annual frequencies. In addition, many of the standard macroeconomic determinants of changes in inflation forecasts are ordinarily also only available at the quarterly frequency. Available raw monthly data were converted to the quarterly frequency via arithmetic averaging. Data at coarser frequencies (viz., semi-annual) were converted to the quarterly frequency via linear interpolation. Annual data available were considered too coarse and, hence, were not used except in the case of the measurement of central bank transparency (see below).

The length of the sample is affected by the absence of significant amounts of forecast data prior to the 1990s for most of the economies in our sample. Depending on the data source then the sample begins in 1990 for the more mature economies in the Asia-Pacific (e.g., Australia, New Zealand, Japan, the U.S., and the euro zone) with the bulk of the forecast data beginning in the mid-1990s (usually 1994 or 1995) in the remaining economies considered in this study.[6] Asia-Pacific economies are notable in that, since the late 1990s, they have been exposed to three large financial shocks, namely the Asian financial crisis of 1997-8, the 'global' financial crisis that originated in the United States in 2007 and is thought to have largely ended in 2009, followed soon thereafter by the ongoing sovereign debt crisis in the euro zone which began in the Spring of 2010.

[6] A separate appendix, available on request, provides the details.

An essential element of our understanding of inflation forecasts involves quantifying the level of disagreement among forecasters. Accordingly, it is imperative that a wide variety of forecasts should be collected. Four major sources of inflation forecasts are included in this study.[7] They are: private sector forecasts (e.g., Consensus, Survey of Professional Forecasters), forecasts published by public agencies (e.g., OECD, International Monetary Fund), forecasts derived from household and business surveys, and forecasts published by central banks. In the empirical work that follows, I make no explicit distinction between central bank forecasts that are produced by staff versus ones that represent the views of, say, the policy making body.[8]

While we do not observe the loss function of the individual forecasters it is plausible that private, public and central bank forecasts may be motivated by different views about the costs and consequences of forecast errors. In addition, some of the forecasts are purely judgmental, others are derived from single or multiple models while others still combine judgment with model-based forecasts.[9]

Next, forecasts are published in a variety of forms. For example, some forecasts are of the fixed event variety, such as when a forecast for a calendar year is published. Alternatively, forecasts are of the fixed horizon kind which mirror more closely the usual definition of inflation adopted for time series analysis. In what follows all data are converted to fixed horizon forecasts using a commonly used, but arguably *ad hoc*, procedure.[10] Using fixed horizon forecasts requires current and year-ahead forecasts for conversions from fixed event forecasts. In a very few cases we kept current or year ahead fixed event forecasts in the data set when both types of fixed event forecasts were unavailable.

Not all household or business inflation outlook surveys are published in the form of inflation rates. Instead, these sometimes need to be converted from an index. Two well-known

[7] It should be noted, however, that coverage across these forecast sources differs substantially across the economies considered.

[8] Readers will be able, however, to identify the nature of the central bank forecast from the information contained in the appendix.

[9] Faust and Wright (2012) provide a thorough and up to date review of model-based and judgmental forecasts of inflation. Notably, they conclude that judgmental forecasts (of which the U.S. Greenbook forecasts available from the U.S. Federal Reserve with a fairly long lag) are "…remarkably hard to beat."

[10] See Siklos 2013, n. 20, for the details.

techniques have been widely used in the literature.[11] As might be expected each approach has advantages and disadvantages. Accordingly, I adopt an approach that takes the arithmetic average of the implied inflation forecasts generated from the two approaches (see Siklos 2013).

Finally, a few other data related issues require explanation. First, since the availability of forecasts differs across time, economies, and forecast types, the complete data set has the appearance of an unbalanced panel. Second, because of the publicity devoted to Consensus style forecasts, available for every economy in the data set, some of the evidence presented below examines these forecasts separately. In defining Consensus forecasts, the arithmetic mean of all forecasters surveyed by Consensus is used although not all forecasters in the survey are retained. For example, some forecasters dropped out of the survey or their forecasting record is highly irregular. Again, readers are asked to consult the appendix for the details.

Since I am also interested in the determinants of changes in forecasts there exist a range of macroeconomic and institutional determinants one can marshal to assess sources of variation in, say, forecast disagreement, a key indicator of how policies interact with forecast performance and, by implication, accuracy. At the institutional level three obvious factors emerge. They are: the exchange rate regime, whether the central bank in question is required to meet a numerical inflation target, and the degree of central bank transparency. Half of the economies in our sample have adopted a numerical inflation target. They are: Australia, Indonesia, Korea, New Zealand, Philippines, and Thailand. Details about the adoption dates and the target ranges over time are also relegated to the Appendix. In addition, the dating of financial crises (e.g., banking versus currency crises, systemic versus non-systemic crises), and the type of exchange rate regime are other channels that might influence whether forecasters disagree with each other. In the short-run, economic slack, real exchange rate movements, the size of foreign exchange reserves in relation to GDP, are examples of additional determinants of changes in forecast disagreement over time. For crises before the most recent GFC I adopt the dates suggested by Reinhart and Rogoff (2009), Valencia and Laeven (2012) while exchange rate

[11] Smith and McAleer (1995) provide a survey.

regime data are from Reinhart and Rogoff (2004).[12] For the GFC I follow Dominguez, Hashimoto, and Ito (2012).[13]

3.2 Methodological Approaches

As discussed previously the approach taken here is an eclectic one meant to uncover what drives inflation forecast performance and disagreement among forecasters. Since there exist well-known and commonly used metrics to describe inflation and inflation forecast performance we begin with a descriptive analysis by investigating the root mean squared error of forecasts (RMSE), assessing forecast efficiency and the persistence of inflation. To conserve space some results are relegated to a separate appendix. Also in order to conserve space the evaluation is conducted for all forecast types taken together. As we shall see later on, disaggregating some of the results according to the source of the forecast (e.g., central bank versus private sector forecasts) is an important consideration and does yield some useful additional insights into inflation forecast behavior.

Denote annualized inflation for economy *i* at time *t* as $\pi_{i,t}^{k}$. The superscript *k* indicates the type of forecast, that is, whether it is a central bank, private sector, survey-based, or other institutional forecast (e.g., IMF). If we drop *k* this indicates that all forecasts are aggregated. Hence, the forecast error is written

$$\pi_{i,t}^{FE} = \pi_{i,t} - \pi_{i,t}^{F} \tag{1}$$

where FE is the forecast error, and F represents the forecast. All other terms were previously defined. The RMSE is, of course, the square root of the sum of squared forecast errors scaled by the number of observations (i.e., forecasts). Forecast efficiency simply asks whether there is any correlation between inflation and forecast errors. For example, if inflation expectations are adaptive in some sense then forecasts will not be efficient. Rational forecasts would, of course, be efficient. Similarly, if forecasters persistently make forecast errors because

[12] For the economies in our data set the only change of note in exchange rate regimes since 2007, when the Reinhart and Rogoff data set ends, is the relaxation of the peg by China in 2009.

[13] They identify different starting and ending dates for the GFC, depending on the economy in question. A Table in the Appendix provides the details.

they follow and adaptive rule or are inattentive then one should observe significant serial correlation in the relevant series.

The persistence property is a pervasive one in macroeconomic time series and especially in the behavior of inflation rates. Depending on how persistent inflation is this may well partially explain the formation and performance of inflation forecasts. Equally important is whether the monetary policy regime in place (e.g., inflation targeting), or large economic shocks (e.g., a financial crisis) changes the persistence properties of inflation. The simplest test consists in estimating the following regression

$$\pi_{i,t} = \alpha_0 + \alpha_1 \pi_{i,t-1} + \varepsilon_{i,t} \tag{2}$$

where $\pi_{i,t-1}$ is the lagged inflation rate in economy *i* at time *t* , α_0, α_1 are, respectively, the constant and persistence parameters, and $\varepsilon_{i,t}$ is a residual. Equation (2) is estimated for each economy individually although, in principle, the expression can also be estimated in a panel setting (see, however, below). Several extensions can be made to (2) to investigate the sensitivity of estimates. For example, if we wish to determine whether the adoption of inflation targeting impacts inflation persistence then an interaction dummy variable, set to 1 during the period when inflation targets are in place, can be added. Similarly, one might wish to examine whether the global financial crisis of 2007-9 affected inflation persistence in which case another interaction dummy variable can augment (2). Finally, adding other potential determinants of inflation, such as inflation expectations, and some output gap indicator, amounts to equation (2) taking the form of a commonly estimated version of a New Keynesian Phillips curve. Alternatively, adding the foreign exchange reserves to GDP ratio, in recognition of the surge in foreign exchange reserves holdings in several Asia-Pacific economies (e.g., see Filardo and Siklos 2013), is another device to determine the sensitivity of inflation persistence to alternative forms of (2). Clearly, other permutations of (2) are possible. However, these are not considered in part because my interest concerns the behavior of forecasts and forecast disagreement and not the development of a full-fledged model of inflation.

The connection between inflation and inflation forecasts in each one of the economies considered in the present study, together with other forces at play, such as openness, financial globalization, intervention in foreign exchange markets, to name but three such factors, suggests that there are both fundamental and, possibly, non-fundamental reasons for forecasters to cast their eyes on forecasts of others in the region or in the economies of large trading partners (e.g., the U.S., and the euro zone). Indeed, given that the source of the Asian Financial Crisis (AFC) was financial in nature, and the economies in the region sought to protect themselves from such crises in the future, one can ask whether inflation forecasts in some countries can influence similar forecasts in other economies. The transmission can be via fundamentals of the kind just discussed or via another mechanism that reflects contagion type effects. Put differently, if forecasts are determined by a common set of macroeconomic and financial factors in each one of the economies examined this is suggestive of interdependence in the determination of inflation forecasts (and, by implication, disagreement over inflation expectations). Alternatively, any co-movements in inflation and forecasts of inflation may be due to contagion type effects that manifest themselves in a crisis. Thus, if expectations of inflation are likely to become unanchored then a proximate source can be a crisis that emerges somewhere inside or outside the region. There is, of course, a vast literature on contagion testing. In what follows the so-called Chow Contagion Test (CCT) is adopted. Its aim is to evaluate whether inflation and inflation forecasts become more highly correlated in a crisis period, with the correlation adjusted for the upward bias induced by the rise in volatility during crisis periods (e.g., see Forbes and Rigobon 2002; also see Burdekin and Siklos 2011).

For simplicity, the test specification shown below illustrates the case of inflation rates in four groups of economies although, in principle, the specification can readily be generalized to consider contagion in a more disaggregate set of economies. The economies in the dataset are grouped as follows: China, Japan, the U.S., and the remaining economies in the sample. Alternatively, I consider economies that target inflation (i.e., Australia, Korea, Philippines, New Zealand. Thailand, and Indonesia) as well as a group of economies that actively intervenes in foreign exchange markets (i.e., Hong Kong, Malaysia, Singapore, and India). In this manner we can indirectly determine contagion type effects according to the monetary policy strategy in

place as well as between the large economies and a group of relatively smaller open economies. Next, I assume that crisis and non-crisis episodes can be identified. The focus is on the GFC dated to begin in 2007Q1 and ending in 2009Q2. The resulting dummy variables take on the value of one for the crisis sample, and zero otherwise. Next, I normalize inflation rates by the standard deviation of inflation during the normal or non-crisis periods. For *n* inflation rates there are *n*-equations to assess the direction of contagion. Continuing with the example of four groups of economies we can write:

$$\begin{aligned}
\tilde{\pi}_{1t} &= \omega_1^{'} + \theta_1^{'}GFC_t + \theta_{12}^{'}\tilde{\pi}_{2t} + \theta_{13}^{'}\tilde{\pi}_{3t} + \lambda_{12}\tilde{\pi}_{2t}GFC_t + \lambda_{13}\tilde{\pi}_{3t}GFC_t + \theta_{14}^{'}\tilde{\pi}_{4t} + \lambda_{14}\pi_{4t}GFC_t + \xi_{1t} \\
\tilde{\pi}_{2t} &= \omega_2^{'} + \theta_2^{'}GFC_t + \theta_{21}^{'}\tilde{\pi}_{1t} + \theta_{23}^{'}\tilde{\pi}_{3t} + \lambda_{21}\tilde{\pi}_{1t}GFC_t + \lambda_{23}\tilde{\pi}_{3t}GFC_t + \theta_{24}^{'}\tilde{\pi}_{4t} + \lambda_{24}\pi_{24}GFC_t + \xi_{2t} \\
\tilde{\pi}_{3t} &= \omega_3^{'} + \theta_3^{'}GFC_t + \theta_{31}^{'}\tilde{\pi}_{1t} + \theta_{32}^{'}\tilde{\pi}_{2t} + \lambda_{31}\tilde{\pi}_{1t}GFC_t + \lambda_{32}\tilde{\pi}_{2t}GFC_t + \theta_{34}^{'}\tilde{\pi}_{4t} + \lambda_{34}\tilde{\pi}_{4t}GFC_t + \xi_{3t} \\
\tilde{\pi}_{4t} &= \omega_4^{'} + \theta_4^{'}GFC_t + \theta_{41}^{'}\tilde{\pi}_{1t} + \theta_{42}^{'}\tilde{\pi}_{2t} + \lambda_{41}\tilde{\pi}_{1t}GFC_t + \lambda_{42}\tilde{\pi}_{2t}GFC_t + \theta_{43}^{'}\tilde{\pi}_{3t} + \lambda_{43}\tilde{\pi}_{3t}GFC_t + \xi_{4t}
\end{aligned} \quad (3)$$

where $\tilde{\pi}_{it}$ are the standardized inflation rates for markets *i*=1,…,*n* and GFC_t is the global financial crisis dummy. Hence, $\tilde{\pi}_{it} = \dfrac{\pi_{it}}{\sigma_{s_i^{GFC=0}}}$ where $\sigma_{s_i}^{GFC=0}$ is the standard deviation of inflation in economy *i* in the non-crisis period, and π_{it} is observed inflation as defined above. Equation (3) can be estimated as seemingly unrelated regressions. Moreover, while (3) is written in terms of observed inflation the same test equation would be specified for inflation forecasts with π^F replacing π. Indeed, the test results reported below assume that contagion in inflation forecasts is what is of interest.

The test for contagion is based on the null hypothesis that $\lambda_{ij} = 0$.[14] Thus, for example, if $\lambda_{12} \neq 0$ this is an indication of contagion from economy "2" to economy "1". While the unconditional nature of these correlations is understood and recognized by researchers, it is important to also appreciate that such correlations can change through time but, perhaps more importantly, may be sensitive to their location in the distribution of inflation rates. For example, if correlations between inflation rates across the economies examined here rise significantly during crises in some economies but not others, or generally increase during

[14] Joint tests for whether there is contagion from market i to markets j or k, where $j \neq k$ are also possible. See Dungey, Fry, and Martin (2009).

certain phases of economic activity, then an unconditional correlation will not reveal sensitivities to underlying changes in the economic environment. An obvious alternative, of course, is to consider a sub-sample. However, it is not always obvious how to select such a sample. Moreover, even if one opts for a data-driven technique to choose a sub-sample, one may still inadvertently omit observations relevant to an understanding of what moves the relationship between inflation rates over time and across regions. Another issue concerns the resort to a common definition for the crisis period across the regions considered. While the definition used here overlaps with the dates used in Dominguez, Hashimoto and Ito (2012), their dating of the crisis is country-specific. Consequently, results from such tests, while useful, should nevertheless only be treated as suggestive.

Next, I examine the relationship between inflation outcomes and forecasts via the graphical device of the sunflower plot. This is a useful device under the circumstances as there exist a large number of forecasts and the plot provides an early indication of whether and where most of the forecasts lie vis-à-vis inflation outturns. One of the many advantages of examining as wide variety of forecasts as possible is that it provides us with an opportunity to identify extreme observations, that is, inflation expectations that exceed the mean forecast by several standard deviations.

The availability of a relatively large number of forecasts from different source also allows us to construct a probability distribution of inflation forecasts. While it is typical to assume that the underlying probability distribution of inflation forecasts is uniform (viz., each forecast is equally likely to be the 'best' forecast) there is no *a priori* reason for this to be true. Instead we can construct a forecast density that allows us to determine the 'sharpness' of views about future inflation. It is convenient to rely on the Normal distribution to construct such densities. Recall that the sunflower plot discussed earlier permits us to uncover some clustering in inflation versus inflation forecast data. A metric that can be used to compare forecast performance against an 'ideal' forecast is the expected difference between their logarithmic score called the Kullback-Liebler (K-L) distance measure (e.g., see Wallis 2011, and Filardo and

Guinigundo 2008). This provides yet another means of investigating how forecasters change their views and the extent to which they disagree with each other over time.

There is no universally agreed upon measure of forecast disagreement (see Siklos 2013 for a brief discussion). Since we examine one year ahead inflation forecasts define d_{t1}^{i} represent forecast disagreement at time *t*, over a forecast of horizon of one year, for economy *i*. Then,

$$d_{t1}^{i} = \frac{1}{N_i - 1}\sum_{\delta=1}^{N_i}(\pi_{\delta t1}^{i,F} - \overline{\pi}_{\bullet t1}^{i,F})^2 \qquad (4)$$

where π_{t1}^{F} is the forecast for inflation at time *t* for a one year ahead horizon, N_j is the number of forecasts, δ identifies the forecaster, while $\overline{\pi}^{i}$ represents the mean forecast value for all forecasts for economy *i*. Forecast disagreement is first evaluated for each type of forecast. The mean value of *d* is then calculated for each economy *i* in the dataset. Disaggregated estimates of *d* can also evaluated for each forecast. The types of forecasts include ones prepared by central banks, survey-based forecasts conducted among households and businesses, a set of widely followed or core forecasts (i.e., OECD, IMF, Consensus), and a group consisting of all non survey-based forecasts. Grouping of forecasts is likely to be useful for a variety of reasons. For example, some of the data used in this study are projections, others are actual forecasts. Moreover, the assumptions and models (whether of the implicit or explicit variety) used to generate inflation forecasts are also likely to differ across the available sources. Moreover, in part because central banks are under increased scrutiny, as well as because of concerns raised by the results of Morris and Shin (2002), I also compare disagreement vis-à-vis the central bank forecast (i.e., $\overline{\pi}_{t}^{i,CB}$)as opposed to the mean forecast reflected in (4) above.[15]

4. Assessing Inflation and Inflation Forecasts in the Asia-Pacific Region

Figure 1 plots observed inflation (thick solid line) and the range of one year ahead inflation forecasts (shaded area). The first part provides plots for the 12 Asia-Pacific economies in the

[15] In several cases central banks generate a distribution of forecasts. To make clear that the focus is on the mean central bank point forecast a bar is placed over π^{CB} .

sample while the second part considers the record of the U.S. and the euro zone. To simplify the presentation economies will be identified by their acronym. They are:

Australia	AU
China	CN
Hong Kong	HK
India	IN
Indonesia	ID
Japan	JP
Korea	KR
Malaysia	MY
New Zealand	NZ
Philippines	PH
Singapore	SG
Thailand	TH
United States	US
Euro Zone	EZ

There are several interesting features that are worth highlighting. First, there has been considerable variation in inflation although, in most cases, except HK, IN, and possibly ID, there is no apparent trend in observed inflation. Next, again with the exception of ID, NZ, and perhaps KR, the range of inflation forecasts seems to have risen over time. This is especially noticeable in the case of IN, JP, and the EZ. It is also worthwhile to visually examine the degree to which the range of one year ahead inflation forecasts overlap with subsequently observed inflation. The results are rather mixed is spite, for example, of the persistence properties of inflation (see below). Of course, one must keep in mind that no allowances are made for the number and forecast sources. While forecasts tend to overlap with actual inflation as we move into the decade of the 2000s there is considerable variation. For example, inflation forecasts in AU consistently overlap observed inflation since inflation targets were introduced[16] while forecasters routinely either over or under estimate inflation in Malaysia. Of course, the sharp changes in energy prices beginning in 2007 and through 2008 distort the results somewhat.

[16] And the adjustment to inflation following the introduction of the goods and services tax (a type of value-added tax) in 2000 which shows up as spike in the data around that time. Policy makers insisted that the impact of such a tax on inflation would be temporary and forecasters appear to have reacted accordingly.

Forecasts for JP and the PH, the former a low inflation or deflation economy, the latter until recently and assisted by the adoption of an inflation target, a high inflation economy, also overlap with actual inflation. However, in these two cases, inflation outturns tend to be closer to the most optimistic inflation forecasts than the most pessimistic ones. Also, there is no obvious deterioration in the relationship between observed inflation and inflation forecasts since the GFC. Finally, while deflation has appeared in 9 of 14 economies examined at one time or another, sustained episodes of deflation are a feature only in HK, JP, and SG. The bottom line is that there is a rich variety of inflationary experiences and, at least visually, in forecasting performance across the 14 economies studied here.

A long noted stylized fact is that inflation is influenced by the state of the business cycle. Indeed, one can add that crises, particularly of the financial variety, may also contribute to influencing inflation rates, especially if recovery is assisted by expansionary fiscal policy and the resulting public debt load is managed in part through higher inflation (e.g., see Reinhart and Rogoff 2009). Applying these notions to the Asia-Pacific economies provides some challenges not least because many are rapidly growing economies and have been for some time. Hence, for example, in the case of China one speaks of growth recessions not the conventional recessions and expansions experienced in the advanced industrial economies. One other hand, assessing the impact of financial crises on inflation in the region means that we can consider, for several of the economies, at least two episodes of financial crises, namely the Asian financial crisis of 1997-98 as well as the more recent so-called GFC. A complication, of course, is that crises and recessions often overlap. Although evidence is spotty the fraction of the available data subject to recessions or financial crises ranges between 4.55% of the total number of observations in the case of Australia to a high of 42.05% in the case of Japan. By comparison, the U.S. is in recession 15.22% of the sample while the same figure is 34.09% for the euro zone.[17] The GFC, of course, generally represents a smaller fraction of the sample ranging from 2.25% of the sample for the Philippines to a high of 10.11% of the observations for Korea and Japan, based on the dates suggested by Dominguez, Hashimoto, and Ito (2012). If we add the

[17] Data from the NBER's reference cycle chronology for the U.S. and, for a selected group of other economies, the Economic Cycle Research Institute were used. Data are only published for Australia, India, Japan, Korea, and New Zealand. Data for the euro zone are from the CEPR.

Asian Financial Crisis (AFC) to the mix then the fraction of the sample some of the economies find themselves in crisis rises slightly.[18]

We now turn to a discussion of the performance of inflation forecasts in the 14 economies examined in this study. Table 1 provides some summary statistics about inflation forecast errors. Readers are reminded that all forecasts, regardless of the source, are aggregated for the purposes of the data presented in Table 1. Mean forecast errors are low, usually less than 1% over the sample. However, forecast errors are over 1% for Hong Kong and China. In 11 of the 14 economies considered forecasters over-estimate realized inflation as indicated by the negative mean forecast errors. In spite of small mean forecast errors, a reflection of the well-known result that combined forecasts outperform individual forecasts,[19] both the standard deviations and the range of forecast errors, the latter indicated by the columns indicating the largest and smallest under or over-estimated forecast errors, there is considerable variation in inflation forecasting performance. In some instances, this may reflect a form of forecast smoothing wherein some forecasters make no or few allowances for the short-term impact of commodity price changes on observed inflation (e.g., as in Indonesia) while others adjust their forecasts for the likely impact of short-term supply side shocks. However, since we are not able to observe either the 'model' or how judgment is used in generating forecasts, their loss function or how inattentive they are, it is difficult to identify the sources of this variation. I return to this issue below.

Forecast performance is often judged by the root mean squared error (RMSE) criterion. Table 2 presents evidence using the full aggregated data set, for crisis and non-crisis samples, as well as for the period when some economies adopted numerical inflation targets. In addition, separate columns provide data on the performance of central bank forecasts, where available. Keeping in mind that crisis periods tend to be of short duration it is nevertheless the case that

[18] Relying on the data by Laeven and Valencia (2012), China, Indonesia, Japan, Korea, Malaysia, Philippines, and Thailand experience banking crises in 1997 or 1998 (Korea also has a crisis in 1992). Japan is said to have experienced a sovereign debt crisis in the 1997-2002 period while Japan, Malaysia, the Philippines and Thailand faced a currency crisis in 1998. The same source suggests a banking crisis in the U.S. in 2007 and one in the euro zone in 2010.

[19] It is not often noted that this results depends on the forecasts being statistically independent of each other, at least in theory.

the GFC did not impair forecasting performance as RMSE fell relative to the non-crisis sample in 8 of 12 economies for which we have data. Moreover, RMSE during the GFC was lower than in the AFC in 9 of 13 economies shown. If one compares the non-crisis sample against the full sample forecasting is as good or improves in non-crisis times, at least in 11 of the 14 economies considered. Turning to the 9 central banks for which we have data, non-crisis times improve forecasting performance in 6 of 9 cases. However, the GFC results in a deterioration of forecast performance in 6 of 9 cases relative to the full sample.[20]

Turning to forecast efficiency (Table 3) we observe another illustration of the desirability of obtaining insights about expectations beyond an exploration of point forecasts alone. Among forecasters who over-estimate observed inflation the most (i.e., resulting in a negative forecast error) inflation none are considered efficient. In what follows, I refer to these forecasters as the pessimists. Turning to forecasters who produce a positive forecast error (i.e., observed inflation greater than the associated one year ahead forecast) these are associated with a higher observed inflation rate. Typically, there is a one to one relationship between the two. There is considerably more evidence of forecast efficiency, especially at the mean and median as well as for forecasters who underestimate future inflation. These are referred to as the optimists. Moreover, there is generally evidence of forecast efficiency among 5 of 6 inflation targeting (IT) economies in the sample, the only exception being Indonesia. As noted earlier, inflation forecasts for Indonesia tend to be excessively 'smooth' in the sense of being relatively less sensitive to swings in observed inflation likely influenced, for example, by commodity price movements.[21]

I now turn to the investigation of the links between realized and forecasted inflation. It is here that notions of de-linking or un-anchoring of inflation expectations become relevant. Figure 2 displays sunflower plots summarizing the bivariate relationship between observed inflation, measured on the horizontal axis, and one year head inflation forecasts. Whereas the previous summary statistics focused primarily on the mean of the distribution of various

[20] The results do not apply to the same central banks. For example, RMSE for the RBNZ declines in both the GFC and non-crisis samples

[21] Given the foregoing set of stylized facts it should come as no surprise that inflation forecasts are highly persistent, mirroring the persistence of realized inflation. Results are relegated to the appendix.

inflation forecasts the sunflower plots provide, in a visual format, an indication of the varieties of inflation forecast and how far away they are from realized inflation. Nevertheless, it is the mean of individual forecasts across the full sample that is measured against observed inflation. The full available sample (1990 to 1994 to the end of 2012; see the Appendix) is considered. The 'petals' highlight the extent to which inflation forecasts tend to cluster around the same value, or within close range of each other, while the 'sunflower' gives a visual indication of the number of such forecasts that are clustered together. Finally, the circles represent individual combinations of inflation forecasts plotted against CPI inflation in the 14 economies examined.

What immediately strikes the observer is the wide cross-country variation in both inflation performance and in the ability of forecasters to anticipate actual inflation rates one year head. Indeed, while there is a noticeable clustering of inflation forecasts in some economies but not in others. For example, there is a concentration of forecasts of 2% inflation and close to 2% actual inflation in the euro zone. While there is somewhat less clustering in the U.S. case it is is nevertheless the case that the bulk of inflation forecasts range from 2% to 3% which is the observed inflation performance one year later. Similar evidence is obtained for Australia, Korea, Malaysia, Japan, the Philippines, Singapore and Thailand. Also interesting is that there is a greater tendency for inflation forecasts to rise with observed inflation in Japan than in the other economies examined (although the EZ is another manifestation of this phenomenon). Moreover, there is no visual indication that the relationship between mean inflation forecasts and realized inflation is different as between the inflation targeting and the other policy regimes adopted in the economies depicted in Figure 2.[22] Finally, it is perhaps worth mentioning that, except in India, Indonesia, and Korea, some of the forecasters have been expecting a deflation during the period considered.

The previous set of results suggests that persistence is an important property of inflation performance. The notion that there exists significant inflation persistence is, of course, not a new one and it has been extensively studies elsewhere (e.g., Burdekin and Siklos 1999, Fuhrer

[22] Recall that Australia, Indonesia, Korea, New Zealand, the Philippines, Thailand, formally target inflation. More recently, the U.S. and Japan have announced inflation objectives while the ECB also has an inflation objective but does not consider itself an inflation targeting central bank.

2009, Beechey and Österholm 2012). However, the issue has received relatively less attention in Asia (see, however, Gerlach and Tillmann 2012). At the risk of over-simplification, the experience of the last two decades or so suggests a world wide drop in inflation persistence suggestive of the increased emphasis by central banks on inflation control. But this development also offers the opportunity for central banks to more flexibly deal with deviations from an inflation objective. More contentious is whether the drop in persistence is a result that is a property of inflation targeting central banks in particular.

Table 4 displays coefficient estimates of α_1 adjusted or conditioned for a variety of changes to the basic specification outlined in (2). Several such variations are considered including testing for the impact of the introduction of inflation targeting, the possibility of a break in inflation persistence due to some large shocks (e.g., the AFC or the GFC). Additionally, the tests consider the range of estimates of inflation persistence conditioned on whether the most optimistic or pessimistic inflation forecast is used in a version of (2) that mixes forward and back-looking elements. To repeat, the optimist is the forecaster who underestimates realized inflation (i.e., a positive value for equation (1)) whereas the pessimist over estimates actual future inflation. Finally, I examined the sensitivity of estimates when the specification is augmented by a measure of economic slack (i.e., a measure of the output gap) and an indicator of the accumulation of foreign exchange reserves, a phenomenon that defines an important element the macroeconomic response of policy makers in several of the Asia-Pacific economies. Since the focus of the paper is on inflation performance I eschew discussion of estimates of the parameters other than the measure of inflation persistence in the various specifications considered.

The first set of results in Table 4 provide estimates of versions of equation (2) where observed inflation is regressed on its own lag and the sensitivity of the results is examined according to the date when inflation targeting adopted, where relevant, or depending on whether a structural break in the specification is detected.[23] Since it unclear whether one can impose a priori a particular date for a break due to the AFC, the GFC, or both, we let the data

[23] In the case of Australia and New Zealand, virtually the entire sample is one where inflation targeting is in place. Indeed, in all cases, inflation targeting dominates the period covered in the empirical analysis of this paper.

determine the location of the break. The tests rely on the multiple breakpoint test due to Bai and Perron (2003). It should be noted at the outset that the test results are sensitive to the choices made in the test specification.[24] Nevertheless, on economic grounds one would expect that the location of such breaks must also be defensible on economic grounds.

Based on versions of (2), inflation persistence remains high in all of the economies considered when no allowances are made for the policy regime or any structural breaks. Indeed, one is hard-pressed, at least based on the raw data for the full available sample, to find much difference in inflation persistence across the 14 economies examined. However, the picture changes quite a bit when we control for the adoption of inflation targeting but much more so when a data-determined structural break is estimated or when the specification is altered to consider the possibility that inflation responds to the expectations or the optimists or pessimists among forecasters. If we consider the impact of inflation targeting the adoption of the policy reduces persistence in 4 of the 6 IT economies. However, the impact is only statistically significant for Korea. Indeed, persistence is seen as rising in Australia and New Zealand perhaps a reflection of the longer term impact of inflation targeting on inflation persistence. In other words, inflation persistence may fall upon the adoption of IT (see also Siklos 1999) but the gains can be reversed over time as the policy matures or the central bank resorts to (or exploits) the flexibility of the regime to short-term deviations from the target over time.

The results of Table 4 also point to a break in inflation persistence usually around the time of a financial crisis, here either the GFC of 2007-9 or the AFC of 1997-1998. More importantly, except for New Zealand and India, persistence fell significantly after the break. Only in the case of the EZ is the fall a modest one. The results are, to some extent, sensitive to the precise form of the specification. Thus, for example, if we ask: assuming we know how long the GFC lasted, using the dates provided by Dominguez et.al. (2013), did inflation persistence fall? Now we see that the previous finding holds up for all the Asia-Pacific economies considered with the

[24] Given that the samples range from 1990 t0 1994 to 2012 (i.e., 19 to 23 years of quarterly data) the estimation strategy is to fix the maximum number of breaks at 2 and to determine these sequentially, that is, condition the possibility of a second break on having fond the first break.

exception of JP, KR, and NZ.[25] It is worth noting therefore, when viewed for this perspective, that there is considerable variation in inflation persistence across the economies considered that is masked by full sample estimation with no controls. Hence, while regime choice is one proximate reason for a change in inflation persistence another is a financial crisis. For policy makers this implies that the scope for implementing easy monetary policies can rise in the event of a crisis.

Finally, if we return to the simplest specification (i.e., a version of equation (2)) and now ask how responsive is future inflation if it responds to the one year ahead forecast? More importantly, is there a difference in the response depending on whether we rely on the most optimistic versus the most pessimistic forecast? Results reveal that the size of the observed inflation response is considerably higher if we rely on optimistic forecasts than the most pessimistic ones. Moreover, inflation persistence based on the pessimistic forecasts is always lower than based on the observed data. We, therefore, see the first indications of considerable disagreement among forecasters about future inflation prospects. Another way to think of these results is that pessimists are relatively less likely to place as much weight on past inflation as optimists.

There exist, of course, other ways to explore the properties of inflation forecasts across the variety of forecasters examined. It is not difficult to find expressions of concerns over looming inflation either because of the extraordinary levels of monetary ease in many parts of the world or because history has shown that a relatively orthodox way or dealing with sovereign debt problems is for governments and central banks to inflate their way out the constraints imposed by high debt loads. Moreover, the sunflower plots discussed above also make it plain that it is not difficult to locate forecasters who expect much higher than actual inflation. They may not have been correct at the time, however, in probabilistic terms there may well come a time when such forecasts contain a grain of truth. If we were able to observe the loss functions of these forecasters, or the information set that drives such seemingly outlier forecasts, we might be able to take such forecasts more seriously or discard them entirely. Unfortunately, this kind

[25] In the case of NZ the change in persistence is not statistically significant.

of information is not observed. Instead, we can examine more closely when and how frequently large forecast errors are made or consider how forecasts are distributed through time.

Figure 3 stacks estimates of 'extreme events' defined as inflation forecasts that exceed at least twice the standard deviation of observed inflation.[26] It is clear that there is considerable clustering of inflation forecasts that are subsequently found to greatly exceed observed inflation. While the fraction of forecasts deemed to be outliers is small they are by no means rare events. In particular, around the time of the AFC and GFC the economies most affected by financial crises appear to prompt the publication of some excessively high forecasts of inflation. Thus, we observe 'outliers' in 1997-98 for the Philippines, Korea, and Thailand, arguably the economies hardest hit by the crisis. Similarly, large negative forecast errors emerge in 2008 in both the EZ and the US. Occasionally, the excessively high inflation forecasts are economy-specific.[27] The only other source of extreme inflation forecasts takes place in 1991, likely due to the effect among some forecasters of the Gulf War and the dissolution of the Soviet Union.

Next, we turn to a distributional representation of inflation forecasts derived from the K-L distance measure discussed above. Since the spread of inflation forecasts appears greatest around the time of financial crises in the sample considered the plots focus on the years 2008-9 and, data permitting, 1997-8. Figures 4A and 4C considers Consensus forecasts while Figures 4B and 4D examine the available non-Consensus forecasts. To economize on space, as well as owing to some data limitations, data for the Philippines and the euro zone are omitted.

There is clearly evidence of a flattening of the distribution of both types of inflation forecasts in the 2008-9 period. However, it is generally the case that economies with relatively poorer 'long-run' inflation records (e.g., China, Indonesia, and India) produce fatter tails in the distribution even if the mode of the distribution does not appear to change dramatically. This interpretation is also consistent with the sunflower plots discussed previously. Nevertheless, it is also the case in several economies (e.g., India, Indonesia, Korea, Singapore, Thailand) that

[26] The figure identifies the date when an 'extreme' forecast has been identified. The notes to the table provide frequency information.

[27] One example is Australia is the short-term impact of the introduction of the GST (goods and services tax) in 2000.

changes in the shape of the distribution, as well as their mode, displays greater sensitivity among the non-consensus forecasters (i.e., public agencies, surveys, central banks) to the shock stemming from the GFC. Turning to the data from the AFC, displayed in Figures 4C and 4D, we see essentially a repetition of the effects that would mark the GFC a decade or so later. However, it is worth noting that in some economies (i.e., Hong Kong, Thailand, and Indonesia) there are fewer instances of the flattening of the distribution of inflation forecasts. Whether this is a reflection of improvements in some central banks' ability to anchor expectations, or the relatively smaller impact of the GFC compared with the significant economic effects of the AFC, is unclear. Additional tests are required to identify such effects. Overall, however, there is no indication across the economies examined of a pattern whereby modes in the distribution of inflation forecasts shift either to the right or to the left of 'long-run' observed inflation. For example, during the AFC, inflation expectations show a rise in the most likely value in 5 of 11 economies shown, for both Consensus and non-Consensus forecasts. In contrast, modes in one year ahead forecasts tend to fall in relatively more economies, an indication that inflation expectations were more likely to be negatively affected by the GFC than was the case during the AFC.

The foregoing discussion focuses entirely on the domestic inflation record relative to inflation forecasts. Given the wide varieties of exchange rate regimes adopted by the economies in the region, changes in the pass-through effects of exchange rate movements on domestic inflation, and the uncertain impact stemming from volatile capital flows, there is conceivably an element of 'contagion' possible in movements of inflation expectations. Again, the inability to observe the loss function of forecasters or their information sets, combined with a global element in inflation shocks, suggests that to the extent there is interdependence in inflation rates in the region, crises might contribute to some of the behavior in inflation forecasts observed since the early 1990s. Equation (3) provides a test of interdependence versus contagion type effects in explaining inflation forecasts across regions. To simplify the testing, as well as provide some insights into the role of exchange rate choice or policy regimes, several of the Asia-Pacific economies grouped together. Australia, Korea, the Philippines, New Zealand, Thailand and Indonesia comprises the group of IT economies. Inflation rates are

averaged across these economies for the purposes of the test specification. Hong Kong, Malaysia, Singapore, and India, are defined as the group of managed exchange rate economies. China, Japan, and the U.S. enter the specification in their own right and the EZ is excluded, for simplicity. In another variant, economies other than the big three economies are grouped together. Clearly, other combinations are possible and may influence the test results. However, no sensitivity analysis is conducted. Since a financial crisis is the proximate explanation for inflation expectations in one country to spillover onto other economies in the region I focus on the GFC and define the crisis as beginning in 2007Q1 and ending in 2009Q2. As with the grouping of economies the results may well be sensitive to the choice of the period when various economies may well have suffered the effects of the financial crisis. Tables 5A, 5B, and 5C summarize the findings. Finally, since inflation forecasts of most optimistic and pessimistic forecasters provide additional insights into the behavior of expectations, specification (3) is also estimated for these cases.

When economies other than China, and Japan, and the U.S. are grouped together (Table 5A, there are considerable spillovers in mean inflation forecasts. In contrast, there is no evidence of any contagion among the most pessimistic forecasters (i.e., MAX) while the only evidence of contagion among the optimists among the forecasters is from Japanese inflation to U.S. inflation. Therefore, relying on mean forecasts suggests that there are non-fundamental sources of influence on inflation rates across the regions while effectively no such evidence is found in the tail end of the distribution of one year ahead forecasts. When economies are grouped according to whether they are ITers or managed their exchange rates to differing degrees there are striking differences. There is almost no evidence of contagion between the IT and the large economies in the sample (Table 5B). In contrast, there is considerable evidence of shocks being transmitted among the large economies considered (i.e., China, Japan, and the U.S.) and from or to the managed exchange rate regime economies (Table 5C). Contagion may well be a phenomenon restricted to the large economies but, as noted earlier, this does not diminish the interdependence that exists between inflation or forecasts of inflation among the economies in the region.

By now, it should be clear that there exists considerable disagreement among forecasters and across the 14 economies examined in this study. Figures 5 and 6 plot measures of forecast disagreement in the 14 economies examined in this study. Figures 5A and 5B display the measure summarized by equation (4) on a log scale to diminish the impact of outliers and to facilitate comparisons across economies with rather disparate inflation and inflation forecast histories. Figure 6 repeats the exercise by changing the benchmark from all inflation forecasts to forecasts from central banks, where available. Finally, since the distinction between optimistic and pessimistic inflation forecasts provides useful insights it is also worthwhile considering the range of disagreement depending on the forecaster in question. This is illustrated by the shaded areas in both Figures.[28]

There is clearly considerable disagreement about one year ahead inflation rates but there is no clear visual evidence that the range of forecast disagreement rises during financial crises. However, it is also clear that mean levels of disagreement (the solid lines in Figures 5A and 5B) tend to fluctuate nearer the top of the range of estimated disagreement in every economy considered. This suggests, in the absence of any weighting scheme, that un-weighted disagreement estimates may be 'biased' upward. However, without any clear decision rule about such a weighting scheme, it is not obvious that mean levels of forecast disagreement are an inappropriate metric under the circumstances. Indeed, an immediate observation from mean levels of disagreement is that they are clearly seen as rising sharply during the GFC (identified by the vertical shaded area), especially in the U.S. and the euro zone, while a sharp fall in inflation forecast disagreement is also visually apparent in at least 9 of the 14 economies in the sample (i.e., euro zone, U.S., AU, HK, ID, KR, MY, NZ, and SG).

Next, if we consider changing the benchmark against which forecast disagreement is evaluated from $\overline{\pi}^{i}_{\bullet t1}$, that is, a mean across all types of forecasts, to the mean forecast published by central banks one obtains a rather dramatically different picture, as shown in Figure 6. The figure plots the available data from 9 central banks which release inflation

[28] Recall that *d* in equation (4) can be defined for each forecaster.

forecasts and shows the disagreement measure from Figures 5A and 5B and the one evaluated using central bank inflation forecasts for the available sample.

The most obvious finding is that forecast disagreement vis-à-vis central banks can be vastly different from average forecast disagreement as conventionally evaluated. Nevertheless, differences in disagreement are most apparent during the financial crisis of 2008-9. Unfortunately, we only have data during the period of the AFC for two economies in the Asia-Pacific (i.e., NZ and TH) but the impact of this episode in 1997-8 is evident from the TH data but less so for NZ.[29] In a few cases we also observe a second rise in forecast disagreement relative to central bank inflation forecasts in 2010-11, namely at the height of ongoing euro zone sovereign debt crisis. This effect is clearly apparent in the case of AU, NZ, and SG. Moreover, it does appear that the effect of the GFC on forecast disagreement dwarfs that of the euro zone crisis.

The lessons are, therefore, clear. The benchmark against which forecast disagreement is evaluated is critical to our understanding of how inflation expectations are formed. Hence, if forecasters are complacent in the sense of Morris and Shin (2002) this is not apparent when there is a financial crisis. What is as yet unclear are the precise sources of the differences between the two disagreement indicators. In particular, simply stating that a financial crisis is the proximate cause for the findings illustrated in Figure 5 may mask the fundamental variable or variables that can explain the movements observed in the plots.[30] It may also be of interest to find out the extent to which the monetary policy regime, or the exchange rate regime, plays

[29] The plot for TH is in two parts because the impact of the AFC is many times the size of the impact of the GFC. However, once the data are broken down into two parts it is clear that the GFC also affects disagreement with the Bank of Thailand to a considerable degree.

[30] Some central banks have been criticized (e.g., see Stockton) for their poor forecasting record in part because they appear to have been too optimistic about the speed of economic recovery following the crisis or the behavior of inflation during and following the GFC. A central bank that is credible, particularly one that must achieve a numerical inflation target, should expect inflation to return to target within the two year horizon that many economic models assume policies reach their full impact. Post-mortems, however, instead suggest an 'optimism bias' characterizes some inflation (or real GDP growth) central bank forecasts. In one memorable illustration of the problem, Mark Carney, former Bank of Canada Governor, when asked by a politician during a Committee hearing, whether the Bank of Canada "goes out on something of an optimistic limb, replied: "We don't do optimism; we don't do pessimism," Carney countered. "We do realism at the Bank of Canada. We don't do spin." (http://www.cbc.ca/news/business/story/2009/02/10/bank-of-canada-projections.html).

a role in the outcome. Needless to say, these questions also apply to asking about the behavior of forecast disagreement more generally.

This study began by noting that the GFC and the greater acceptance of central bank transparency may well have contributed to anchoring mean inflation forecasts even if forecasters disagree amongst each other. In particular, forecast disagreement vis-a-vis central bank forecasts look quite different over time and across economies especially during financial crises. In addition, we have seen that how inflation forecasts behave also seems to depend in part on the policy regime in place. In concluding Table 6 provides some preliminary findings about the likely determinants of the *differences* between forecast disagreement relative to mean forecasts and levels of disagreement relative to mean central bank forecasts (i.e., see Figure 6). Given the length of the available time series at our disposal I am only able to examine 8 economies in the Asia-Pacific and the estimates are restricted to the 1999-2012 sample.[31] Various determinants of forecast disagreement are pooled and the resulting cross-section time series (unbalanced panel) regression is estimated with fixed effects.[32]

It seems reasonable to suppose, assuming that all forecasters potentially have access to the same information set, that differences in disagreement will be due to differences in the importance placed on some fundamentals over others, inattention to certain economic signals, different incentives to minimize forecast errors (i.e., varieties of loss functions), to name some of the most important factors. Nevertheless, if the evidence presented so far is correct then there are also likely to be explanatory variables that may well be common to all types of forecasts and forecasters, such as the impact of the GFC, the role of the exchange rate regime, the policy to build-up foreign exchange reserves, or even the degree of economic slack. Finally, we expect significant differences between optimistic and pessimistic forecasters.

[31] Data for the U.S. and the EZ are excluded.
[32] Fixed effects could not be rejected. See Table 6 for the details.

The results in Table 6 strongly indicate that the GFC reduces forecast disagreement across all forecasters.[33] It is likely that the GFC represented both a wake-up call among forecasters leading at first to more forecast disagreement vis-a-vis central banks (also see Figure 6). And yet, on average, differences between all forecasters and central banks decline among all forecast 'personalities'. In contrast, forecast disagreement is higher the higher the build-up of foreign exchange reserves. Note that while the rise in forex reserves is symptomatic of central banks' attempts to sterilize inflows it is a highly imperfect indicator of the success at complete sterilization. Clearly, mean forecasts, optimistic and pessimistic forecasters disagree more as reserves to GDP rise perhaps a reflection over the inflationary consequences of inflows or doubts about the degree of sterilization. The output gap is the only other determinant that affects all kinds of forecasts. However, whereas more economic slack reduces forecast disagreement differences in the case of mean and among the pessimists, forecast disagreement rises among the optimists. Beyond these three explanatory variables there is considerable diversity among the kind of forecasters in what influences their forecasts relative to those of the central bank. Optimists are influenced by the exchange rate regime but pessimists are not. Similarly, pessimists and optimists are both significantly affected by changes in central bank transparency but react differently to the type of information released by central banks. Hence, optimists react negatively to central bank transparency, an indication that their views become more in line with those of the central bank. The opposite holds for the pessimists amongst inflation forecasts.

5. Conclusions and Policy Implications

It is often remarked that inflation appears too difficult to forecast. By implication economists are said to struggle with understanding the dynamics of inflation. Indeed, Harding (2013), speaking about the recent behavior of U.S. inflation, claims: "It has often defied all predictions in the US during the past five years and, once again, inflation's general perversity is complicating life for the Federal Reserve."

[33] A variety of specifications forms were considered including ones with interaction terms (e.g., the GFC, and foreign exchange reserves to GDP) without changing the conclusions. However, I cannot claim as yet that the results are robust.

The results of this paper suggest that both of these depictions of inflation and inflation forecasts are misleading. It is possible to forecast inflation and, on average, forecast performance is reasonably good. What is closer to the truth is that forecasters can disagree considerably amongst each other and that different forecasters react to different sets of fundamentals. Therefore, when central banks worry about the potential for an un-anchoring of inflation expectations there is implicit in this statement a notion that all forecasts can be reduced to a single (mean) forecast. This is not the case. Optimists and pessimists among forecasts view future inflation performance differently and it is unclear, *a priori*, why any tipping point in the direction of destabilizing inflationary expectations would necessarily originate from the behavior of average forecasts.

At least two other findings are worthy of note. Crisis times are precisely when central banks have the greatest flexibility to exploit deviations from some inflation objective. Third, forecasters can express large disagreement with central banks in the case of one year ahead inflation forecasts especially during stressful economic times. The notion that forecasters essentially adopt or mimic central bank forecasts does not hold at all times, and especially not during stressful economic times.

The fact that inflation rates in many parts of the world have been relatively low and stable for the past decade or more masks two facts. First, there are emerging markets where the memory of volatile and high inflation is not a distant memory (e.g., Indonesia, India, and the Philippines) but where the existing policy regime in place (often a form of inflation targeting), together with greater central bank transparency, has made a difference. Second, the possibility of overrating the likelihood of continued low and stable inflation while dismissing the possibility of a return to higher and more volatile inflation appears to be present.[34] Otherwise, crises, monetary policy actions (e.g., the build-up of foreign exchange reserves), and even the degree of economic slack, would not prompt more or less disagreement among forecasters.

[34] This notion is associated with Kahneman and Tversky's notion of heuristic behavior that probably characterizes some inflation forecasts. See, for example, Kahneman (2011).

Therefore, central banks have the very difficult task of explaining to the public, even if indicators and institutions support the continuation of low and stable inflation rates because this environment has become a familiar one, that a seemingly improbable return to high and volatile inflation cannot be dismissed. Navigating the tension between wanting to avoid something that is economically damaging, namely excessively high and volatile inflation, while focusing on the need to support the effort, through ultra-easy policies, to facilitate a return to 'normal' economic conditions is the needle that central banks will have to thread. Perhaps this is what Carney (2013) had in mind when he spoke of, but did not explain, the nature of the 'new' contract that needs to be written between central banks and governments.

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TABLE 1 FORECAST ERRORS: SUMMARY STATISTICS

Economy	Mean	S.D.	Max	Min
AUSTRALIA	-0.40	1.38	4.60	-4.40
CHINA	-1.13	2.47	6.06	-.976
HONG KONG	-1.25	2.17	8.83	-8.94
INDIA	0.21	2.87	10.28	-9.04
INDONESIA	0.84	7.13	38.55	-21.93
JAPAN	-0.10	0.75	2.40	-3.29
KOREA	-0.22	1.49	7.67	-9.08
MALAYSIA	-0.52	1.44	5.40	-14.73
NEW ZEALAND	-0.26	1.17	3.12	-4.00
PHILIPPINES	-0.74	1.87	5.73	-6.57
SINGAPORE	-0.14	1.68	5.60	-4.60
THAILAND	-0.21	1.99	7.94	-7.67
U.S.	-0.10	1.10	3.81	-4.62
EURO ZONE	0.23	0.67	2.49	-2.45

Note: equation (1) defines inflation forecast errors. *Max* refers to the largest positive forecast error, *Min* the largest negative forecast error. MAX forecasters are labeled as being pessimists while MIN are referred to as optimists.

TABLE 2 Root Mean Squared Errors

ECONOMY	FULL	NON-CRISIS	GFC	AFC	IT	FULL	NON-CRISIS	GFC
	ALL FORECASTS					CENTRAL BANKS		
AUSTRALIA	1.31	1.69	1.06	2.56	1.55	1.31	1.28	1.43
CHINA	3.78	2.72	4.72	7.22	-	-	-	-
HONG KONG	2.96	3.01	0.79	3.29	-	-	-	-
INDIA	3.00	2.87	2.51	3.92	-	-	-	-
INDONESIA	6.51	4.60	0.97	11.78	2.72	-	-	-
JAPAN	0.78	0.79	0.58	0.87	-	0.55	0.55	0.53
KOREA	1.92	1.74	0.79	3.77	2.02	1.06	1.07	0.90
MALAYSIA	2.42	1.68	1.35	4.93	-	-	-	-
NEW ZEALAND	1.26	1.24	0.58	1.71	1.26	1.06	0.98	0.54
PHILIPPINES	1.58	1.58	INS	ND	1.58	0.96	2.61	3.08
SINGAPORE	1.77	1.59	2.55	2.12	-	1.05	0.82	1.91
THAILAND	2.17	1.98	4.02	2.77	1.89	2.64	2.65	3.27
U.S.	1.18	0.99	2.77	1.32	-	1.01	0.97	1.73
EURO ZONE	0.74	0.43	ND	ND	-	0.57	0.49	0.87

Note: GFC is the global financial crisis, AFC is the Asian financial crisis. Details about the duration of crisis periods, as well as the sample span, by economy, are relegated to the Appendix.

TABLE 3 FORECAST EFFICIENCY

Economy	Mean	Median	Max	Min
AUSTRALIA	0.35	0.28	1.54*	-0.45*
CHINA	-0.09	-0.09	0.74*	-0.29*
HONG KONG	0.62*	0.48*	0.86*	0.16
INDIA	0.94*	0.95*	1.70*	-0.96*
INDONESIA	1.59*	1.59*	1.38*	0.68*
JAPAN	1.13*	1.02*	0.72*	0.09
KOREA	0.38	0.30	1.32*	-0.70
MALAYSIA	0.12	0.17	1.26*	-0.42
NEW ZEALAND	-0.17	-0.12	0.59*	-0.74*
PHILIPPINES	-0.29	0.04	0.98*	-1.00
SINGAPORE	1.04*	1.01*	1.27*	0.27
THAILAND	0.87*	0.70*	1.38*	-0.13
U.S.	0.49	0.60	1.80*	-0.88*
EURO ZONE	2.42	2.13*	1.90*	0.09

Note: See Table 1 for the definition of *Max* and *Min*. shown is the coefficient β in the regression: $\pi_t = \beta \pi_t^{FE} + \varepsilon_t$ where all the terms are defined in the text (e.g., see equation (1)) and ε_t is an error term. * indicates that the coefficient is statistically significant at the 1% level.

TABLE 4 CHANGING INFLATION PERSISTENCE:

POLICY REGIME, CRISES, AND OPTIMISTS VERSUS PESSIMISTS

ECONOMY	EQUATION (2)	BREAK *IT*	PRE-POST GFC	(2) + GFC	IT	OPTIMISTS-PESSIMISTS
AUSTRALIA	0.82	2001Q3 *1993Q1*	0.92-0.50	0.77-0.29+	0.25*	1.05-0.68
CHINA	0.97	1995Q1	1.09-0.83	0.93-0.56	NA	0.40-0.26
HONG KONG	0.96	1999Q4	1.14-.91	0.66-0.33	NA	0.79-0.41
INDIA	0.85	1999Q2	0.65-0.91	0.84-0.07	NA	1.17-0.80
INDONESIA	0.88	1999Q1 *2001Q1*	1.20-0.63	0.73-0.13	0.08	1.28-0.64
JAPAN	0.82	2008Q4	0.65-.57	0.41+0.25	NA	.65-0.38
KOREA	0.82	1998Q4 *1998Q2*	0.70-0.63	0.78+0.10	-0.13*	1.13-0.63
MALAYSIA	0.81	2008Q4	0.95-0.58	0.59-0.15	NA	1.00-0.49
NEW ZEALAND	0.79	1994Q3 *1990Q1*	0.48-.80	0.72+0.03	0.26@	1.23-0.77
PHILIPPINES	0.86	1999Q2 *2002Q1*	0.81-0.74	0.78-0.20	-0.04	0.99-0.70
SINGAPORE	0.91	2007Q3	0.87-0.78	0.64-0.14	NA	1.21-0.73
THAILAND	0.85	2009Q4 *2002Q1*	0.90-0.24	0.81-0.37@	-0.06	1.18-0.61
U.S.	0.74	2008Q4	0.82-0.53	NA	NA	1.09-0.72
EURO ZONE	0.79	2008Q4	0.84-0.73	NA	NA	1.31-0.93

NOTE: BREAK, *IT* refer to the date of a structural break as located using the Bai-Perron multiple break test and the date of the introduction of inflation targeting. A sequential testing procedure is applied with a maximum of 2 breaks permitted. PRE-POST GFC refers to the estimated coefficient of inflation persistence (α_1 in equation (2)) prior to and in the period following the break identified according to the Bai-Perron test. (2)+GFC is the estimate of the coefficient α_1 +/- the estimate of coefficient α_2 in the version of (2) augmented with an interaction term that captures the impact of the GFC using a 0,1 dummy based on the dating scheme identified by Dominguez et. al. (2012), as well as other controls. The estimated specification is $\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2 GFC_t\pi_{t-1} + \alpha_3\pi_t^f + \alpha_4\pi_t^f GFC_t + \alpha_5\tilde{y}_t + \alpha_6 RESGDP_{t-1} + \varepsilon_t$ where $\tilde{y}, RESGDP$ are, respectively, the output gap and foreign exchange reserves to GDP ratio. A smoothing parameter of 400,000 was applied to the logarithm of real GDP. All equations were estimated via OLS. OPTIMISTS and PESSIMISTS represents the coefficient estimates from the regression of 4 quarter ahead realized inflation on the most optimistic forecast (i.e., the highest positive forecast error; see equation (1)) or the most pessimistic forecast (i.e., largest negative error). OLS is used to estimate this expression.

All coefficients are statistically significant at the 1% level unless explicitly indicated as in the IT column. In the columns (2)+GFC all of the persistence estimates are statistically significant at the 1% level but the individual interaction terms are significant only if indicated. Nevertheless, the joint test $\alpha_1 = 0; \alpha_2 = 0$ is always rejected at the 1% level of significance.

TABLE 5A CONTAGION VERSUS INTERDEPENDENCE IN ASIA-PACIFIC INFLATION FORECASTS: IT AND LARGE ECONOMIES

Coefficient	Mean	MAX	MIN
Inflation Targeting economies (*i* = 1)			
λ_{12}	0.49 (.00)*	-0.06 (.60)	-0.05 (.57)
λ_{13}	-0.19 (.09)	0.22 (.20)	-0.05 (.58)
λ_{14}	0.05 (.19)	-0.02 (.84)	-0.08 (.77)
U.S. (*i* = 2)			
λ_{21}	3.30 (.00)*	-0.23 (.82)	4.90 (.07)
λ_{23}	-1.18 (.00)*	0.66 (.30)	-0.06 (.93)
λ_{24}	0.46 (.20)	-0.05 (.88)	3.10 (.00)*
China (*i* = 3)			
λ_{31}	1.11 (.03)*	-0.002 (.99)	2.19 (.05)
λ_{32}	-1.06 (.00)*	-0.05 (.86)	0.01 (.98)
λ_{34}	-0.03 (.90)	-0.21 (.58)	-0.50 (.50)
Japan (*i* = 4)			
λ_{41}	-1.98 (.04)*	0.41 (.34)	-2.15 (.15)
λ_{42}	0.32 (.20)	-0.66 (.09)	-0.08 (.81)
λ_{44}	0.93 (.00)*	0.25 (.12)	0.12 (.35)
χ^2	43.55 (.00)*	6.80 (.00)*	67.49 (.00)*

TABLE 5B CONTAGION VERSUS INTERDEPENDENCE IN ASIA-PACIFIC INFLATION FORECASTS: MANAGED EXCHANGE RATE REGIMES AND LARGE ECONOMIES

Coefficient	Mean	MAX	MIN
IT rate economies (*i* = 1)			
λ_{12}	0.08 (.62)	-0.16 (.30)	-0.13 (.28)
λ_{13}	0.02 (.89)	0.25 (.21)	0.08 (.61)
λ_{14}	0.13 (.56)	0.26 (.08)	-0.59 (.17)
U.S. (*i* = 2)			
λ_{21}	0.68 (.32)	-0.37 (.69)	2.51 (.05)*
λ_{23}	-0.38 (.22)	0.56 (.40)	0.11 (.79)
λ_{24}	0.12 (.73)	0.49 (.20)	3.51 (.00)*
China (*i* = 3)			
λ_{31}	0.35 (.54)	-0.06 (.91)	2.71 (.02)
λ_{32}	-0.46 (.12)	0.10 (.72)	-0.08 (.79)
λ_{34}	-0.22 (.38)	-0.65 (.06)	-1.29 (.16)
Japan (*i* = 4)			
λ_{41}	-0.51 (.39)	0.31 (.55)	-1.72 (.05)*
λ_{42}	0.13 (.47)	-0.72 (.12)	-0.28 (.22)
λ_{44}	0.42 (.06)	0.28 (.22)	0.17 (.23)
χ^2	8.12 (.78)	18.08 (.11)	82.06 (.00)*

TABLE 5C CONTAGION VERSUS INTERDEPENDENCE IN ASIA-PACIFIC INFLATION FORECASTS: ASIA-PACIFIC AND LARGE ECONOMIES

Coefficient	Mean	MAX	MIN
Managed exchange rate economies (*i* = 1)			
λ_{12}	0.67 (.00)*	-0.04 (.76)	0.04 (.65)
λ_{13}	-0.34 (.01)*	0.15 (.43)	-0.16 (.15)
λ_{14}	0.01 (.96)	-0.13 (.25)	0.29 (.37)
U.S. (*i* = 2)			
λ_{21}	3.74 (.00)*	-0.77 (.55)	-4.76 (.24)*
λ_{23}	-1.31 (.00)*	0.62 (.33)	1.54 (.05)*
λ_{24}	0.44 (.17)	-0.21 (.44)	4.21 (.00)*
China (*i* = 3)			
λ_{31}	1.87 (.00)*	0.56 (.52)	2.66 (.02)*
λ_{32}	-1.26 (.00)*	-0.13 (.68)	-0.03 (.85)
λ_{34}	0.04 (.87)	-0.16 (.67)	-1.33 (.01)*
Japan (*i* = 4)			
λ_{41}	-2.84 (.01)*	0.90 (.17)	-0.27 (.87)
λ_{42}	0.44 (.08)	-0.64 (.12)	-0.18 (.55)
λ_{44}	0.92 (.00)*	0.34 (.03)*	-0.05 (.67)
χ^2	53.89 (.00)*	8.63 (.73)	82.06 (.00)*

NOTE: Coefficient estimate and p-value in parenthesis from equation (3) and represents the interaction term of inflation in economy *i* and a GFC crisis dummy i=1,2,3,4). Rejections are highlighted by the shading. Rejection implies contagion from economy *j* to economy i, where $\lambda_{i,j}$ and $i \neq j$. The GFC dummy is set equal to 1 in the 2007Q1-2009Q2 sample period. Mean, MAX, and MIN, represent estimates based on mean inflation, maximum inflation forecast (relative to observed inflation), and the minimum inflation forecast. IT economies are: Australia, Indonesia, Korea, the Philippines, New Zealand, and Thailand. Managed exchange rate regime economies are: Hong Kong, Malaysia, Singapore, and India. LARGE economies are China, Japan, and the U.S. Cross-country estimates of inflation are averages across economies (unbalanced panel). Equation (3) is estimated via SURE (seemingly unrelated regression). The highlighted figures are coefficient with p-values of .05 or less.

TABLE 6 THE DETERMINANTS OF DIFFERENCES IN FORECAST DISAGREEMENT, 1999-2012

ECONOMY	Mean forecasts	MAX Forecasts	MIN forecasts
Constant	5.85 (1.86)*	17.55 (4.86)*	-0.97 (0.86)
Nonfuel inflation	0.001 (0.002)	0.005 (0.004)	-0.001 (0.001)
Oil price inflation	-0.001 (0.001)+	-0.001 (0.001)	-0.001 (0.001)
Exchange Rate Regime	-0.56 (0.16)*	-1.55 (0.41)*	0.04 (0.07)
GFC	-0.25 (0.07)*	-0.38 (0.11)*	-0.17 (0.04)*
Deviations from Inflation Target	-0.001 (0.02)	-0.07 (0.04)+	0.002 (0.01)
FOREX reserves to GDP ratio	0.01 (0.004)*	0.03 (0.009)*	0.01 (0.003)*
Gross Capital Inflows	-0.001 (0.003)**	-0.002 (0.001)*	-0.0002 (0.0002)
Output Gap	-0.02 (0.011) **	0.04 (0.02)**	-0.02 (0.01)*
Stock Market Returns	0.002 (0.001)**	0.001 (0.001)	0.001 (0.0004)
FDI to GDP ratio	0.03 (0.03)	-0.01 (0.04)	0.04 (0.02)**
Cumulative Change in CB Transparency	-0.01 (0.03)	-0.16 (0.06)*	0.03 (0.01)**
Fixed effects	F(7,245)=10.95*	F(7, 245)=11.30 (.00)	F(7,245)=7.39 (.00)
$\overline{R}^2$	0.35	0.43	0.31
F-Statistic (p-value)	8.98 (.00)	12.13 (.00)	7.55 (.00)
# of cross-sections	8	8	8
# Observations (pooled)	264	264	264

NOTE: The dependent variable is $d_t - d_t^{CB}$ where *d* is the measure of forecast disagreement against the mean of all forecasts or the means of central bank (CB) forecasts only. Data for only 8 economies are used (US and euro area excluded). The economies included are: AU, ID, JP, KR, NZ, PH, SG, and TH. All except JP and SG are inflation targeting economies. Oil price inflation (WTI prices) and non-fuel inflation are calculated in the same manner as CPI inflation. The exchange rate regime is from Reinhart and Rogoff's fine grid index (see text and Appendix) which ranges in value from 1 to 13. The output gap is HP-filtered log difference of real GDP with a smoothing parameter of 400,000 and is expressed in percent. FDI is foreign direct investment and FOREX are foreign exchange reserves. Stock market returns are calculated in the same manner as CPI inflation and typically represent and all stocks or industrial stocks index. The cumulative change in central bank transparency is the cumulative sum of changes in the index for Questions 2, 4, and 5 only. See the appendix for the details and a Table indicating the sources of changes in the index. The raw data (1998 to 2012) are annual and were converted to the quarterly frequency via cubic-last match.

FIGURE 1 OBSERVED INFLATION AND THE RANGE OF INFLATION FORECASTS

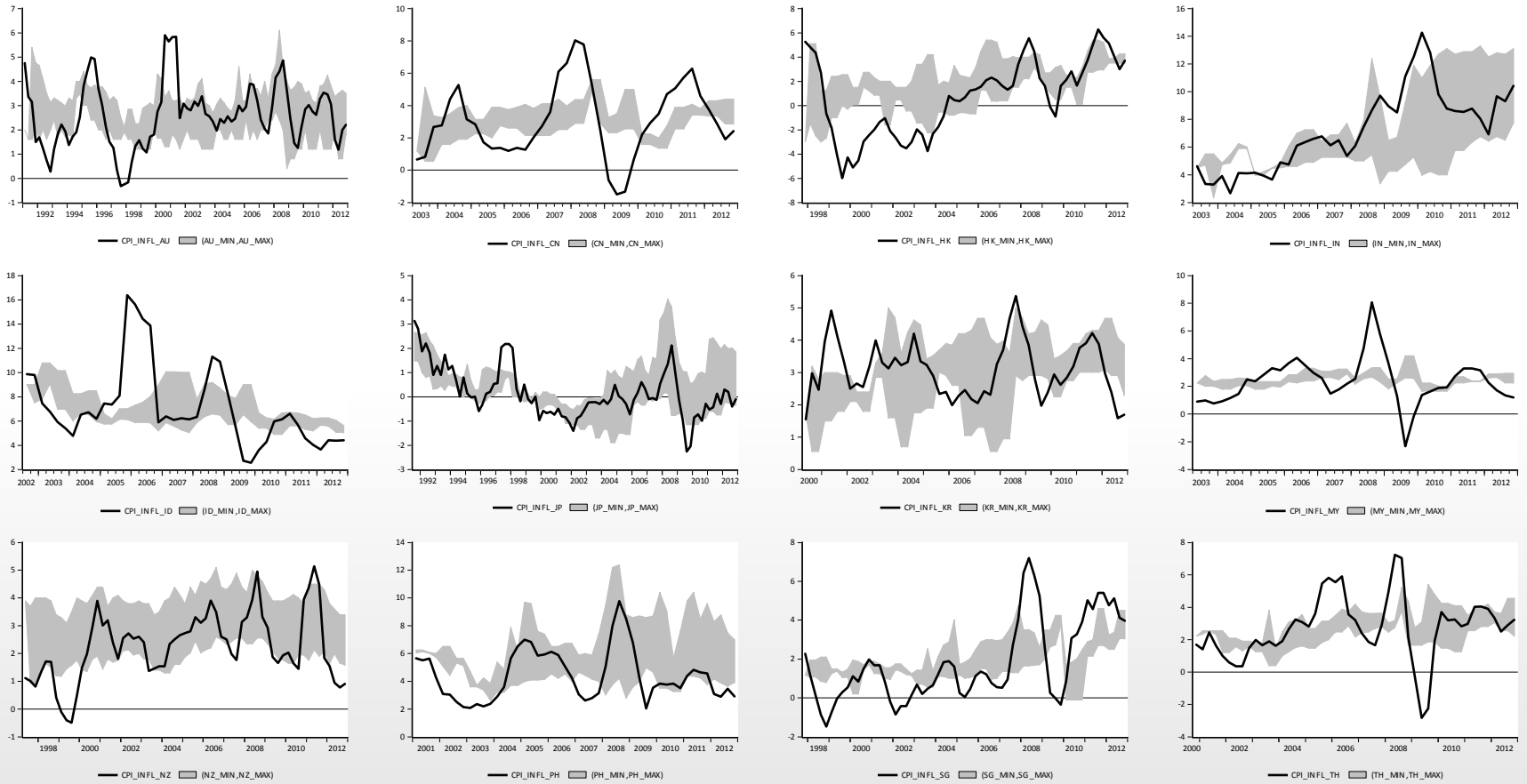
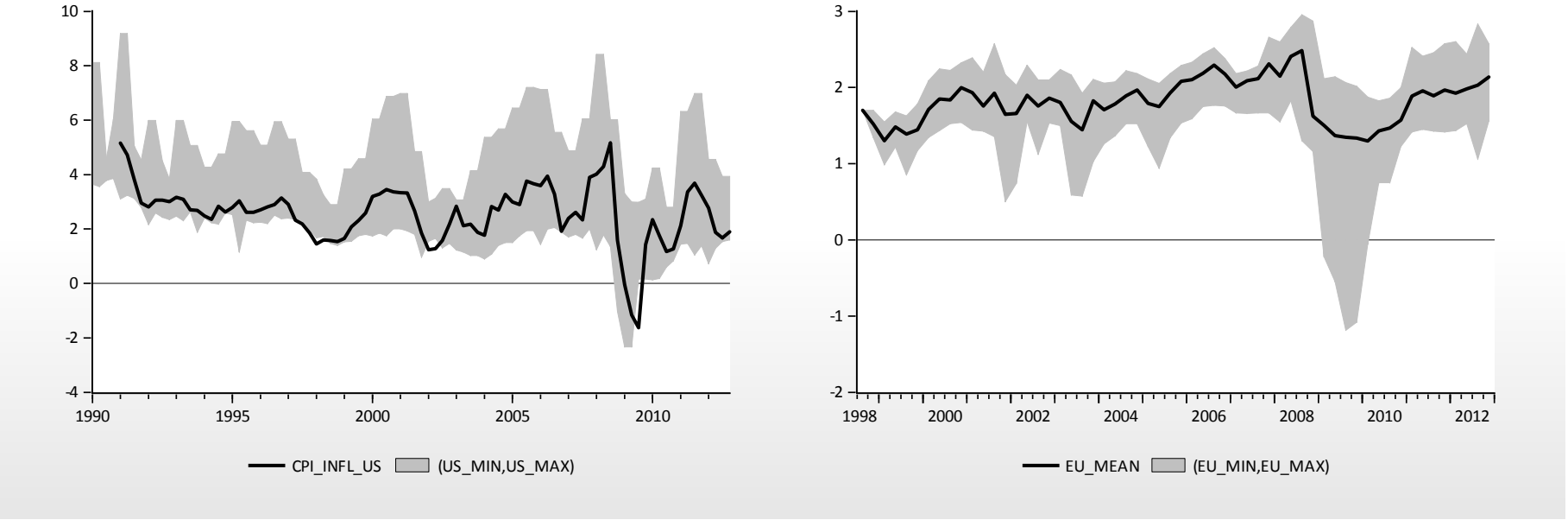
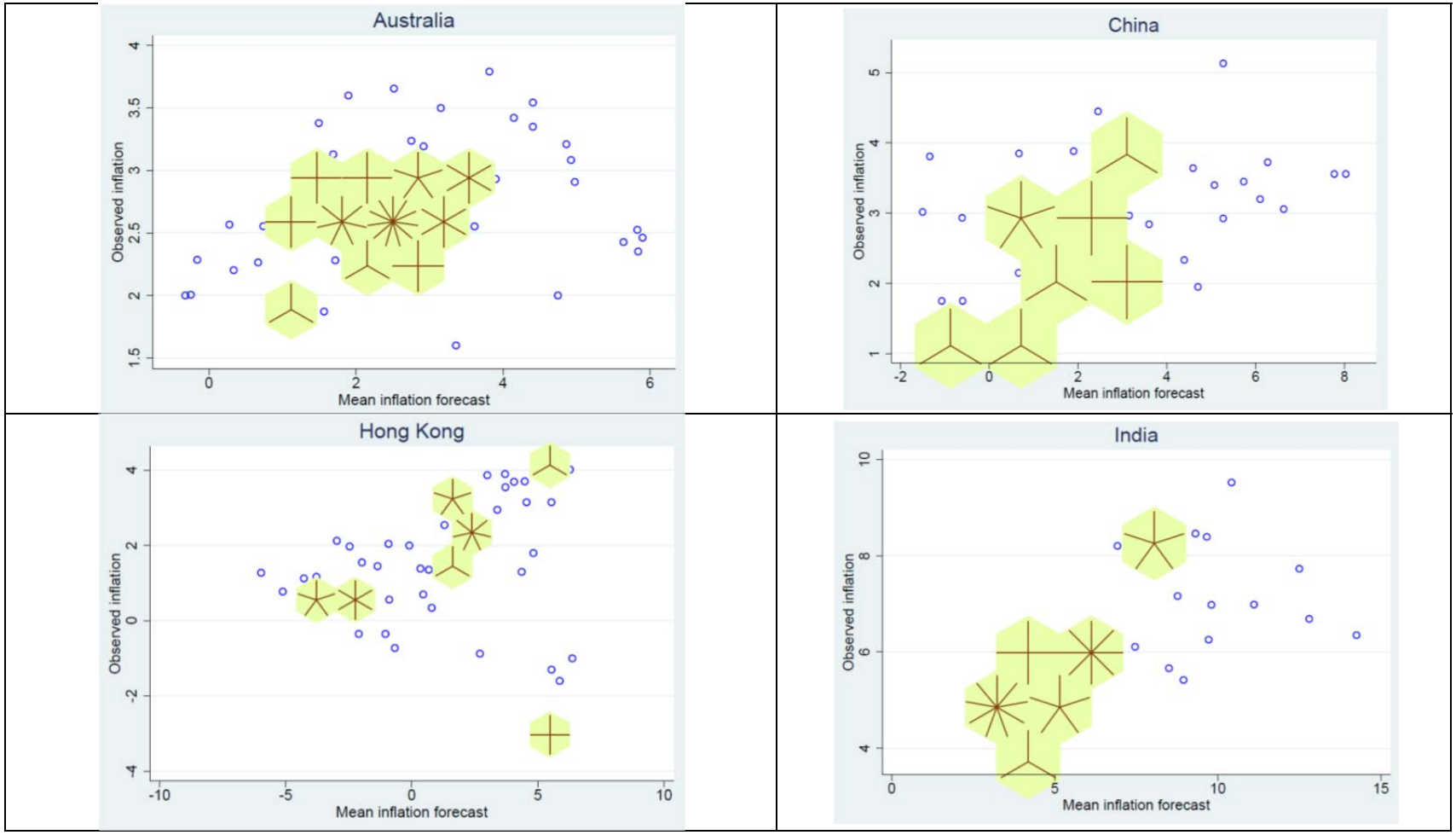


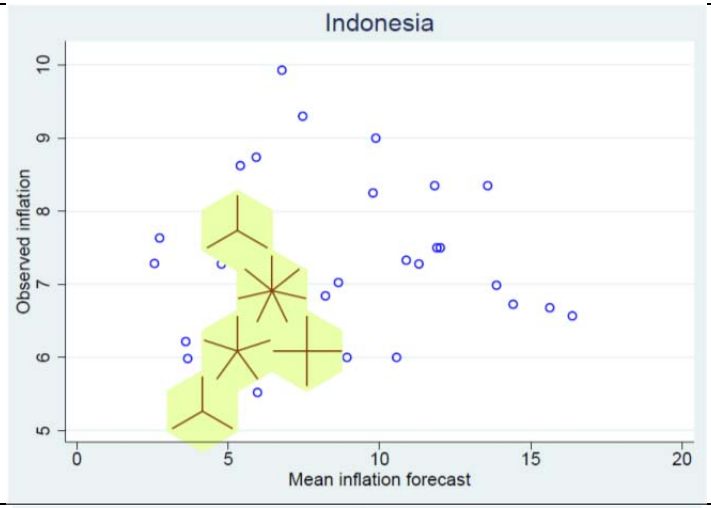
FIGURE 1 (CONT'D) OBSERVED INFLATION AND THE RANGE OF INFLATION FORECASTS

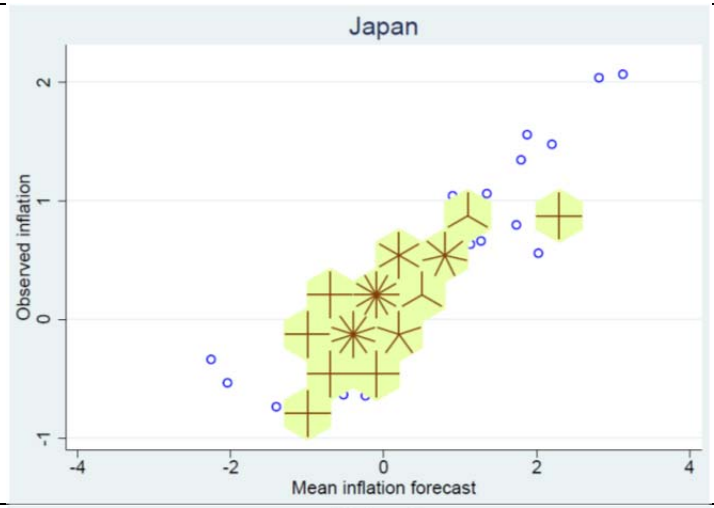


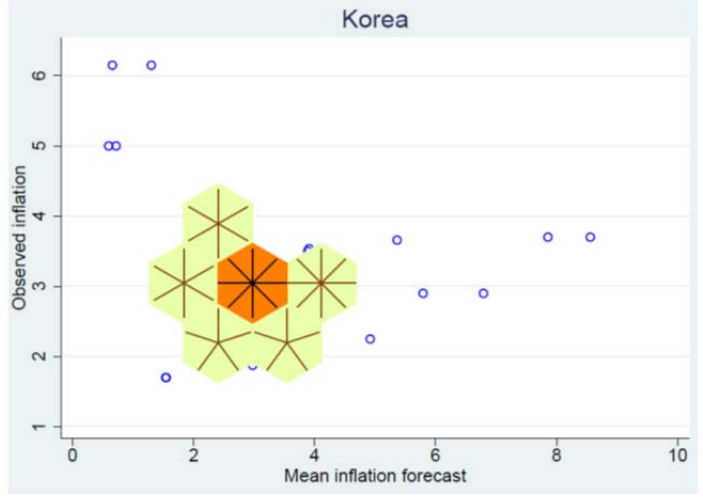
NOTES: Country identifiers and sample details are listed in the Appendix. MIN refers to the lowest inflation forecasts; MAX is the highest recorded inflation forecast. The solid line is observed inflation while the shaded area represents the range of inflation forecasts.

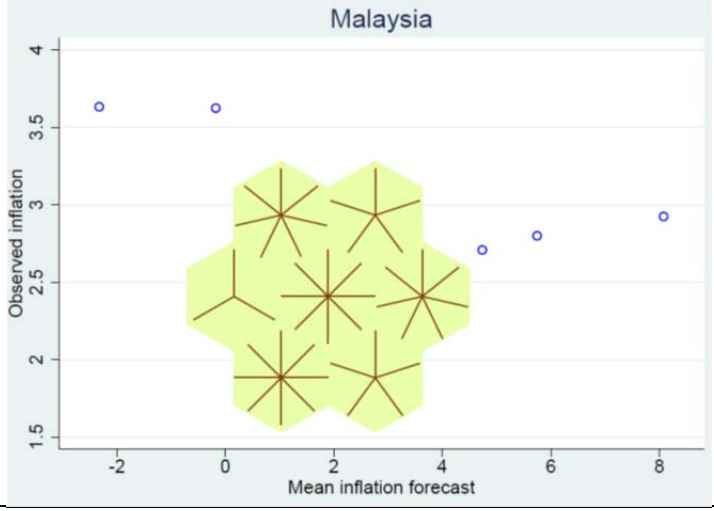
FIGURE 2 INFLATION VERSUS ONE YEAR AHEAD INFLATION FORECASTS

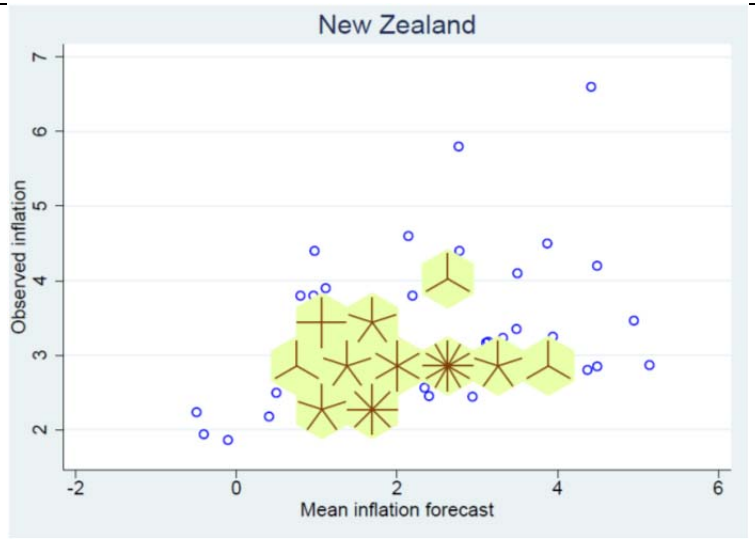


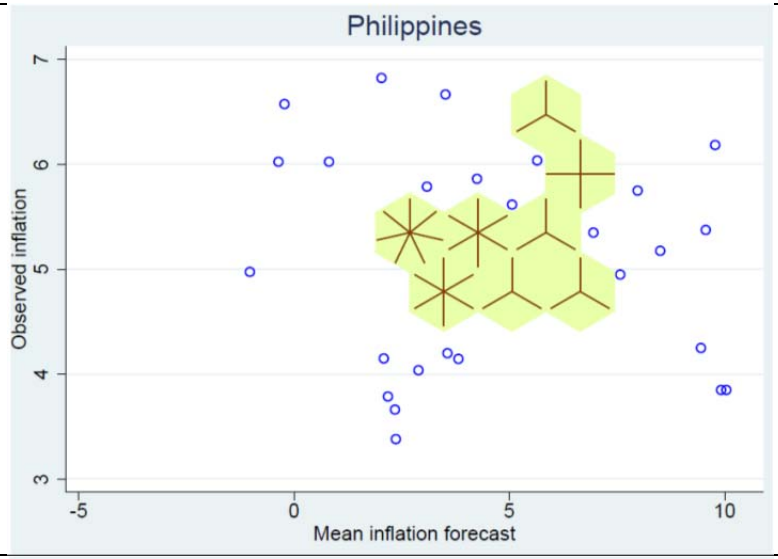

Indonesia
Observed inflation
Mean inflation forecast

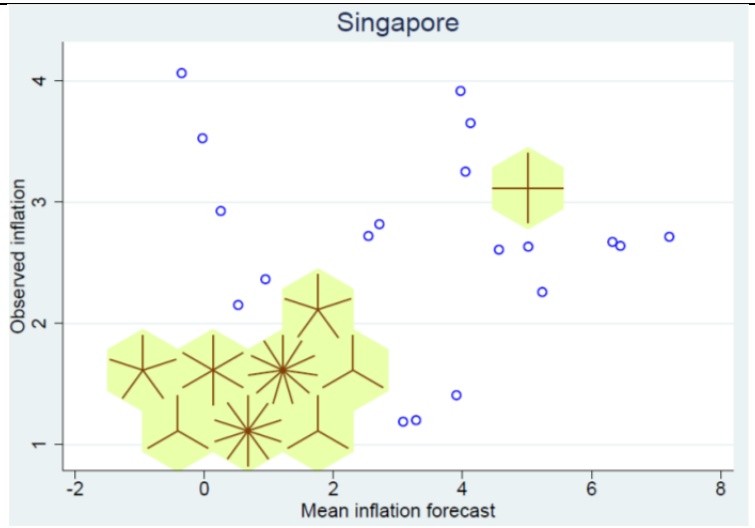

Japan
Observed inflation
Mean inflation forecast

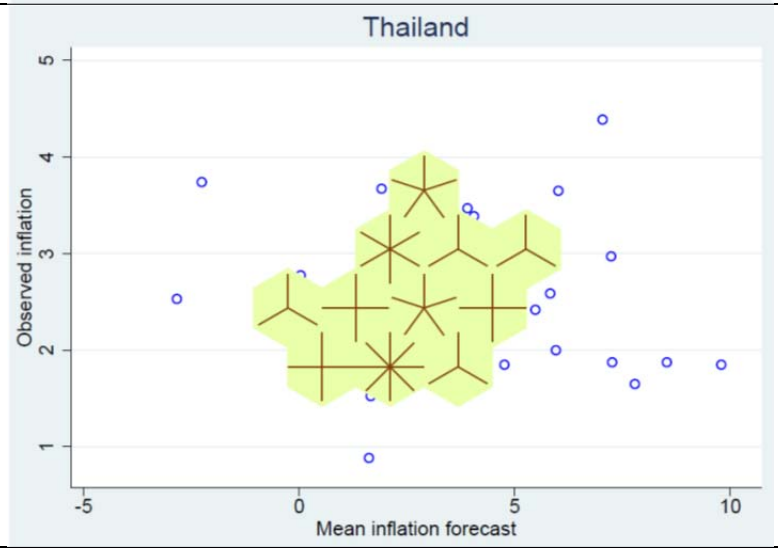

Korea
Observed inflation
Mean inflation forecast

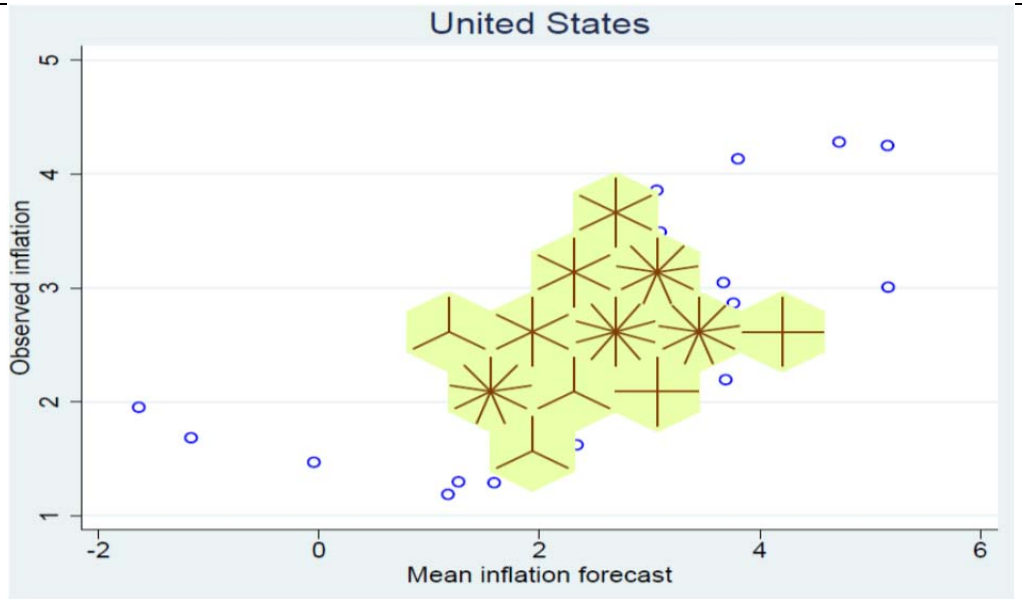

Malaysia
Observed inflation
Mean inflation forecast

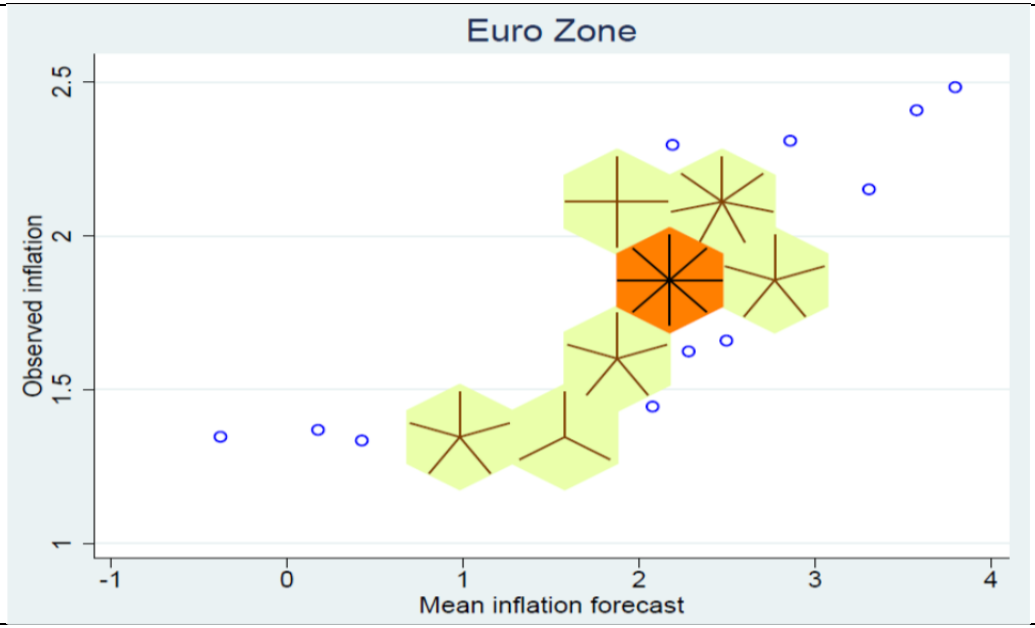

New Zealand
Observed inflation
Mean inflation forecast


Philippines
Observed inflation
Mean inflation forecast


Singapore
Observed inflation
Mean inflation forecast

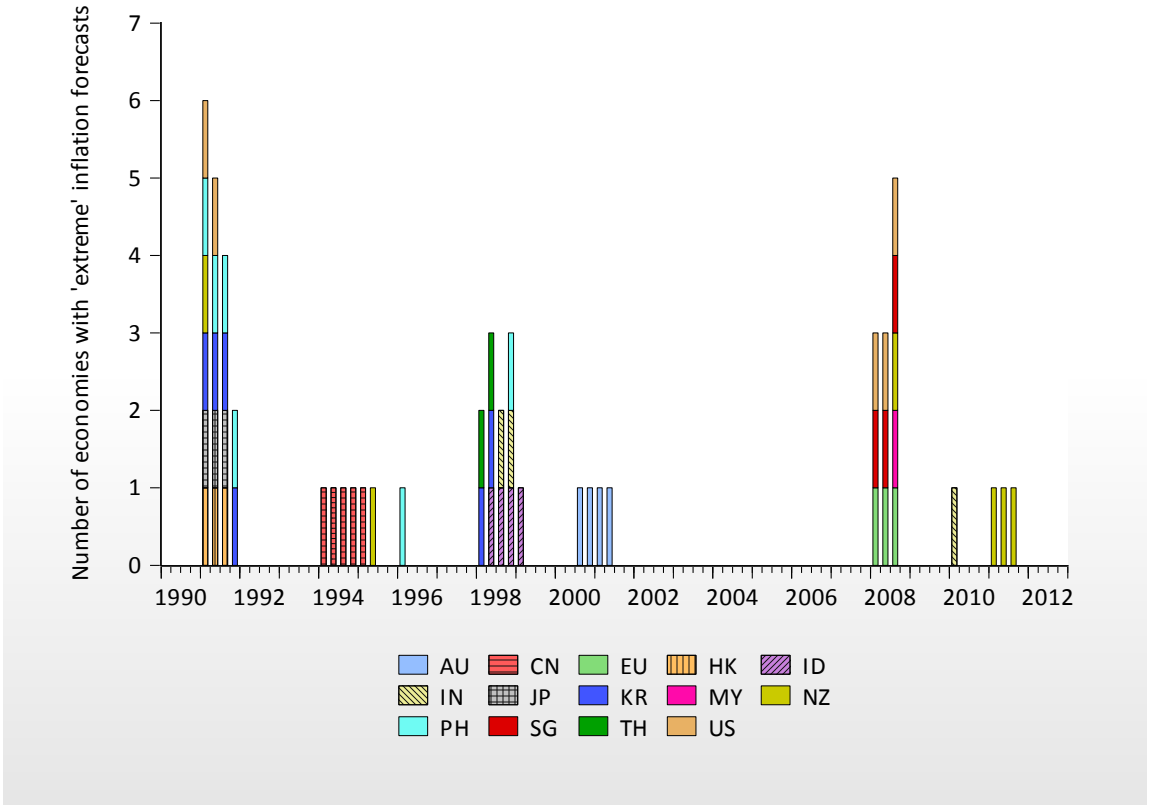

Thailand
Observed inflation
Mean inflation forecast


United States
Observed inflation
1
2
3
4
5
-2
0
2
4
6
Mean inflation forecast


Euro Zone
Observed inflation
1
1.5
2
2.5
-1
0
1
2
3
4
Mean inflation forecast

NOTE: The horizontal axis measures mean inflation forecasts for the full available sample (see Appendix) across individual forecasters in each economy. The vertical axis is observed inflation for the same sample. The darker the sunflower the larger the number of observations included, also highlighted by the number of 'petals' (i.e., the number of observations in each bin). Lighter sunflowers contain 13 observations, darker ones include 30 observations. Circles represent individual observations.

FIGURE 3 'EXTREME' INFLATION FORECASTS



NOTE: each bar takes on the value of 1 for each economy that exhibits a forecast defined as 'extreme', essentially a one year ahead inflation forecast that exceeds mean inflation over the 1990-2012 period by at least 2 standard deviations of observed inflation. The inflation threshold with the fraction of the total number of observations included in the 'extreme' bin in parenthesis is shown next. AU:5% (4.55%); CN: 10% (5.68%); HK: 10% (3.41%); IN: 14% (3.41%); ID: 40% (4.54%); JP: 3% (3.41%); KR: 7% (5.69%); MY: 8% (1.14%); NZ: 4% (6.82%); PH: 10% (6.82%); SG: 6% (3.41%); TH: 8% (2.27%); US: 4% (5.68%); EU: 3% (5.36%).

FIGURE 4A SELECTED DISRTIBUTIONS OF INFLATION FORECASTS – Consensus Forecasts and the GFC

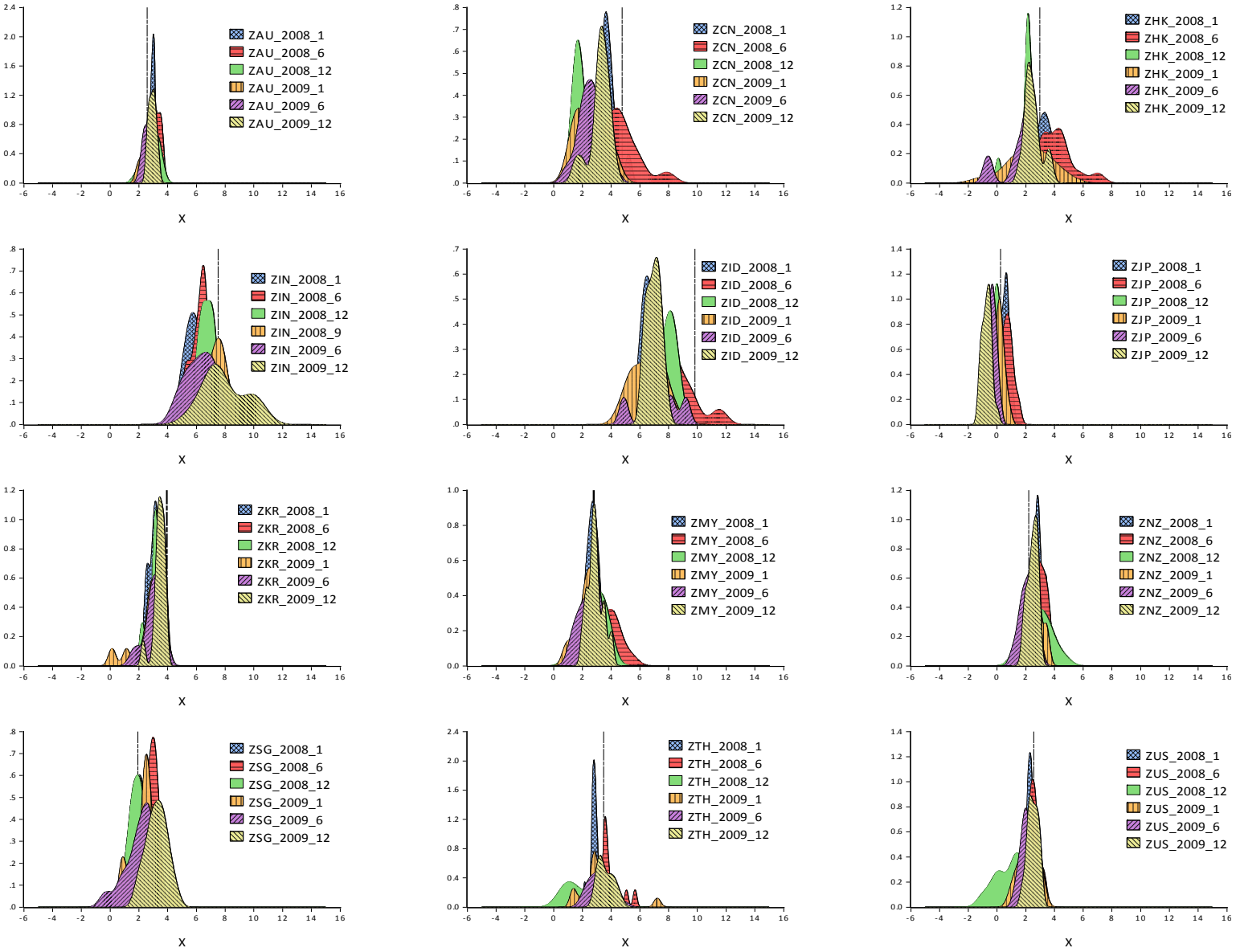
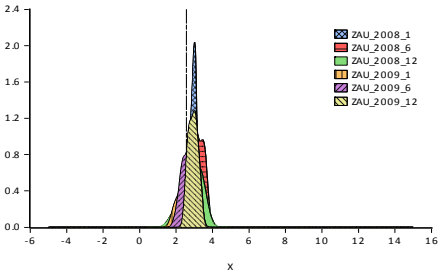
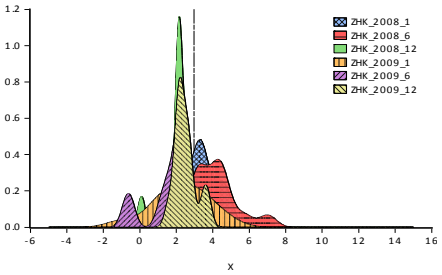
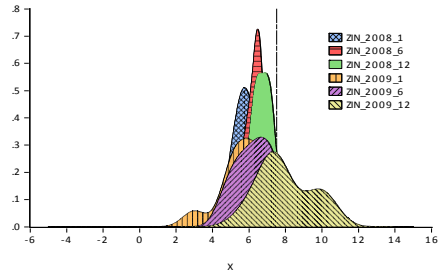
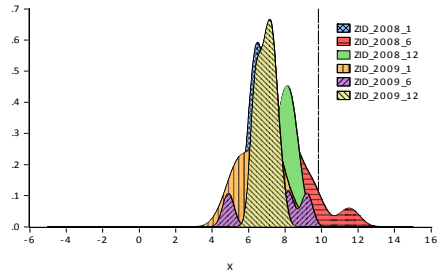


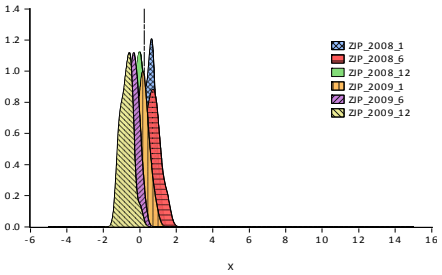
FIGURE 4B SELECTED DISRTIBUTIONS OF INFLATION FORECASTS – Non-Consensus Forecasts and the GFC

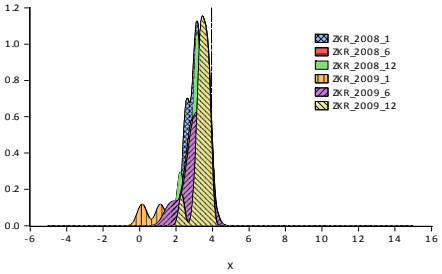


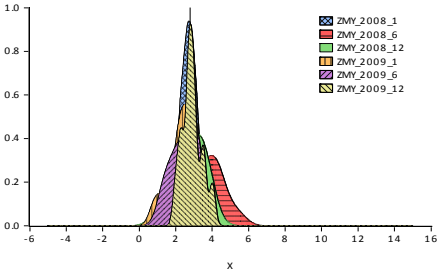


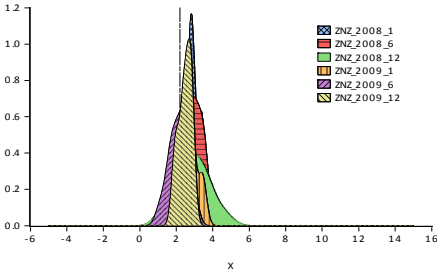


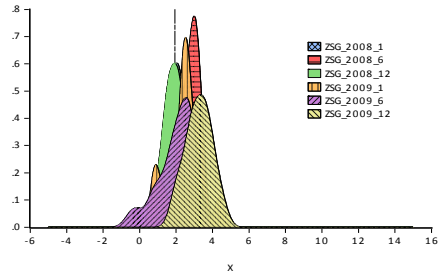


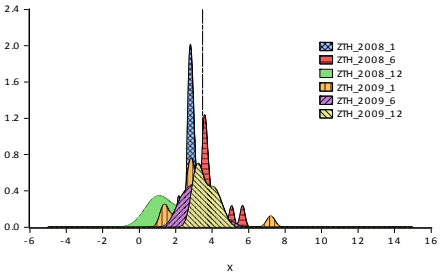












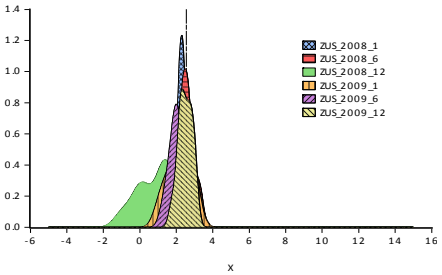
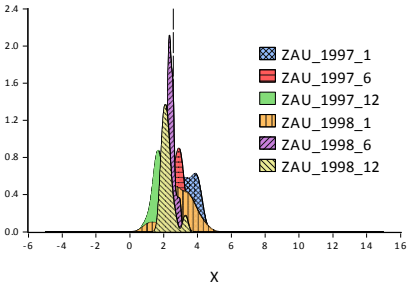
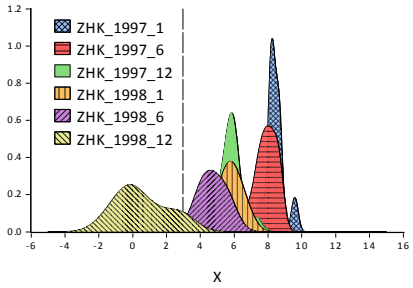
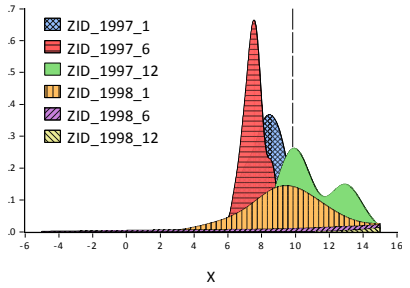
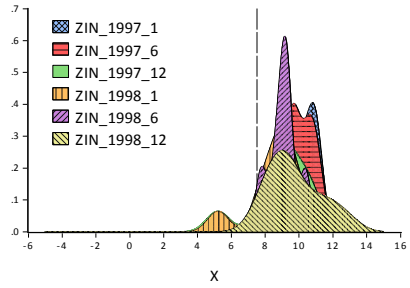


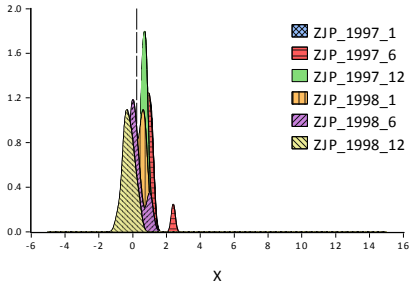
FIGURE 4C SELECTED DISRTIBUTIONS OF INFLATION FORECASTS – Consensus Forecasts and the AFC

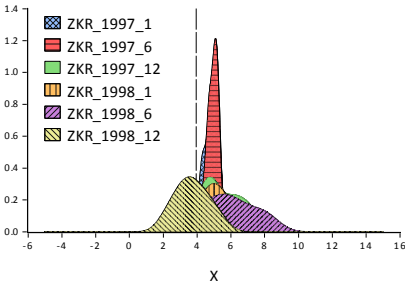


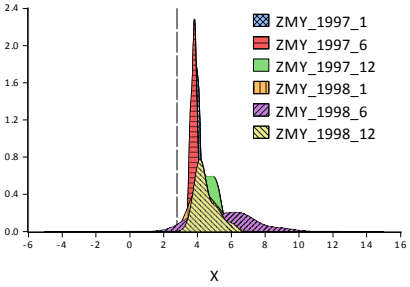


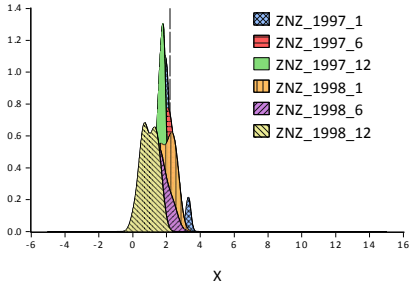


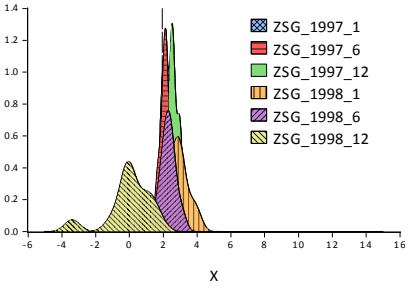


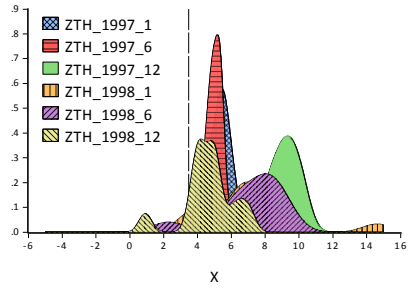












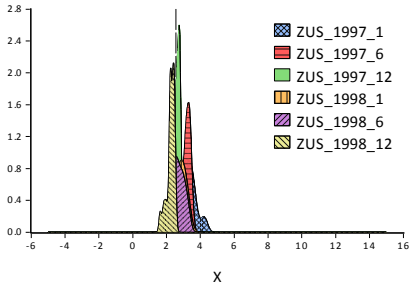
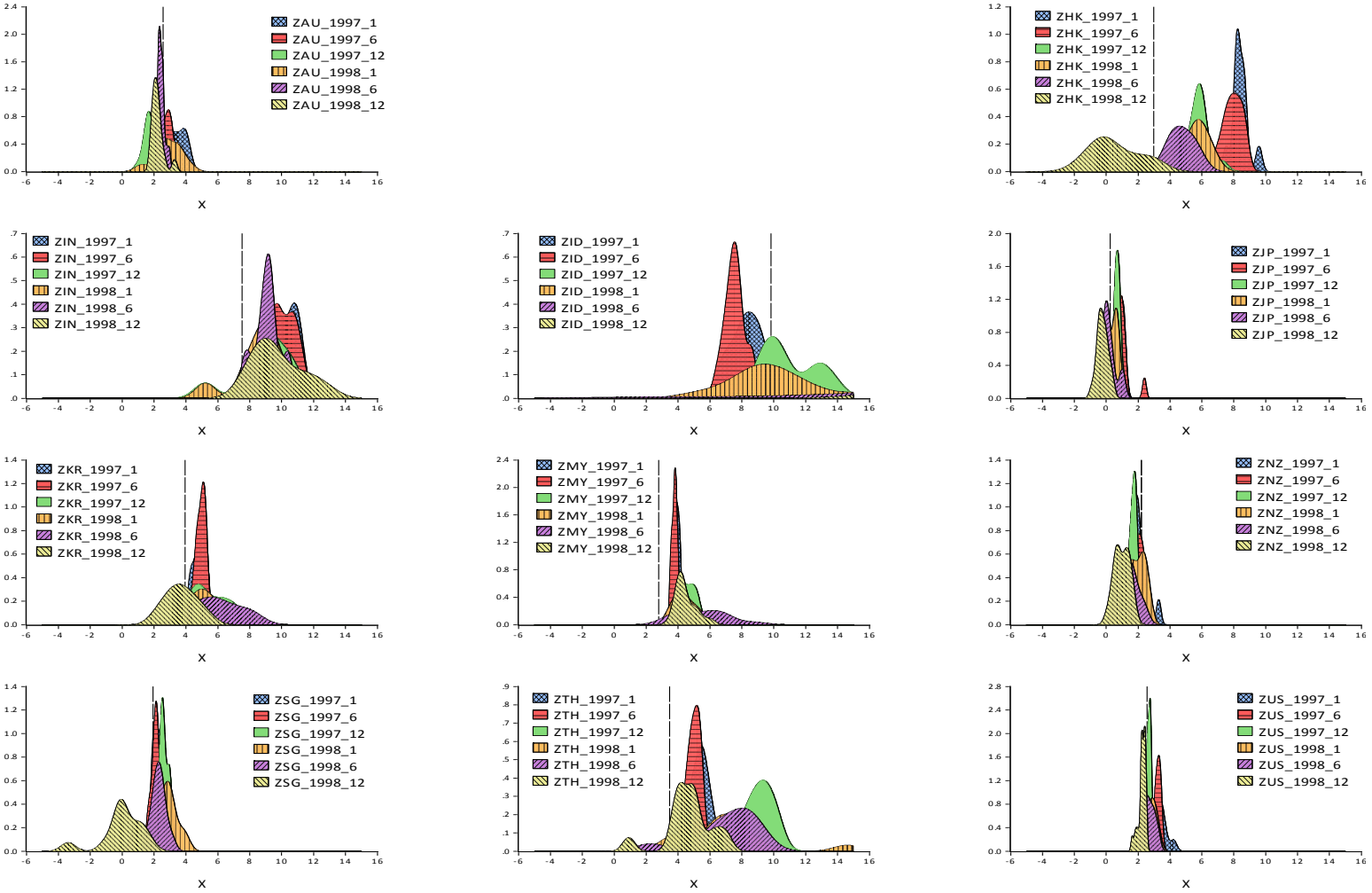


FIGURE 4D SELECTED DISRTIBUTIONS OF INFLATION FORECASTS – Non-Consensus Forecasts and the AFC



NOTE: The horizontal axis measures inflation rates (one year ahead forecasts). Z** refers to the code for each economies (see text). YYYY_MM is the year and month for which a distribution is estimated using the K-L distance measure described in the text. The vertical dashed lines represent the mean inflation rates for the full sample for each of the economies shown. See the appendix for the actual values.

FIGURE 5A INFLATION FORECAST DISAGREEMENT

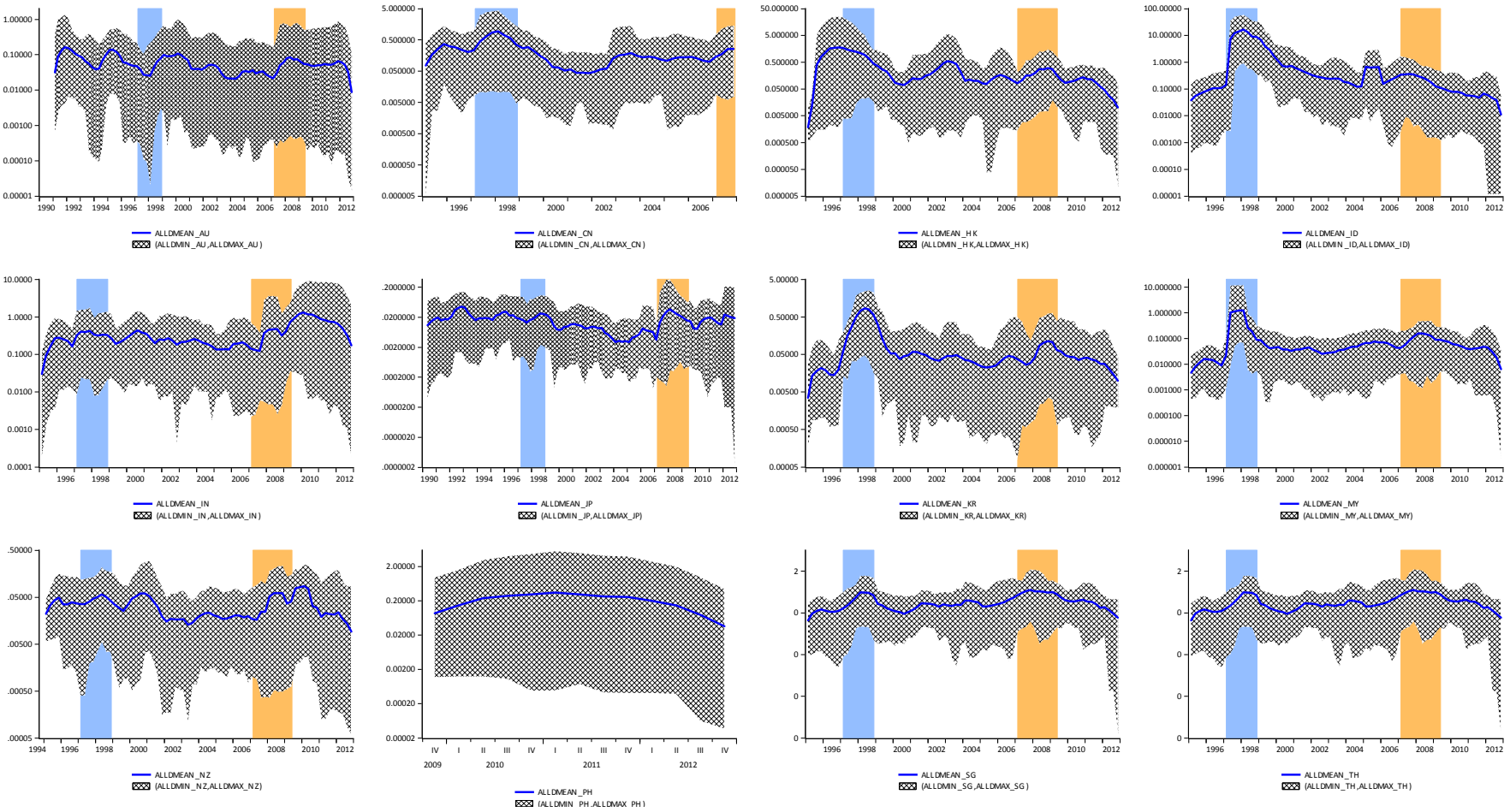
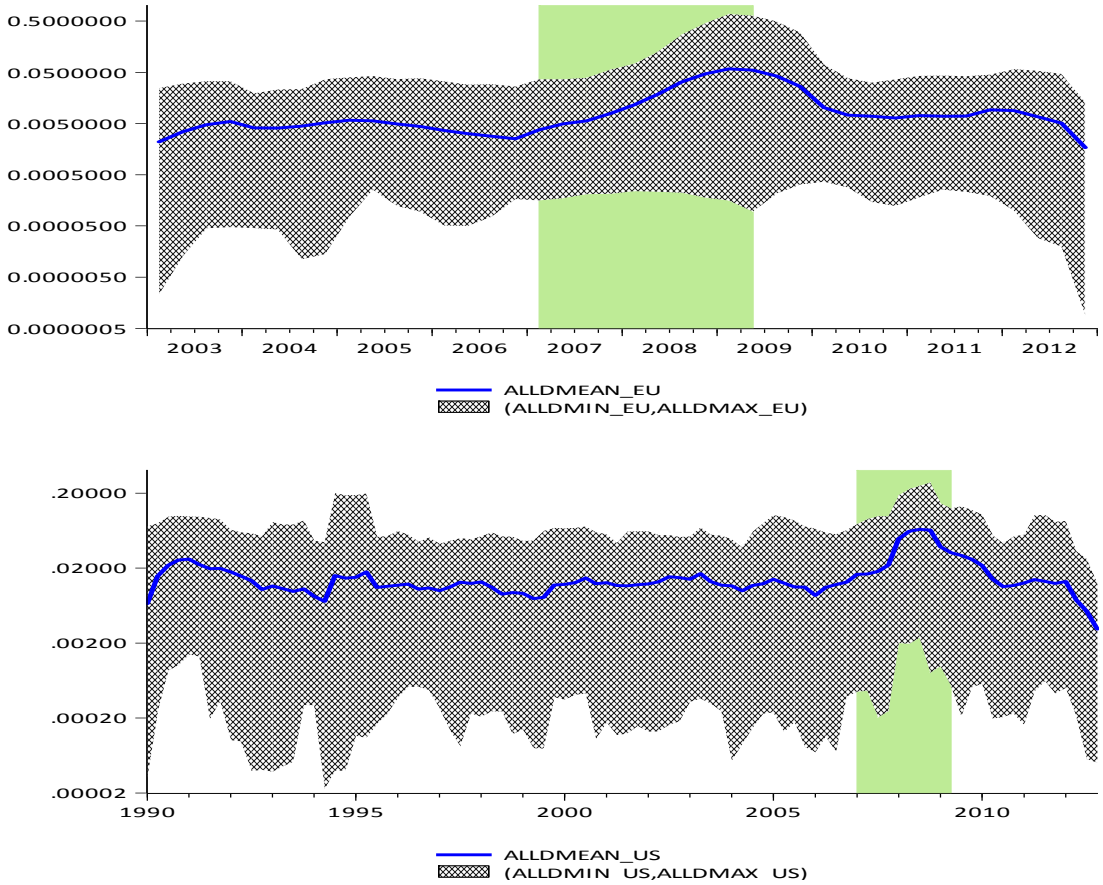
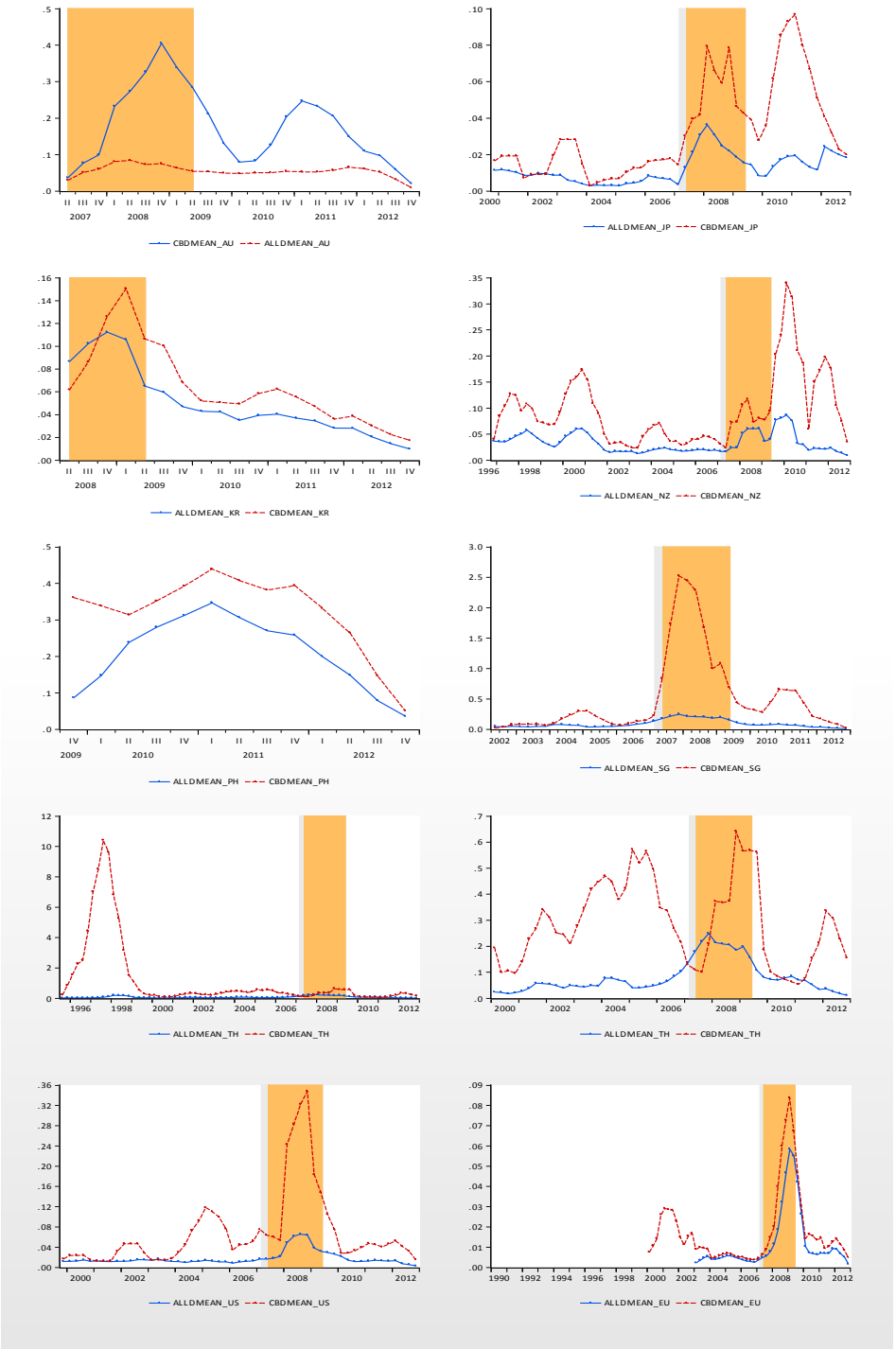


FIGURE 5B INFLATION FORECAST DISAGREEMENT: U.S. and the EURO ZONE (cont'd)



NOTE: The solid line represents an estimate of disagreement as defined in equation (4). The logarithm of *d* is used on the vertical axis. The vertical shaded area represents the GFC (2007Q1-2009Q2). The cross-hatched area identifies the range of values taken by *d* across the various forecasters considered.

FIGURE 6 INFLATION FORECAST DISAGREEMENT: CENTRAL BANKS versus ALL FORECASTS AS BENCHMARKS



NOTE: *d* as shown in Figures 5A and 5B are shown as is a version of the measure of forecast disagreement where the benchmark is the mean central bank inflation forecast. Actual values of *d* are measured on the vertical axis. The vertical shaded areas identify the AFC (1997Q1-98Q4) and the GFC (also see Figure 5A and 5B).