Inflation forecasts in Asia and the Pacific: performance, disagreement and spillovers

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Abstract

Until the global financial crisis of 2008–09, 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 unanchoring of expectations depends crucially on whether central banks convince the optimists or the pessimists amongst forecasters. Second, crisis times are precisely when central banks have the greatest flexibility to exploit deviations from some inflation objective. Third, forecasters can express a large degree of 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.

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1. Introduction

Until the global financial crisis of 2008–09, central banks celebrated the achievement of lower and more stable inflation rates. 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. Indeed, inflation has been referred to as "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). Perhaps unsurprisingly then, 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 characterised 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, 2003, 2007; Bohl, Mayes and Siklos, 2011). However, exactly which items comprise the "menu" of good policies 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 the achievement of price stability rests crucially on monetary policy being forward-looking. Therefore, inflation forecasts are central to the implementation of 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 easing, especially in the industrial world (see, eg, White, 2012).[2] 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 (ie the United States, Japan, China and the euro zone) faced bouts of deflation. As this is written, several central banks are once again seeing inflation rates fall to very low levels as

[2] 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).

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 destabilising 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 (see, eg, Siklos, 2013).

The 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 blocs is partly motivated by the possibility that monetary actions in one part of the world (ie the United States) can and do spill over into other regions (eg Taylor, 2013) and that this may be reflected in forecasters' views about the inflation outlook. Slow economic growth has also revived in some quarters fears of a return to the stagflation of the 1970s (eg Meltzer, 2008).

Relying on previous evidence that univariate models easily outperform multivariate ones (eg Stock and Watson, 2007) much of the analysis that follows relies on a simple framework to explain the behaviour and performance of inflation forecasts in the 14 economies examined. In light of the global spillovers argument (eg see Taylor, 2013), the paper also considers the degree to which inflation forecasts are possibly subject to contagion-type effects. That is, the study considers whether there are non-fundamental reasons for inflation and inflation forecasts to be transmitted globally. One can think of this as the empirical characterisation of the "bad luck" story of global inflationary developments as it pertains to the Asia and Pacific regions.

An under-appreciated element in the analysis of forecasts is that these can differ greatly between forecasters. To the extent that disagreements in forecasts stem from changes in inflationary developments, reflect unclear or non-transparent signals emanating from policymakers, these can be far more informative about forecast performance and the consequences of policy actions. Forecast disagreement (see, eg, Siklos, 2010, 2013a, 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 may have 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 organised as follows. The next section briefly asks why many policymakers 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, especially the finding that forecasters tend to express a large degree of 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) haunt us still

The stagflation of the 1980s and early 1990s left a lasting impression on policymakers inside and outside central banks. Improvements in the "contract" between governments and the central bank since that time have 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.[3] The potential global impact of stimulating economies worldwide prompted fears of a looming inflation or, at least, the destabilisation of inflationary impulses that characterised pre-central bank independence stop-go monetary policy regimes (see, eg, Goodfriend and King, 2013). These factors, when combined, can easily lead to conditions that can unanchor 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 on the part of policymakers 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 (eg Schoder, 2013), there is the worry that central banks are losing their independence. Even if an inflationary surge is not imminent, any unanchoring of inflation expectations, given inflation's persistence properties (eg Fuhrer, 2009), 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 (eg Brittan, 2013; Wadhwani, 2013).

Other than the fact that the IMF's study focuses only on the inflation record in advanced economies, and 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 unanchoring of inflation expectations 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.

[3] 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).

Rules-like behaviour, of which the Taylor rule is the embodiment of modern monetary policymaking, 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, 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 characterises central bank behaviour in normal times.[4] More generally, the implication is that central banks may be required to act "irresponsibly" for a time until normal economic conditions return.[5]

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 lack of evidence that mild deflation is economically harmful[6] some central banks are determined to avoid 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.

3. Data and empirical methods

3.1 Data

Our principal focus is on inflation and inflation forecast performance in 12 economies of Asia and the Pacific. These are: Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the 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 quarterly and semiannual. In addition, several 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 (ie semiannual) were converted to the quarterly frequency via linear interpolation. Annual data available

[4] 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*, pp 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 to Asia-Pacific economies.

[5] 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.

[6] 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), and Borio and Filardo (2004).

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 and elsewhere (eg Australia, New Zealand, Japan, the United States 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. 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 1997–98, 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.

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 (eg Consensus, Survey of Professional Forecasters), forecasts published by public agencies (eg 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 policymaking 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 still others 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 more closely mirror 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

[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 Greenbook forecasts available from the Federal Reserve with a fairly long lag) are "remarkably hard to beat".

[10] See Siklos (2013) note 20, for the details.

index. Two well known techniques have been widely used in the literature. I rely on the arithmetic average of the implied inflation forecasts generated from the two approaches (see Siklos, 2013, and references therein).

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. Not all forecasters in the survey are retained. For example, some forecasters dropped out of the survey or their forecasting record is highly irregular.

There exists 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. These are: Australia, Indonesia, Korea, New Zealand, the Philippines and Thailand. Financial crises (eg 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, and 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 crisis, I adopt the dates suggested by Reinhart and Rogoff (2009), Laeven and Valencia (2012), while exchange rate regime data are from Reinhart and Rogoff (2004).[11] For the global financial crisis, I follow Dominguez, Hashimoto and Ito (2012).[12]

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 well known and commonly used metrics are available to describe inflation and inflation forecast performance, I begin with a descriptive analysis by investigating the root mean squared error of forecasts (RMSE).

Denote annualised 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 (eg IMF). If we drop k, this indicates that all forecasts are aggregated. Hence, the forecast error is written

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

[11] 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.

[12] They identify different starting and ending dates for the global financial crisis, depending on the economy in question.

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 (ie forecasts).

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 globalisation, 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 make reference to the forecasts of others in the region or in the economies of large trading partners (eg the United States and the euro zone). Indeed, given that the source of the Asian financial crisis was financial in nature, and that 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.

As a result, if inflation expectations are likely to become unanchored, then a proximate cause 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 (see, eg, Burdekin and Siklos, 2011, and references therein).

For simplicity, the test specification shown below considers the case of inflation rates in four groups of economies although, in principle, the specification can readily be generalised to consider contagion in a more disaggregated set of economies. The economies in the data set are grouped as follows: China, Japan, the United States and the remaining economies in the sample. Alternatively, I consider economies that target inflation (ie Australia, Korea, Philippines, New Zealand, Thailand and Indonesia) as well as a group of economies that actively intervene in foreign exchange markets (ie Hong Kong SAR, 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 global financial crisis dated to begin in 2007 Q1 and ending in 2009 Q2. The resulting dummy variables take on the value of one for the crisis sample, and zero otherwise. Next, I normalise 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:

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

where $\tilde{\pi}_{it}$ are the standardised inflation rates for markets i=1,...,n and GFC_t is the global financial crisis dummy. Hence, $\tilde{\pi}_{it} = \frac{\pi_{it}}{\sigma_{s_i}^{GFC=0}}$ 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 (2) can be estimated as seemingly unrelated

regressions. Moreover, while (2) 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 $\lambda_{ij} = 0$.[13] 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 recognised 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 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 subsample. 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 subsample, 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.

Arguably, a critical indicator of policymakers' success in ensuring that expectations are anchored is to ascertain the extent to which forecasters disagree.[14] There is no universally agreed measure of forecast disagreement (see Siklos, 2013, for a brief discussion). Since we examine one-year-ahead inflation forecasts, define d^i_{t1} to represent forecast disagreement at time *t*, over a forecast of horizon of one year, for economy *i*. Then,

$$d^i_{t1} = \frac{1}{N_i - 1} \sum_{\delta=1}^{N_i} (\pi^{i,F}_{\delta t1} - \bar{\pi}^{i,F}_{\bullet t1})^2 \qquad (3)$$

where π^F_{t1} is the forecast for inflation at time *t* for a one-year-ahead horizon, N_i is the number of forecasts, δ identifies the forecaster, while $\bar{\pi}^i$ 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 be 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 (ie 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

[13] 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).

[14] Also relevant are the proximate economic forces that drive disagreement. Space limitations prevent me from exploring this issue. However, see Siklos (2013).

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 (ie $\bar{\pi}_t^{i,CB}$) as opposed to the mean forecast reflected in (3) 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 sample while the second part considers the record of the United States and the euro zone. To simplify the presentation economies will be identified by their acronym. They are:

Australia	AU
China	CN
Hong Kong SAR	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	EU

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 EU. It is also worthwhile to visually examine the degree to which the range of one-year-ahead inflation forecasts overlaps with subsequently observed inflation. For example, inflation forecasts in AU have consistently overlapped with observed inflation since inflation targets were introduced,[16] whereas forecasters routinely

[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}.

[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. Policymakers insisted that the impact of such a tax on inflation would be temporary and forecasters appear to have reacted accordingly.

either over- or underestimate inflation in Malaysia. Of course, the sharp changes in energy prices beginning in 2007 and through 2008 distort the results somewhat. 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 global financial crisis. Finally, while deflation has appeared in nine 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 stylised 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 (eg 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 rather than the conventional recessions and expansions experienced in the advanced industrial economies. On the 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 global financial crisis. 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 United States is in recession for 15.22% of the sample while the same figure is 34.09% for the euro zone.[17] The global financial crisis, 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 Asian financial crisis to the mix, then the fraction of the sample in which 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 SAR and China. In 11 of the 14 economies

[17] Data from the NBER's reference cycle chronology for the United States 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.

[18] Relying on the data by Laeven and Valencia (2012), China, Indonesia, Japan, Korea, Malaysia, the Philippines and Thailand experienced banking crises in 1997 or 1998 (Korea also had 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 United States in 2007 and one in the euro zone in 2010.

considered, forecasters overestimate realised 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 overestimated forecast errors, there is considerable variation in inflation forecasting performance. In some instances, this may reflect a form of forecast smoothing whereby some forecasters make few allowances or none for the short-term impact of commodity price changes on observed inflation (eg as in Indonesia) while others adjust their forecasts for the likely impact of short-term supply side shocks. However, since we are unable to observe either the "model" or how judgment is used in generating forecasts, their loss function or how inattentive forecasters may be, 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 the global financial crisis did not impair forecasting performance as RMSE fell relative to the non-crisis sample in eight of the 12 economies for which we have data. Moreover, RMSE during the global financial crisis was lower than in the Asian financial crisis in nine of the 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 nine central banks for which we have data, non-crisis times improve forecasting performance in six of nine cases. However, the global financial crisis results in a deterioration of forecast performance in six of nine cases relative to the full sample.[20]

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. Equation (2) provides a test of interdependence versus contagion-type effects in explaining inflation forecasts across regions. To simplify the testing, as well as to provide some insights into the role of exchange rate choice or policy regimes, several of the Asia-Pacific economies are 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 SAR, Malaysia, Singapore and India are defined as the group of managed exchange rate economies. China, Japan and the United States enter the specification in their own right and the euro zone is excluded, for simplicity. In another variant, economies other than the big three are grouped together. Clearly, other combinations are possible and may influence the test results. However, no sensitivity analysis is

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

[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.

conducted. Since a financial crisis is the proximate explanation for inflation expectations in one country to spill over onto other economies in the region, I focus on the global financial crisis and define the crisis as beginning in 2007 Q1 and ending in 2009 Q2. As with the grouping of economies, the results may well be sensitive to the choice of the period when various economies may have suffered the effects of the financial crisis. Tables 3A, 3B and 3C summarise the findings. Finally, since inflation forecasts of most optimistic and pessimistic forecasters provide additional insights into the behaviour of expectations, specification (2) is also estimated for these cases.

When economies other than China, Japan and the United States are grouped together (Table 3A), there are considerable spillovers in mean inflation forecasts. In contrast, there is no evidence of any contagion among the most pessimistic forecasters (ie MAX), while the only evidence of contagion among the optimists among the forecasters is from Japanese inflation to US 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 manage 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 3B). In contrast, there is considerable evidence of shocks being transmitted among the large economies considered (ie China, Japan and the United States) and from or to the managed exchange rate regime economies (Table 3C). 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 2 and 3 plot measures of forecast disagreement in the 14 economies examined in this study. Figures 2A and 2B display the measure summarised by equation (3) 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 3 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 to consider the range of disagreement depending on the forecaster in question. This is illustrated by the shaded areas in both Figures.[21]

An additional observation from mean levels of disagreement is that they are clearly seen as rising sharply during the global financial crisis (identified by the vertical shaded area), especially in the United States and the euro zone, while a sharp fall in inflation forecast disagreement is also visually apparent in at least nine of the 14 economies in the sample (ie euro zone, US, AU, HK, ID, KR, MY, NZ and SG).

Next, if we consider changing the benchmark against which forecast disagreement is evaluated from $\bar{\pi}^{i}_{\bullet t1}$, that is, a mean across all types of forecasts, to the mean forecast published by central banks, one obtains a dramatically different

[21] Recall that *d* in equation (3) can be defined for each forecaster.

picture, as shown in Figure 3. The figure plots the available data from nine central banks that release inflation forecasts and shows the disagreement measure from Figures 2A and 2B 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 2008–09. Unfortunately, we only have data during the period of the Asian financial crisis for two economies in the Asia-Pacific (ie NZ and TH) but the impact of this episode in 1997–98 is evident from the TH data but less so for NZ.[22] 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 the 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 global financial crisis 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 3 may mask the fundamental variable or variables that can explain the movements observed in the plots.[23] It may also be of interest to find out the extent to which the monetary policy regime, or the exchange rate regime, play a role in the outcome. Needless to say, these questions also apply to asking about the behaviour of forecast disagreement more generally.

5. Conclusions and policy implications

The results of this paper suggest that it is possible to forecast inflation and, on average, forecast performance is reasonably good. Moreover, forecasters can disagree considerably with each other. When central banks worry about the potential for an unanchoring of inflation expectations, there is implicit in this

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

[23] Some central banks have been criticised (see, eg, 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 behaviour of inflation during and following the global financial crisis. 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 over which many economic models assume that policies reach their full impact. Post-mortems, however, instead suggest an "optimism bias" characterises 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).

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 destabilising inflationary expectations would necessarily originate from the behaviour 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 a large degree of 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 (eg 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.[24] Otherwise, crises, monetary policy actions (eg the build-up of foreign exchange reserves), and even the degree of economic slack, would not prompt more or less disagreement among forecasters.

Therefore, central banks have the very difficult task of explaining to the public that a seemingly improbable return to high and volatile inflation cannot be ruled out – even if indicators and institutions support the continuation of low and stable inflation rates because this environment has become a familiar one. 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.

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

Forecast errors: summary statistics

Table 1

Economy	Mean	SD	Max	Min
Australia	–0.40	1.38	4.60	–4.40
China	–1.13	2.47	6.06	–.976
Hong Kong SAR	–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
US	–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 labelled as being pessimists while MIN are referred to as optimists.

Root mean squared errors

Table 2

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
United States	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.

Contagion versus interdependence in Asia-Pacific inflation forecasts: Asia-Pacific (excluding China and Japan) and large economies

Table 3A

Coefficient	Mean	MAX	MIN
Asia-Pacific 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)
US (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)*

Contagion versus interdependence in Asia-Pacific inflation forecasts: inflation targeting economies and large economies

Table 3B

Coefficient	Mean	MAX	MIN
Inflation targeting 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)
US (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)*

Contagion versus interdependence in Asia-Pacific inflation forecasts: managed exchange rate and large economies

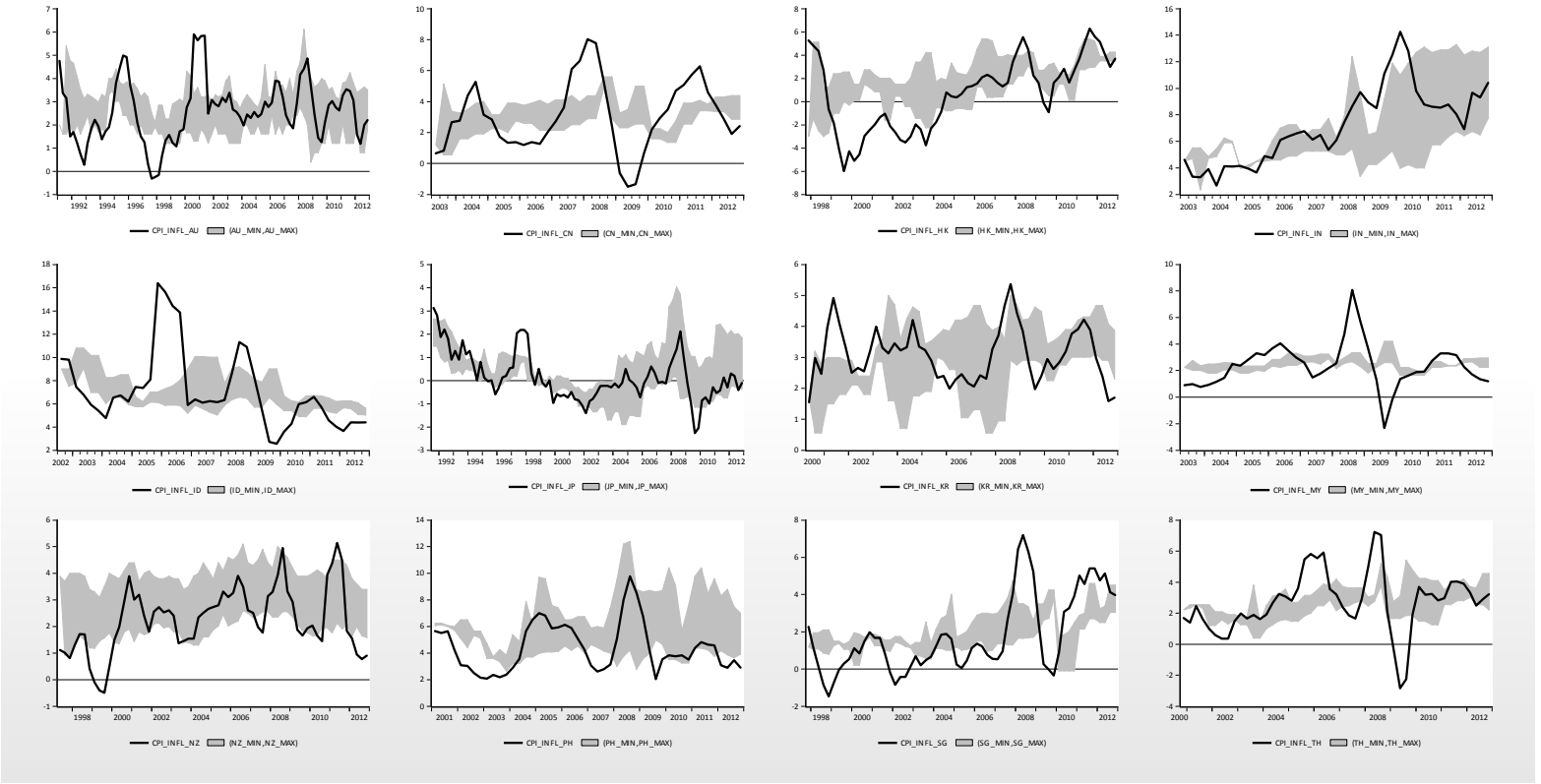
Table 3C

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)
US (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 are from equation (2) and represent the interaction term of inflation in economy i and a GFC crisis dummy i=1,2,3,4). Rejections are highlighted by the asterisks. 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 SAR, Malaysia, Singapore and India. LARGE economies are China, Japan and the United States. Cross-country estimates of inflation are averages across economies (unbalanced panel). Equation (2) is estimated via SURE (seemingly unrelated regression). The highlighted figures are coefficients with p-values of .05 or less.

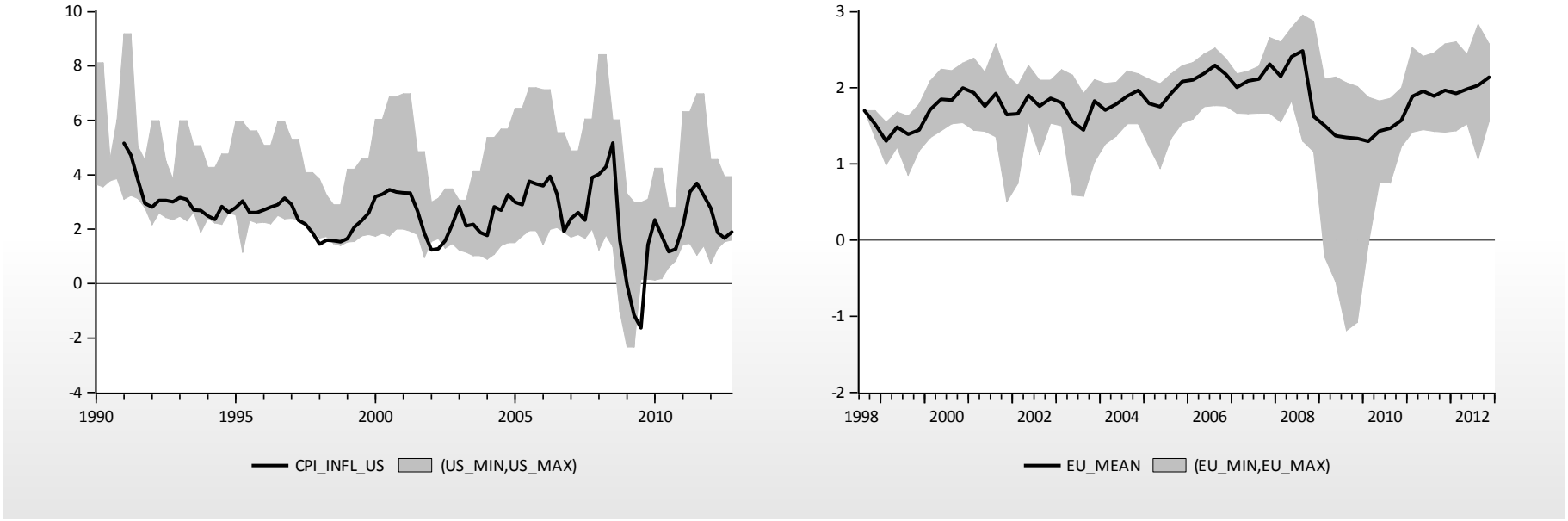
Observed inflation and the range of inflation forecasts

Figure 1



Observed inflation and the range of inflation forecasts (cont)

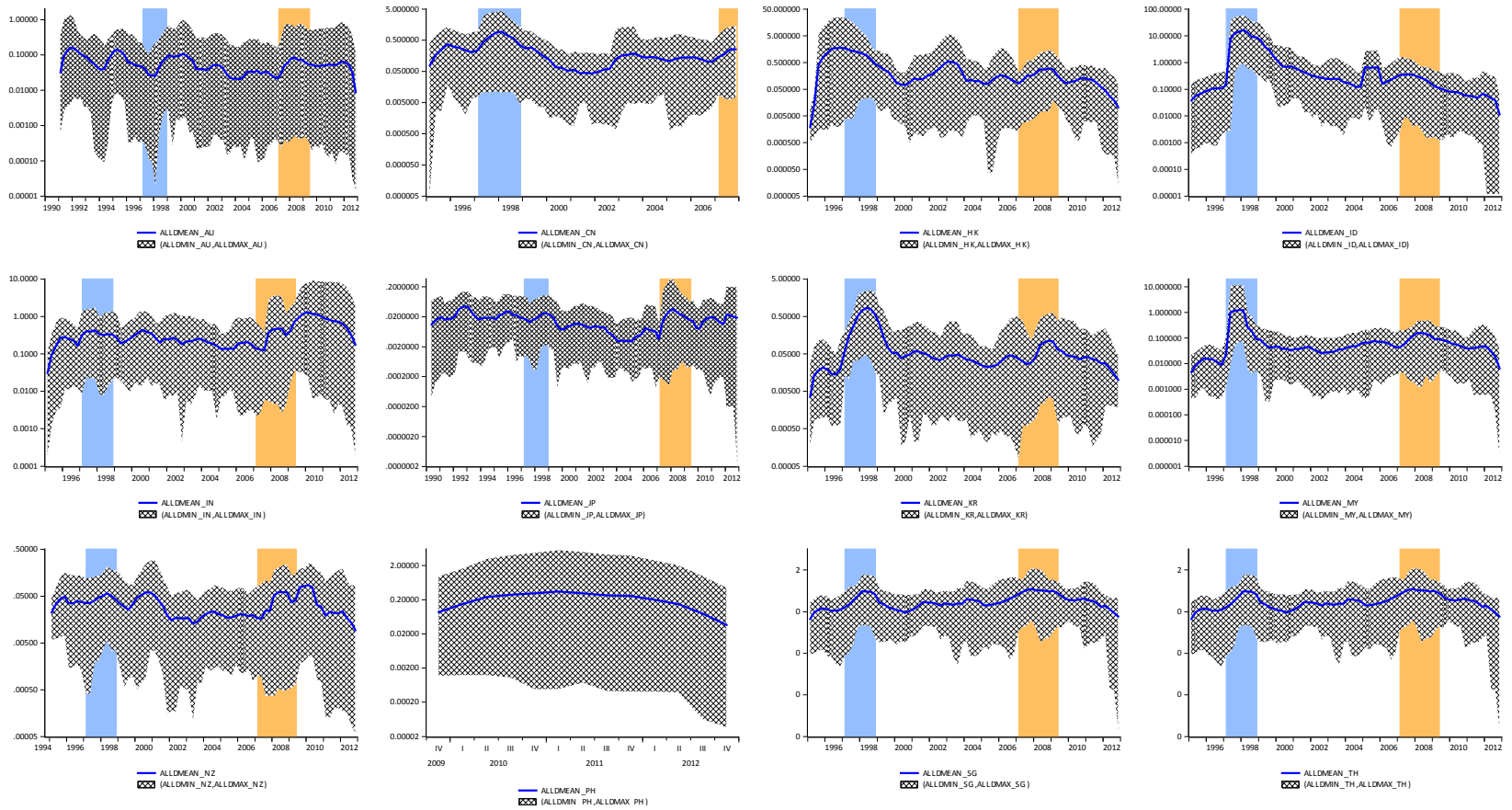
Figure 1



NOTES: 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. Here and elsewhere EU refers to the euro zone.

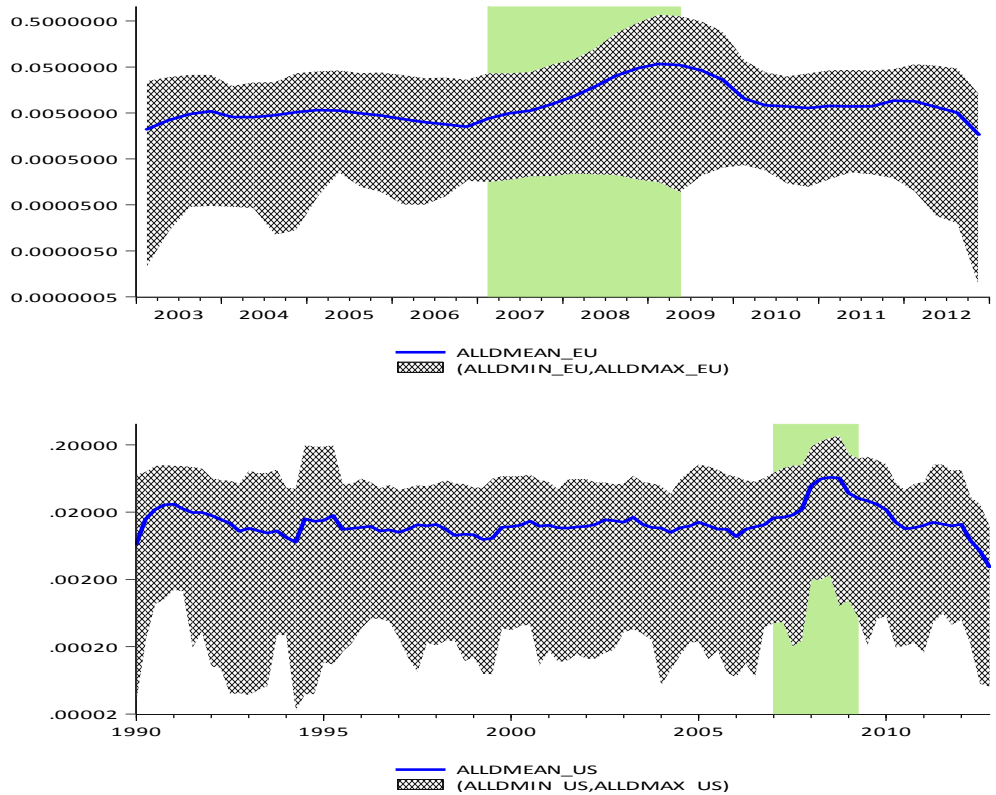
Inflation forecast disagreement

Figure 2A



Inflation forecast disagreement: United States and the euro zone

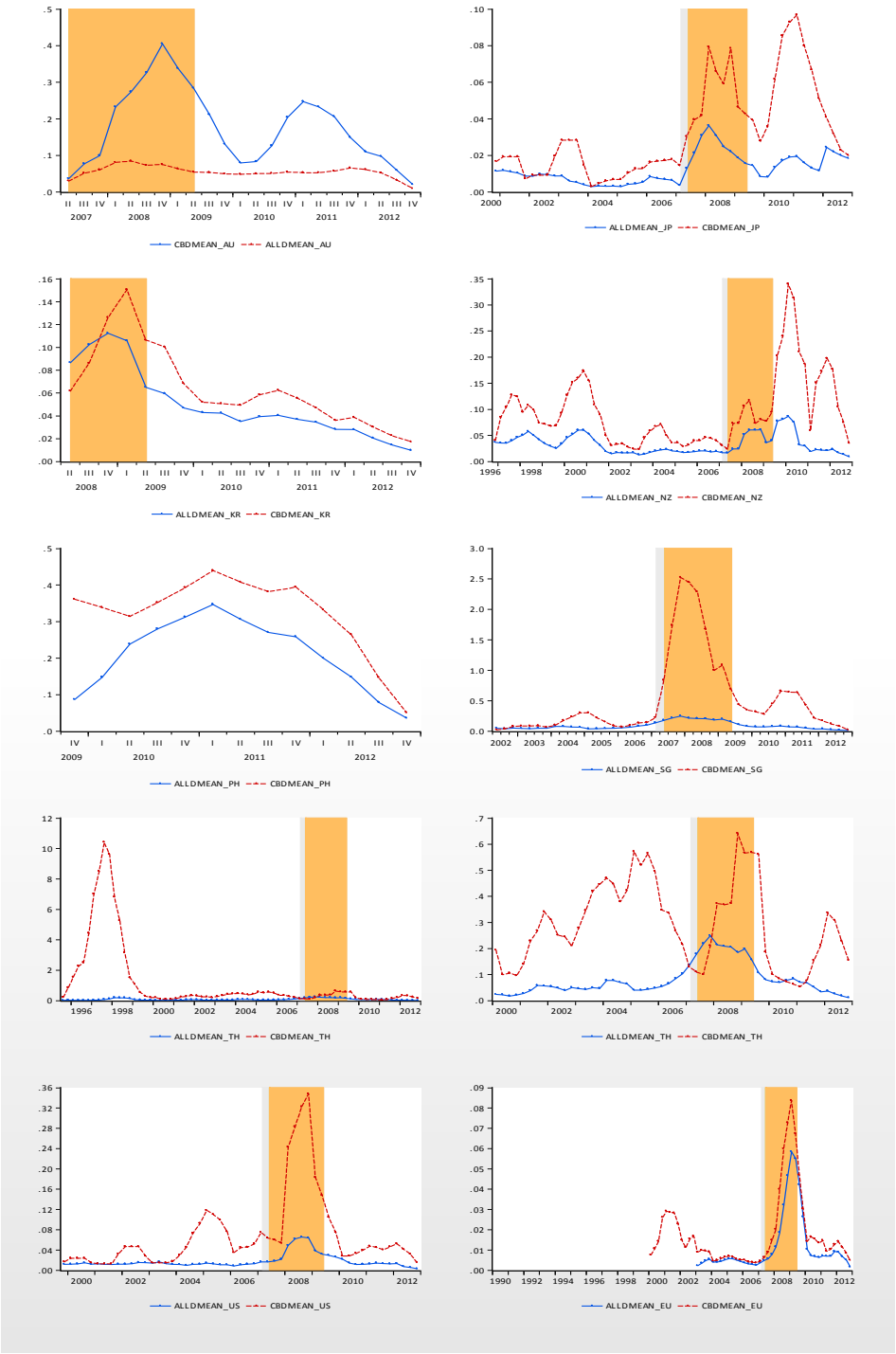
Figure 2B



NOTE: The solid line represents an estimate of disagreement as defined in equation (3). The logarithm of *d* is used on the vertical axis. The vertical shaded areas represent the Asian financial crisis (1997Q1–98Q4) and the global financial crisis (2007Q1–2009Q2). The cross-hatched area identifies the range of values taken by *d* across the various forecasters considered.

Inflation forecast disagreement: central banks versus all forecasts as benchmarks

Figure 3



NOTE: d as shown in Figures 2A and 2B, together with 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 global financial crisis (also see Figure 2A and 2B).

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