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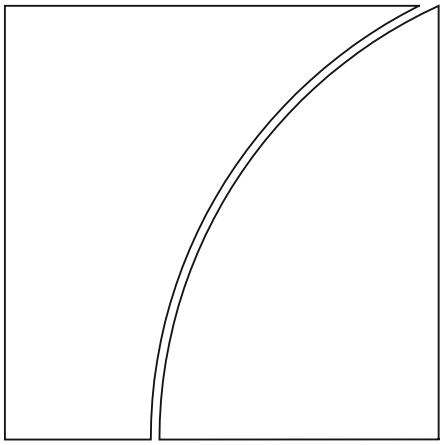

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Foreword

Frank Packer and Aaron Mehrotra

The People's Bank of China and the Bank for International Settlements co-hosted a research conference on "Globalisation and Inflation Dynamics in Asia and the Pacific" on 23–24 September 2013 in Beijing. This was the wrap-up conference for the BIS Asian Office's two-year research programme on globalisation and inflation that was launched by the Asian Consultative Council in February 2012. The event brought together senior officials and researchers from central banks, international organisations and academia.

The research papers presented at the conference covered the dynamics of inflation forecasts in the region; the measurement of economic slack; supply chains and inflation spillovers; financial globalisation and the role of exchange rate in monetary policy; global commodity price cycles and their monetary policy implications; and the role of inflation in China's monetary policy rule.

Governor Zhou Xiaochuan of the People's Bank of China made the opening remarks and former Governor Masaaki Shirakawa of the Bank of Japan delivered the keynote address. The conference also included a policy panel discussion by Deputy Governors focusing on the challenges posed by globalisation to the Asia-Pacific region. The panel was chaired by Deputy Governor Yi Gang of the People's Bank of China.

There was general agreement among the participants that the nature of real globalisation was changing. In economies that are integrated into international supply chains, cost shocks may result in significant cross-border spillovers. At the same time, increased financial globalisation could present a challenge to exchange rate management in the region's economies. The participants also broadly recognised that financial globalisation was creating significant monetary policy spillovers across borders.

This volume is a collection of the speeches, presentations and a background paper from the conference.

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Central banks

Reserve Bank of Australia	**Philip Lowe** Deputy Governor
People's Bank of China	**Zhou Xiaochuan** Governor
	Yi Gang Deputy Governor
	He Jianxiong Director General of International Department
	Jin Zhongxia Director General of Research Institute
	Zhu Jun Deputy Director General of International Department
	Yao Yudong Deputy Director General of Monetary Policy Department
	Guo Jianwei Deputy Director General of Monetary Policy Department II
	Wang Yi Deputy Director General of Statistics and Analysis Department
Hong Kong Monetary Authority	**Dong He** Executive Director, Research Department
	Charles Xiangrong Yu Manager/Economist
Bank Indonesia	**Perry Warjiyo** Deputy Governor
	Aida S Budiman Director of International Department
Bank of Japan	**Toshitaka Sekine** Deputy Director-General

Bank of Korea	**Jun Il Kim** Deputy Governor and Chief Economist
Central Bank of Malaysia	**Marzunisham Omar** Assistant Governor
Reserve Bank of New Zealand	**Dean Ford** Manager, Forecasting
Bangko Sentral ng Pilipinas	**Veronica Batallones Bayangos** Deputy Director
Swiss National Bank	**Raphael Auer** Deputy Head, International Trade and Capital Flows
Bank of Thailand	**Pornpen Sodsrichai** Division Executive

Keynote speaker

Former Governor, Bank of Japan	**Masaaki Shirakawa**

Academic and policy institutions

University of New South Wales	**James Morley** Professor
Australia National University	**Ippei Fujiwara** Associate Professor
University of British Columbia	**Michael Devereux** Professor
Wilfrid Laurier University	**Pierre Siklos** Professor
Aix-Marseille University	**Eric Girardin** Professor
University of Glasgow	**Richard Dennis** Professor
International Monetary Fund	**Luis Catao** Senior Economist

Bank for International Settlements	**Stephen Cecchetti** Economic Adviser
	Andrew Filardo Head of Monetary Policy
BIS Representative Office for Asia and the Pacific	**Frank Packer** Head of Economics and Financial Markets for Asia and the Pacific
	James Yetman Senior Economist
	Guonan Ma Senior Economist
	Aaron Mehrotra Senior Economist

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Authors: Michael Devereux (University of British Columbia)

James Yetman (Bank for International Settlements)

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Authors: Andrew Filardo (Bank for International Settlements)

Marco Lombardi (Bank for International Settlements)

Discussant: Luis Catão (International Monetary Fund)

09:30 – 10:45 ***Understanding the monetary policy rule in China: what is the role of inflation?***

Authors: Eric Girardin (Aix-Marseille University)

Sandrine Lunven (Aix-Marseille University)

Guonan Ma (Bank for International Settlements)

Discussant: Dong He (Hong Kong Monetary Authority)

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Moderator: Yi Gang (People's Bank of China)

Panellists: Philip Lowe (Reserve Bank of Australia)

Jun Il Kim (Bank of Korea)

Perry Warjiyo (Bank Indonesia)

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Speaker: Stephen Cecchetti (Bank for International Settlements)

13:20 – 14:45 Lunch

Opening remarks

Zhou Xiaochuan[1]

Ladies and gentlemen, good morning. It's our great pleasure to co-host this research conference with the BIS here in Beijing to discuss the very important issue of globalisation and inflation in Asia and the Pacific. On behalf of the People's Bank of China, I would like to extend a warm welcome to all participants from the BIS, the IMF, the central banks of the Asia-Pacific region and academics.

Globalisation and inflation is a very broad topic. In my welcoming remarks, I would like to reflect on one small part of it, related to globalisation and fighting the crisis. My theme is "monetary policy; learning from each other". And I would focus on the unconventional monetary policy measures, in particular the forward guidance, a topic frequently visited in recent discussions of the central bank community.

Because of globalisation, monetary policy in one country has an impact on others. We face considerable challenges in areas such as inflation targeting, the use of unconventional measures and the formulation of macroprudential countercyclical policies. We are also working to expand our toolkits, and one new device is the use of forward guidance by some advanced economies. In this respect, one question is whether Asia-Pacific economies too should consider the use of forward guidance.

In answering this question, we need to look at the issue carefully and understand the implication of these measures: for China, and for the People's Bank of China more specifically, and perhaps also for our colleagues in other Asia-Pacific economies. In my opinion, there are a lot of challenges and plenty of room for debate.

First of all, do central banks have more information than the market? If we assume that central banks have superior information that is unavailable to market participants, then they really do have an advantage when guiding market participants. But in most contemporary economies, it is far from clear whether central banks have an obvious information advantage. I think that, at least in some economies, financial markets have as good information as central banks can get.

Second, do central bankers have a better analytical framework, or mathematical models, than the market does, ones which can provide better analysis and prediction of future trends? I think this is also questionable. Central banks certainly try to hire the best people, the best economists and the best econometricians, to use the best mathematical models and to produce the best forecasts. However, everyone else in the marketplace is trying to do exactly the same thing. So there is no obvious way that central banks can have a better analytical framework than the marketplace. Especially in emerging markets and developing economies, central banks sometimes find themselves less able to attract the best people for the job due to certain institutional constrains. So, on the analytical side, central banks do not necessarily have any advantage over the market participants.

Third, in forward guidance, we tend to use a single variable in communicating with the public about the formulation of monetary policy. An example is to say that

[1] Governor, People's Bank of China.

"once the unemployment rate is lower than 6.5%, we can then adjust our policy accordingly". By saying this, we seem to indicate that one variable is central to a change in monetary policy. But this is an oversimplification of economic phenomena. Admittedly, for many years when inflation targeting was the popular framework, inflation was the single variable that central banks tended to focus on. But economic systems are complicated, and I think that's partly why the United States has emphasised that they have more than one target: not just inflation but also unemployment.

However, even two variables may not be enough. We need to look at many other indicators. As monetary policy is itself a function of many variables, to simplify and focus on one variable understates the challenges and uncertainties we face – even if such a simplification might be useful for communication purposes. Moreover, even the assumption that other indicators are stable has not proved workable recently, for there are uncertainties that complicate the reality and some variables that may change unexpectedly. So it's questionable whether this simplification is a good thing.

A fourth issue is that the monetary function is a continuous function, not a discrete one. But in recent practices of forward guidance, for the convenience of communication, it is simplified into a single threshold for a single variable to change monetary policy. This is also an oversimplification.

A thing to mention is that, with these challenges, we need to be very cautious: in what conditions, under what assumptions, will forward guidance work well? For example, when we reach the zero lower bound during a crisis, there is no room for further use of conventional monetary policy. In such circumstances, central banks will try to find alternative tools and come up with something else, such as forward guidance, the aim of which is to use a commitment about future monetary policy changes to guide market expectations. But this strategy is very specific to the crisis period, when conventional monetary policy tools no longer work and central banks have to find alternative solutions. That said, the unconventional measures, although they have produced some favourable outcomes, are not for every country in every situation.

The fifth question is related to communication. Central banks have been placing increasing emphasis on communication with both the general public and politicians. But it is challenging for central banks to do a good job. Some journalists have even remarked that central banks have become too talkative. Communication can be controversial, especially when we use too many conditional terms, such as when we say "if this happens, then the monetary authority is going to do that". Such communications may contain little valuable information for market participants.

So, we are in a very interesting and challenging period as a result of the crisis. We may have to do many creative and unconventional things. Meanwhile, we need to study these issues further. Looking at the Asia-Pacific region, with the exception of Japan, which is in its own very unique situation, most countries are not at the zero lower bound. We are not in a position where conventional monetary policy tools no longer work, so we probably do not need to follow the examples elsewhere or immediately adopt some of the new methodologies being employed. Many countries are still facing traditional challenges related to inflation and capital flows, which are closely connected with globalisation.

I hope this will be helpful to your discussions at this conference, which I'm sure will be a very successful one. Thank you very much.

Session 1

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

Pierre L Siklos[1]

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.

Keywords: inflation forecast performance, persistence, disagreement, spillovers.

JEL classification: E52, E58, C53.

[1] Department of Economics, Wilfrid Laurier University, Balsillie School of International Affairs, Pierre L Siklos, WLU and BSIA, e-mail: psiklos@wlu.ca. An earlier, and longer, version of this paper was presented at the People's Bank of China-BIS Research Conference, and at a lunchtime seminar at the BIS Hong Kong Office, April 2013. It is available from the Conference website at http://www.bis.org/events/gidap2013/home.htm. Comments from Frank Packer, Aaron Mehrotra, James Yetman, seminar and Conference participants, and my discussant, Richard Dennis, were very helpful. The financial support of the BIS is also gratefully acknowledged. A separate Appendix that contains additional results not shown in this paper is available on request. Samantha St. Amand and Lillie Lam provided excellent research assistance.

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

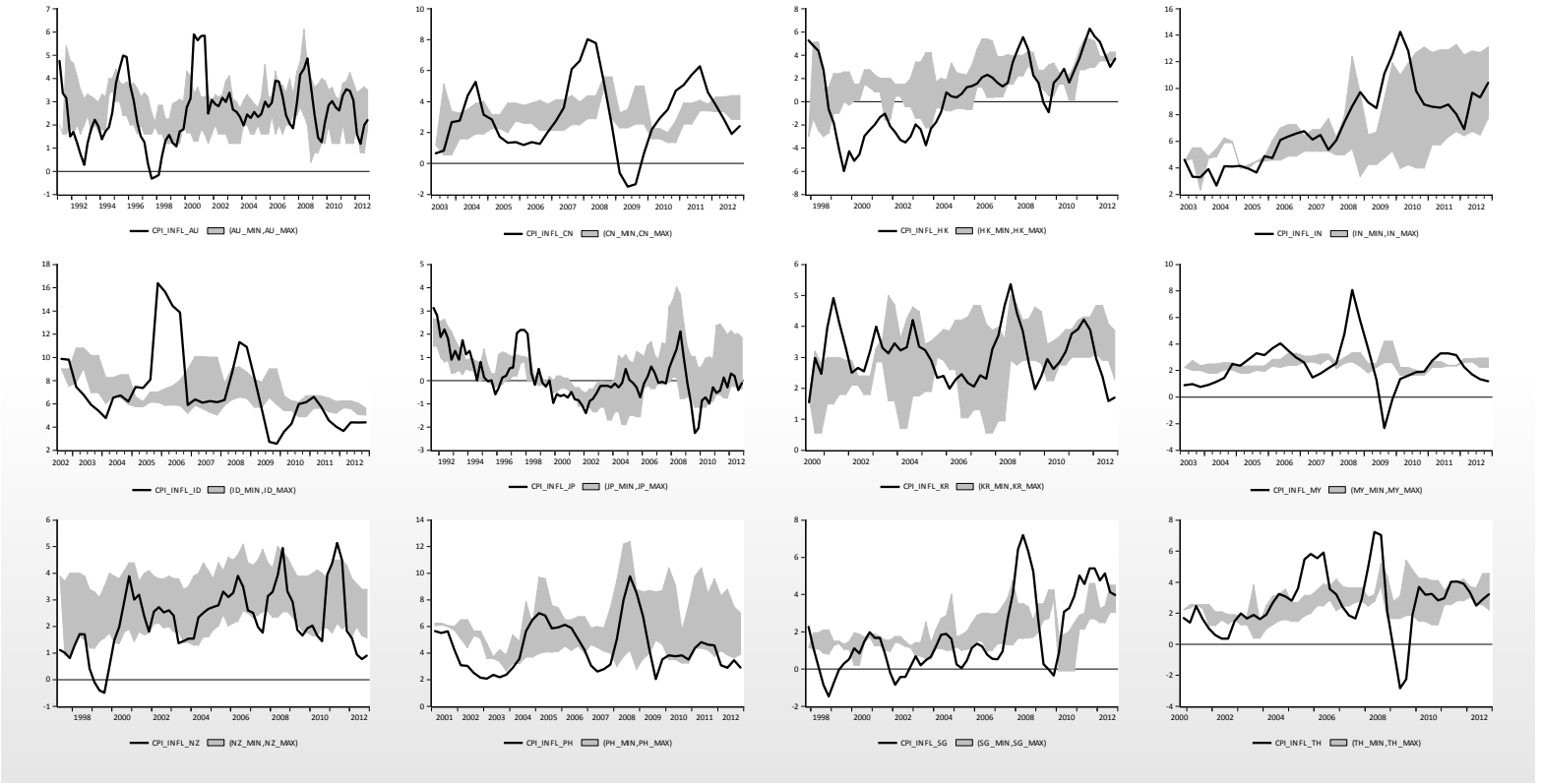
Table 3C

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.

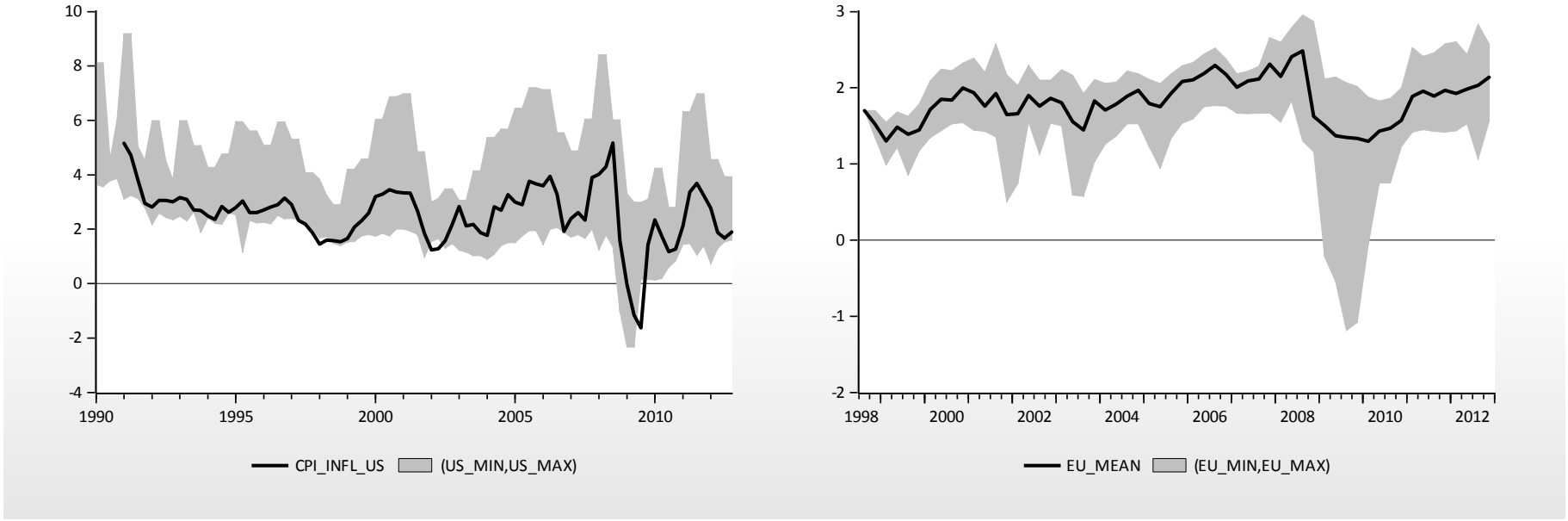
Observed inflation and the range of inflation forecasts

Figure 1



Observed inflation and the range of inflation forecasts (cont)

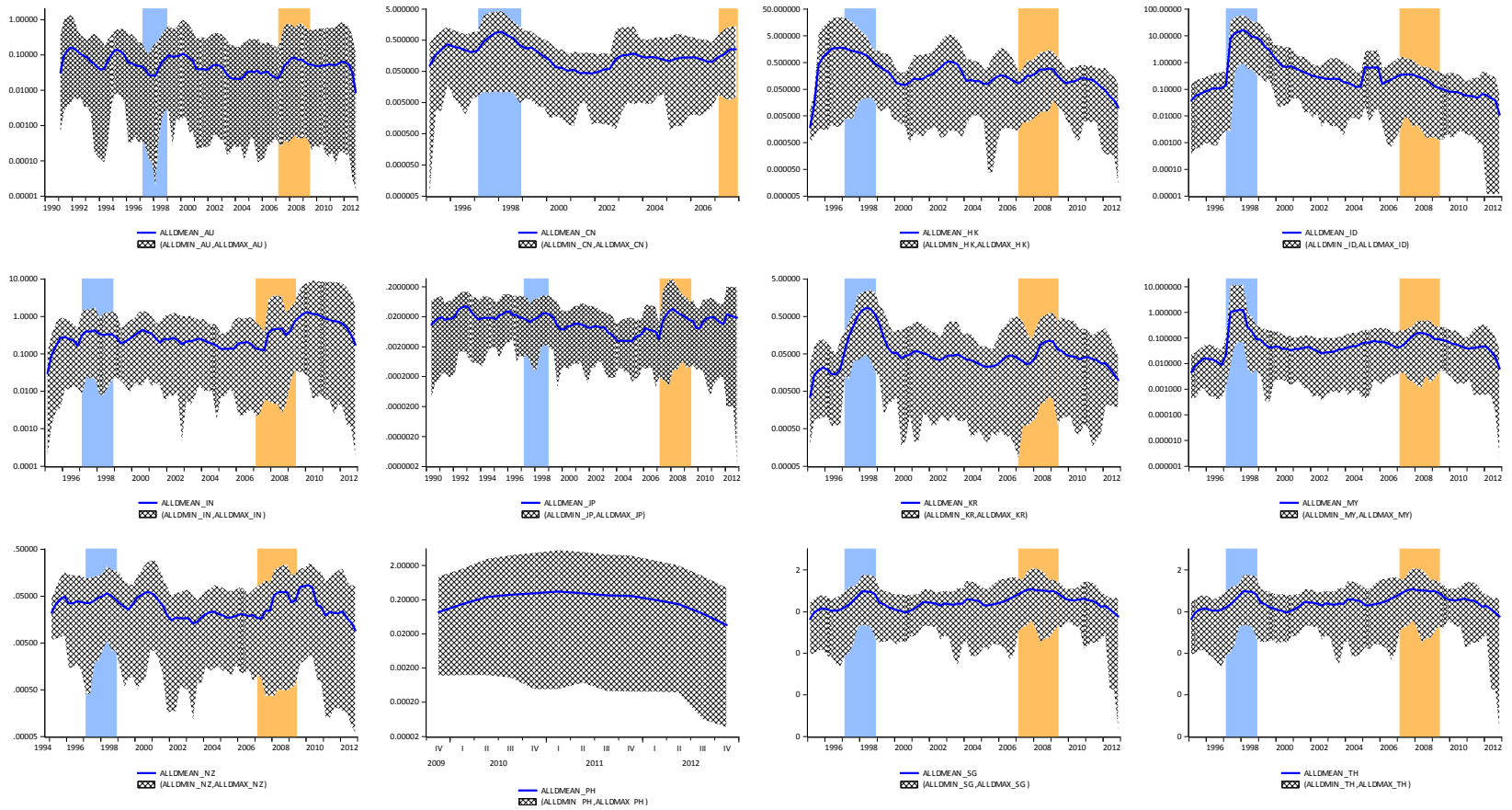
Figure 1



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.

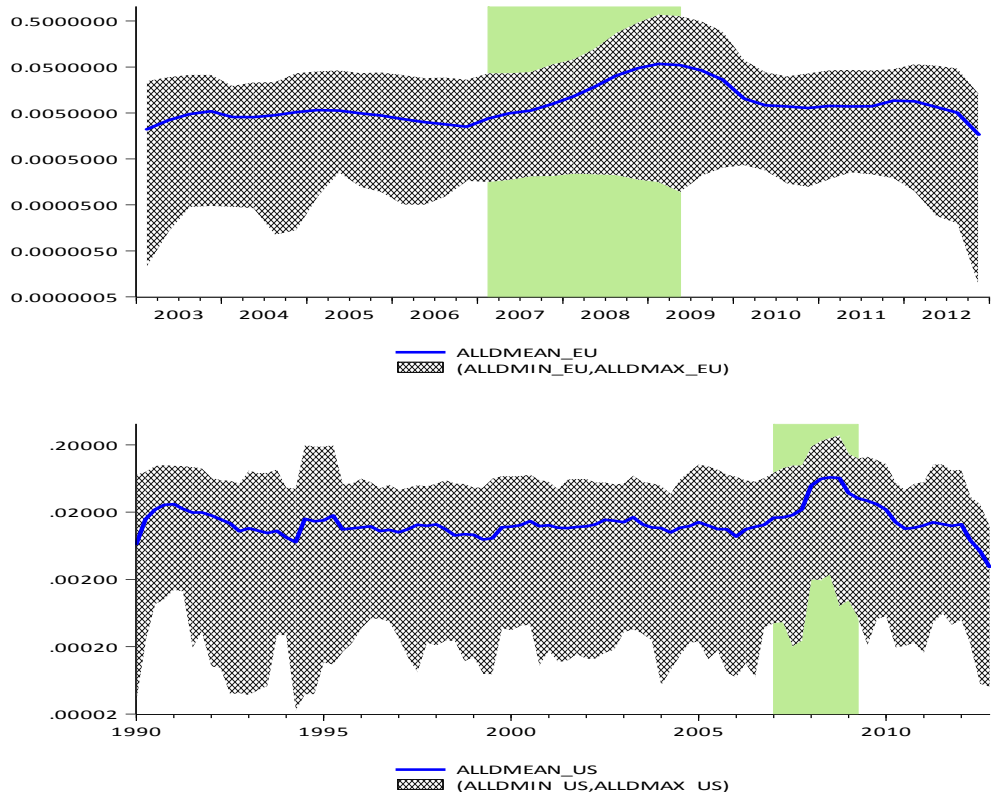
Inflation forecast disagreement

Figure 2A



Inflation forecast disagreement: United States and the euro zone

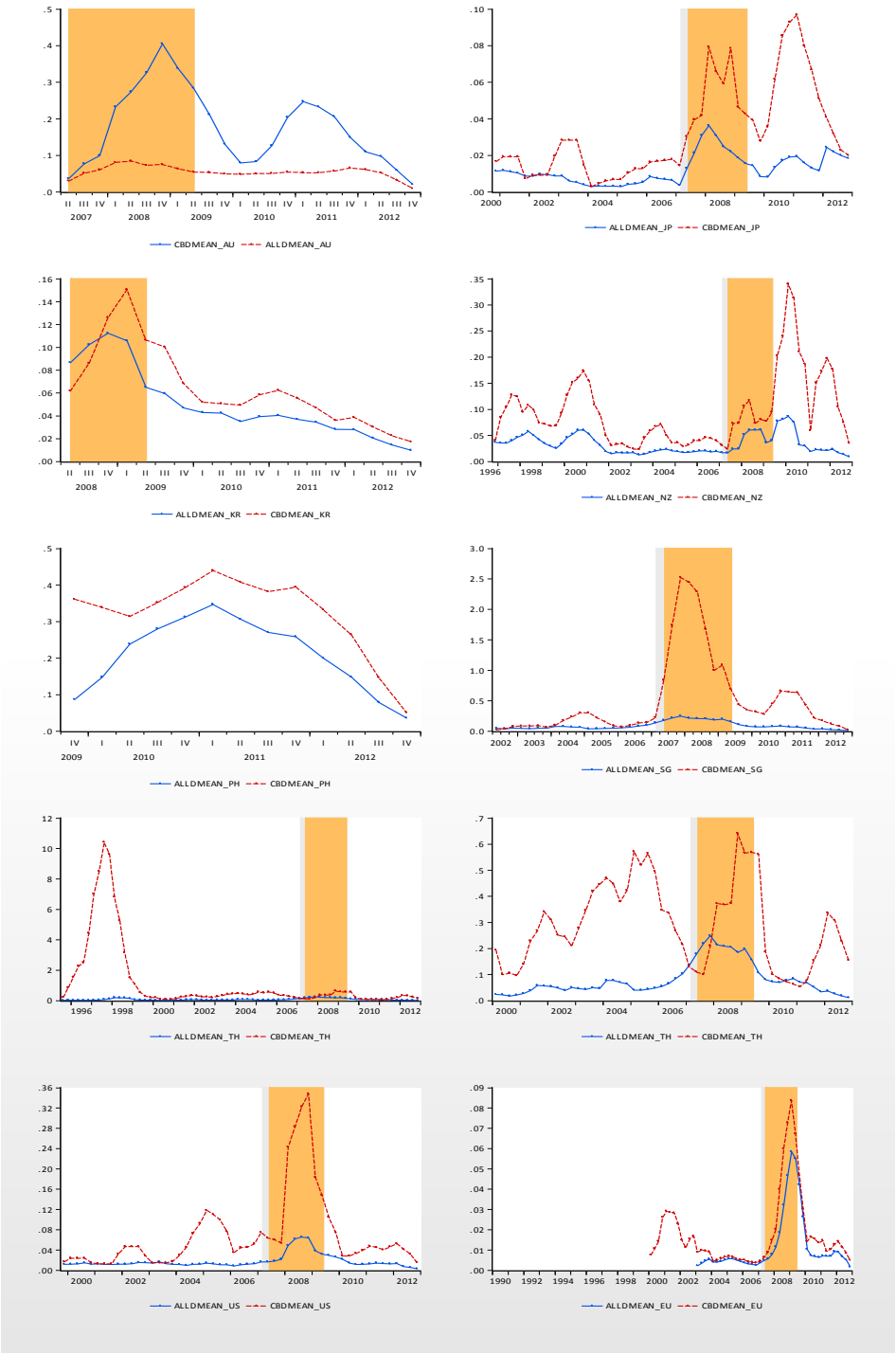
Figure 2B



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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Comments on Pierre Siklos' paper

Richard Dennis[1]

Introduction

Inflation expectations are central to most modern macroeconomic models. Through the Phillips curve, which critically links the real and nominal sides of the economy, inflation expectations are an important determinant of actual inflation, and the mechanism by which inflation expectations are formed has important implications for the sacrifice ratio. As a consequence, managing inflation expectations is important for central banks tasked with the duty of keeping inflation low and stable. But in most macroeconomic models, everyone residing in the model holds the same expectation of inflation; there is no heterogeneity or disagreement about inflation expectations, a feature that is very much at odds with observations on actual economies.

In this paper Pierre Siklos takes a close look at the inflation outcomes and inflation forecasts of twelve economies, all of which are in the Asia-Pacific region, and those of the United States and the euro zone.[2] By gathering together the one-year-ahead inflation expectations/forecasts produced by surveys, professional forecasters, central banks and government agencies, and such like, Siklos is able to construct a time-series for the distribution of inflation expectations for each of these fourteen economies. These distributions can then be used to quantify inflation forecast disagreement, they can be correlated with shocks, recessions, and crises to assess how well inflation expectations are anchored, and they can be used to investigate spillovers in inflation from one economy to another.

Main findings

As you might expect for a paper about inflation expectations, one of the first questions asked is whether the inflation forecasts are "rational". Perhaps unsurprisingly, in light of the literature on this issue, the inflation forecasts are found not to be rational/efficient. At the same time, using a weak definition of efficiency, one that simply looks at whether inflation and expected inflation move one-for-one, the forecasts for India, Japan, Singapore, and Thailand look to be more efficient than those for the other economies. When forecast biases are taken into account, the inflation forecasts do not appear to be rational/efficient for any economy. Although the inflation forecasts do not appear to be rational, Siklos shows that forecast accuracy (at least when measured using a criterion such as RMSE) does not appear to deteriorate during crisis periods. This finding might

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[2] The twelve Asia-Pacific economies included in the study are Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Thailand, and Singapore.

suggest that forecast errors – at least those of inflation – play little role in determining the depth and duration of crises, an issue that may be well worth investigating. Of course, there is plenty more that we might learn about rationality from these data. In particular, by picking through the forecast errors we might learn whether forecasters tend to under-react or over-react to data releases, and to which data releases. Such information would surely be useful to central banks, helping them to better understand movements in inflation expectations.

Since inflation expectations do not seem to have been formed rationally, an obvious question to ask is whether the forecasts point to an alternative description of expectation formation. Are these expectations better described by adaptive/extrapolative expectations, adaptive learning (Evans and Honkapohja, 2001), sticky information (Mankiw and Reis, 2002), or rational inattention (Sims, 2003)? Of these, the sticky information model of Mankiw and Reis (2002) is particularly interesting since it is founded on a model in which there are heterogeneous agents possessing heterogeneous information.

The second issue that the paper investigates is whether there are spillovers of inflation from one economy to another. This question is interesting in light of on-going concerns over whether easy monetary policies in the United States and Europe may trigger rises in inflation that spill over and push up inflation in other economies. For this exercise, economies are grouped together. One group collected together the inflation targeting economies (Australia, Korea, the Philippines, New Zealand, Thailand, and Indonesia). Another group collected together the economies with managed exchange rates (Hong Kong SAR, Malaysia, Singapore, and India). The large economies (China, Japan, and the US) were allowed to enter separately (the euro zone was omitted for this exercise). Averaging the inflation rates within each group and using a SUR-estimator, the paper found statistically significant spillovers from the large economies to the smaller economies in the sample. Delving deeper, the following interesting result emerges: while there is very little evidence of spillovers from the large economies to the group of inflation targeting economies, there is statistical evidence suggesting spillovers from the large economies to the group of managed exchange rate economies.

Whether an economy experiences spillovers, or inherits inflation from abroad, looks to be related to whether the economy has a floating or a managed exchange rate. Thus, much as economic theory would suggest, this paper finds that economies with floating exchange rates are better able to insulate themselves against external shocks, such as terms-of-trade shocks, as the exchange rate adjusts to compensate.

The third major issue that the paper looks into is inflation forecast disagreement and how this disagreement varies across economies and across time. Precisely how forecast disagreement for a given economy should be measured is not clear. One could, for example, use the inter-quartile range (Mankiw, et al 2003), but Siklos chooses to use a measure based on squared-deviations from a mean. While an inter-quartile range measure of disagreement can be problematic when the number of forecasts is small, a volatility-based measure can similarly be problematic when there are outliers. But using his volatility-based measure of forecast disagreement, Siklos obtains several interesting stylized facts. First, there is considerable forecast disagreement about one-year-ahead inflation for all economies. Second, inflation forecast disagreement looks to rise during recessions. Third, changing the benchmark from the mean forecast to the central bank's

forecast reveals that inflation forecast disagreement rises considerably during recessions, at least in most economies.

While the first two facts are perhaps to be expected, this third point is striking for a couple of reasons. First, it indicates that, contrary to Morris and Shin (2002), the central bank's forecasts do not appear to coordinate the forecasts of the private sector, at least in recession periods. Second, it suggests that central banks may have an even harder time managing inflation expectations during recessions than they do during ordinary times. Of course, the fact that there appears to be greater disagreement about the central bank's forecast during recessions leads to the obvious questions: whose forecasts prove to be more accurate and how can central banks usefully employ information on inflation forecast disagreement when conducting policy?

Why should we care about inflation forecast disagreement?

While the paper makes a compelling case that there is considerable disagreement about inflation forecasts in each economy, on the related issues of why we should care about this disagreement and whether policymakers can feasibly make use of this disagreement when conducting policy the paper is largely silent. This is unfortunate as these are important issues. One reason that we might care about inflation forecast disagreement is if the disagreement arises due to forecasters having private information. If private information is the source of the disagreement, then one wonders whether pooling the inflation forecasts might to some extent proxy for pooling the private information. Alternatively, prediction markets might usefully serve to pool the information.

Another reason that policymakers may care about inflation forecast disagreement is if the distribution of inflation expectations itself matters for economic outcomes. Managing inflation expectations through policy statements and forward guidance – challenging as it already is – is likely to become an even more difficult task when there is considerable inflation forecast disagreement, partly because the forecast disagreement could well signal that inflation expectations are not well anchored. This raises the obvious question of whether there is a connection in the data between inflation forecast disagreement and central bank credibility. To explore these issues, and whether they have implications for central bank credibility/communication, it seems important to understand the underlying sources of the inflation forecast disagreement (model disagreement, heterogeneous information, etc). A difficult task, to be sure.

Wrapping up

This paper gathers together an impressive amount of data on inflation and inflation expectations for economies in the Asia-Pacific region and provides an initial analysis of these data, focusing on three interesting and important questions. Where the finding that the inflation forecasts do not appear to be formed rationally is not surprising (in light of the large literature that finds similarly), the results relating inflation spillovers to exchange rate regimes and forecast disagreement to the

business cycle are very interesting and raise a lot of important issues for policymakers.

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Measuring economic slack in Asia and the Pacific

James Morley[1]

Abstract

Economic "slack" directly implies the ability for an economy to grow quickly without any necessary reversal in the future. This implication motivates a forecast-based approach to measuring economic slack. Given this approach, estimated output gaps for most of the major economies in Asia and the Pacific display strong asymmetry, with larger negative levels during recessions than positive levels during expansions. The estimated output gaps are also strongly correlated with narrower measures of slack given by the unemployment rate and capacity utilisation when these are available for a given economy. In terms of a Phillips Curve relationship with future inflation, there are important non-linearities and evidence of changes across policy regimes for some of the economies, arguing against imposing a fixed linear Phillips Curve when measuring slack. Finally, the output gaps appear to have important dynamic linkages across many of the economies in the Asia-Pacific region.

Keywords: output gap, business cycle asymmetry, Phillips Curve, Asia-Pacific economies.

JEL classification: E32, E37.

[1] E-mail: james.morley@unsw.edu.au; University of New South Wales. This paper was prepared for the People's Bank of China-BIS Conference on "Globalisation and Inflation Dynamics in Asia and the Pacific" and provides a summary of key ideas and results in the companion paper "Measuring economic slack: A forecast-based approach with applications to economies in Asia and the Pacific". I thank Jun Il Kim for his excellent discussion of the paper.

Introduction

In Morley (2014), I argue for a forecast-based approach to measuring economic slack and apply it to estimate output gaps for a number of economies in Asia and the Pacific. Here, I provide a summary of the key ideas motivating the forecast-based approach and discuss the main findings from my empirical analysis of Asia-Pacific output gaps.

First, I define "economic slack" as implying the ability for an economy to grow quickly without any necessary reversal in the future. Given this definition, the output gap provides a measure of economic slack that quantifies the deviation between actual output and a potential level at which expected output growth would equal its long-run average. This definition directly suggests the usefulness of a forecast-based approach to estimating the output gap. Specifically, if the existence of positive/negative output gap would imply below/above average growth, then the prediction of below/above average growth from a forecasting model provides a corresponding inference about a positive/negative output gap. This approach to estimating the output gap goes back to Beveridge and Nelson (1981, BN hereafter), with this particular interpretation of the BN decomposition discussed in Morley (2011).

The forecast-based approach to measuring the output gap is different from the standard "production function" approach employed by the Congressional Budget Office and other agencies that estimate potential GDP, although the two approaches are related. Specifically, the production function approach defines the output gap as the deviation of economic activity from a level of potential determined by full employment of resources for a postulated aggregate production function. The production function approach requires a good measure of capital and an estimate of full employment for labour and other resources. By contrast, the forecast-based approach is a "top-down" approach that only requires data on aggregate output and a forecasting model for it. Thus, it is arguably more applicable for economies with a significant fraction of production driven by intangible capital and/or large social and demographic changes that make full employment of labour difficult to measure. Notably, both of these concerns are likely to be quite relevant for the fast-growing and quickly-evolving Asian economies that I consider in my empirical analysis.

Second, I motivate the forecast-based approach by noting that mismeasurement of economic slack is a much greater problem than is typically acknowledged in academic and policy discussions. From the policy point of view, mismeasurement of economic slack may have been responsible for large monetary policy errors in the 1970s that led to high levels of inflation in the United States and other economies (Orphanides, 2002) and could lead to future policy mistakes. From a more academic point of view, different measures of economic slack have very different implications for the "stylised facts" that motivate macroeconomic theories (see, for example, Canova, 1998). Therefore, because the forecast-based approach can reduce uncertainty about economic slack, it can help both practitioners and academics in formulating policy and theory.

As discussed in Morley and Piger (2012), one reason the forecast-based approach is able to reduce uncertainty about economic slack is because it permits the use of model-averaging to address uncertainty about the best forecasting model for economic activity. In Morley (2014), I show that this model uncertainty is important for the economies of Asia and the Pacific. Also, I note that a

forecast-based approach provides robust inferences across many different theoretical assumptions. Specifically, as discussed in Kiley (2013), a forecast-based output gap depends only on the reduced-form representation of a structural model and is, therefore, robust across different structural identification assumptions. Kiley (2013) also points out that a forecast-based output gap contains information about current and future theory-based output gaps that correspond to a flexible-price equilibrium in a New Keynesian macroeconomic model used by the Board of Governors of the Federal Reserve System in their analysis of the US economy. Given lags in the implementation and transmission of monetary policy, information about future theory-based gaps is highly relevant for current policy actions. So a forecast-based estimate of the output gap is broadly useful even when the exact structure of the macroeconomy is unknown.

As a related issue, the forecast-based approach to measuring economic slack that I argue for in Morley (2014) leaves the relationship between the output gap and inflation as an empirical matter to be determined by the data rather than imposed as a fixed specification of a Phillips Curve. It is important not to "assume the answer" of how the output gap relates to inflation given that the Phillips Curve relationship has likely been altered over time due to changes in monetary policy regimes, as suggested by Lucas (1976) in his famous critique of reduced-form macroeconomic modelling. Also, even during stable times, the Phillips Curve may well correspond to a reasonably complicated non-linear relationship between the output gap and inflation, rather than a simple linear relationship that is typically assumed when estimating the output gap by imposing a fixed specification (eg Kuttner, 1994).

With these key ideas in mind, I estimate the output gap for the United States and 12 major economies in Asia and the Pacific using a forecast-based approach and I examine the empirical relationship between the estimated output gaps and inflation. I also investigate cross-economy linkages between the estimated output gaps.

To summarise the main results, I find that the forecast-based model-averaged output gaps are highly asymmetric for most of the economies in Asia and the Pacific, with much larger negative levels during recessions than positive levels during expansions. I find that the estimated output gaps are strongly correlated with future output growth, consistent with the forecast-based definition taken in the analysis. The estimated output gaps are also strongly correlated with narrower measures of slack given by the unemployment rate and capacity utilisation when available for a given economy. The relationship with future inflation is more mixed, but the overall results, including of a convex Phillips Curve for some economies, argue against imposing a fixed linear relationship with inflation when measuring economic slack. Finally, there are notable dynamic linkages across economies, suggesting potential benefits to multivariate analysis that takes into account economic activity across Asia and the Pacific when measuring economic slack for a given economy, although this is left for future research.

The rest of this paper is organised as follows. Section 2 provides a brief description of the data and methods employed in Morley (2014). Section 3 discusses the main empirical results in that paper. Section 4 briefly concludes.

Data and methods

I consider data for the United States (US) and the following 12 major economies in Asia and the Pacific: Australia (AU), New Zealand (NZ), Japan (JP), Hong Kong SAR (HK), Korea (KR), Singapore (SG), China (CN), India (IN), Indonesia (ID), Malaysia (MY), the Philippines (PH) and Thailand (TH). The variables of interest are real GDP, inflation, the unemployment rate (when available), and capacity utilisation (when available). See Morley (2014) for more details about the various data sources and the relevant transformations of the raw data from these sources.

Table 1, which is drawn from Morley (2014), reports the available sample periods for quarterly output growth based on real GDP. Because the expected growth rate in the absence of shocks used to determine whether the output gap is positive or negative may change over time, especially for economies on a transition path in terms of long-run growth, it is important to allow for structural breaks in the long-run growth rate. Therefore, Table 1 also reports estimated break dates based on Bai and Perron's (1998, 2003) sequential procedures. However, it should be noted that accounting for breaks is only important for output gap estimates when the magnitude of the breaks are large relative to the variance of quarterly fluctuations in output growth. Thus, allowing for additional small and insignificant breaks would not significantly alter inferences about output gaps. See Morley (2014) for more discussion of the structural breaks and the sensitivity of inferences about output gaps to allowing for breaks.

In terms of methods, I employ the BN decomposition to estimate the output gap for linear autoregressive (AR) models and the Kalman filter for linear unobserved components (UC) models. I use the generalisation of the BN decomposition developed in Morley and Piger (2008) to estimate the output gap for non-linear Markov-switching models. The models are all univariate models of real GDP. The linear models that I consider are AR(1), AR(2), AR(4), AR(8), and AR(12) models of output growth, a UC model of the Hodrick-Prescott (HP) filter for log output due to Harvey and Jaeger (1993), and the UC0 and UCUR models for log output of Morley, Nelson, and Zivot (2003). The non-linear models are the bounceback models of output growth developed in Kim, Morley, and Piger (2005), the UC "plucking" model for log output of Kim and Nelson (1999), and its extension due to Sinclair (2010). See the original papers for full details of the models, as well as Morley and Piger (2012) and Morley (2014) for full motivation of their inclusion in the set of models under consideration.

I conduct Bayesian estimation based on the posterior mode in order to avoid overfitting outliers or omitted structural breaks with the UC and non-linear models in particular. This is important given the short sample periods and presence of large outliers and structural breaks for many of the economies, although I have also attempted to address the structural breaks by transforming the data based on estimated structural breaks, as discussed in Morley (2014).

Given estimated output gaps for all of the models listed above, I construct a model-averaged output gap (MAOG) for each economy by taking an equal-weighted average of the model-specific output gaps for that economy. This approach avoids too much weight being put on one model when using Bayesian model averaging for forecasting (see Geweke and Amisano, 2011) and provides a reasonable approximation of optimal weights for linear pooling of models given a diverse set of models.

Empirical results

As with Table 1 in the previous section, the tables and figures reported in this section are drawn from Morley (2014), but with a strict focus on results for the MAOGs across economies, rather than also considering results for some of the individual forecasting models. See Morley (2014) for more analysis of the underlying forecasting models.

Table 2 reports the correlation between the MAOGs and the subsequent four-quarter output growth. Consistent with the definition of the economic slack provided in the introduction, the correlation is always negative and often quite large in magnitude for each economy. This validation of an estimated output gap is motivated by Nelson (2008) and the finding of a negative correlation is not as obvious as it may seem. For example, Nelson (2008) shows that the HP filter estimate of the output gap for US data is positively correlated with future output growth, meaning that the US economy typically grows faster when the HP filter suggests it is above potential output and vice versa. The negative correlation is also encouraging in cases where model selection procedures would have picked a random walk (with drift) model as best overall for log output, such as for Australia. If the random walk model were true, then the correlation of any estimated output gap with future output growth should be zero. So the fact that the correlation for Australia in Table 2 is negative directly suggests that model-averaging is better than choosing just one forecasting model based on standard model selection procedures.

Having verified that the MAOGs are capturing economic slack in the sense that a positive value implies below-average future growth and vice versa, I consider various features of the estimated output gaps. Looking at Figure 1 for the US data and Figure 2 for the data from Asia and the Pacific, the most striking feature of the MAOGs is their strongly asymmetric pattern for all economies except New Zealand, Indonesia, and the Philippines. Specifically, in all of the other cases, the estimated output gaps are highly skewed with large negative levels compared to positive levels. These negative levels are closely related to periods of economic distress and outright recessions, as can be clearly seen in Figure 1 which displays shaded periods corresponding to NBER-dated recessions.[2] Meanwhile, for New Zealand, Indonesia, and the Philippines, the estimated output gaps are small in amplitude, implying that recessions have largely permanent effects for those economies.[3]

[2] The negative mean of the estimated output gap for most of the economies directly implies significant welfare costs of the business cycle (see, for example, Cohen, 2000, and Barlevy, 2005). The unconditional mean of the output gap is identified by the assumption that the output gap is mean zero in expansion regimes for the non-linear models. However, as discussed in Morley and Piger (2012), it should be noted that this assumption places no a priori restriction on the unconditional mean for the output gap and, in practice, it is the only assumption that is consistent with the steady-state notion that output is close to potential when the change in output gap (which depends on the shape of the output gap, not its level) is close to zero for extended periods of time.

[3] Regardless of the degree of asymmetry in the estimated output gaps, the corresponding stochastic trends in real GDP are reasonably volatile for most of the economies under consideration. The estimated standard deviation of permanent shocks is almost twice the value for the United States in the cases of Hong Kong SAR, Korea, Singapore, India, Indonesia, Malaysia, Philippines, and Thailand. This result is consistent with the findings in Aguiar and Gopinath (2007) that emerging economies have volatile stochastic trends. The estimated standard deviations are much closer to

The asymmetric shape of the MAOGs for most of the economies is reminiscent of the asymmetric shape of the unemployment rate, which tends to have strong positive skewness driven by recessions and their aftermath, as is evident in the top panel of Figure 1 for the United States. In general, Figure 1 suggests a strong coherence of the US MAOG with narrower measures of economic slack given by the unemployment rate and capacity utilisation. Meanwhile, the estimated output gap captures slack for the economy as a whole and, by construction, abstracts from long-run structural factors that can obscure the signals about the degree of slack implied by the unemployment rate or capacity utilisation.

Table 3 reports the correlation between the MAOGs and the unemployment rate for all of the economies except India and Indonesia, for which unemployment rate data were unavailable. As is evident in top panel of Figure 1, the correlation is strongly negative for the United States. Consistent with an Okun's Law relationship, it is also negative, often strongly so, in all but one of the other 10 cases. Similarly, Table 4 reports the correlation between the MAOGs and capacity utilisation for all of the economies except Hong Kong SAR, Singapore, China, and India, for which capacity utilisation data were unavailable. Consistent with the lower panel of Figure 1 and what would be expected for a measure of slack, the correlation is strongly positive for the United States. It is also positive, and always strongly so, in all but one of the other eight cases. These results lend credence to the MAOGs as measures of economic slack and are especially notable given that they are based on univariate forecasting model of real GDP data. In particular, based on the estimated output gaps, it does not appear that the model-averaged forecasts of real GDP growth suffer from ignoring multivariate information inherent in the unemployment rate and capacity utilisation.

Having shown that the MAOGs are usually closely related to narrower measures of slack, I turn next to their empirical relationship with inflation. Table 5 reports the correlation between the MAOGs and the subsequent four-quarter change in inflation. Consistent with a basic Phillips Curve relationship, the correlation is positive in 11 of the 13 cases. The relationship is reasonably strong for many of the economies, despite the simple correlation failing to control for cost-push factors, which are likely to be a significant driver of inflation for many of the open economies in Asia and the Pacific.

The simple correlation also understates the strength of the Phillips Curve relationship if it is really non-linear. For example, Figure 3 clearly suggests the US Phillips Curve is convex, with large disinflations requiring very large negative output gaps. Figure 4 for the economies in Asia and the Pacific also suggests possible convex Phillips Curves for Australia, Japan, and Korea. The results for the other economies are less clear in terms of the shape of the Phillips Curve, although they tend to have much shorter sample periods with relatively few episodes of large negative output gaps. Meanwhile, in a lot of the cases, many of the observations of little or no disinflation despite a large negative output gap correspond to the global financial crisis near the end of the sample. Consistent with the Lucas critique, this lack of disinflation could reflect policy regime changes such as formal inflation targets that have led to better anchoring of inflation expectations in recent years (see IMF, 2013). Both the possible non-linear relationship and the breakdown in the previous pattern near the end of the sample raise serious concerns about the

that for the United States in the cases of Australia, New Zealand, Japan, and, perhaps somewhat surprisingly, China.

inevitable mismeasurement that would result from imposing a fixed linear relationship with inflation when estimating the output gap.

The last key finding in Morley (2014) concerns the dynamic linkages between the output gaps across economies. Table 6 reports some of the results for pairwise Granger causality tests for the various estimated output gaps. As can be seen from the table, I am able to reject the null hypothesis of no Granger Causality at the 5% level in 31 of the 156 cases. Notably, this is a higher rate of rejection than for pairwise Granger causality tests for the underlying real GDP growth data. This result suggests that the estimated output gaps are capturing meaningful economic phenomena and also implies potential benefits of multivariate analysis that takes into account economic activity across Asia and the Pacific when measuring economic slack for a given economy. In particular, the output gaps for Hong Kong SAR and Singapore appear to contain significant additional predictive content for a number of the other economies beyond their own output gaps. It is likely that Hong Kong SAR's and Singapore's significant exposure to fluctuations in international trade and finance makes them proverbial "canaries in the coalmine" for other economies.

Conclusions

Similar to the results for the United States reported in Morley and Piger (2012), forecast-based model-averaged output gaps for most major economies in Asia and the Pacific are highly asymmetric, with much larger negative levels during recessions than positive levels during expansions. The estimated output gaps have a strong negative correlation with future output growth, consistent with the definition of economic slack as implying the ability for an economy to grow quickly without any necessary reversal in the future. They also have a strong negative correlation with the unemployment rate and strong positive correlation with capacity utilisation for almost all of the economies. The output gaps have a positive relationship with inflation in most cases, but the relationship is often non-linear or unstable across major changes in policy regimes. Finally, there is some evidence of dynamic linkages between output gaps across some of the economies in Asia and the Pacific, implying the potential usefulness of considering multivariate information when measuring economic slack. Given likely instabilities over time in the relationships across economies, a factor model with time-varying loadings (eg Del Negro and Otrok, 2008) would seem a particularly promising way to conduct the multivariate analysis. But this is left for future research.

Sample periods for output growth and structural breaks in long-run growth

Table 1

	Sample period	Break dates
United States	1947Q2–2012Q3	2002Q2
Australia	1959Q4–2012Q3	
New Zealand	1977Q3–2012Q3	
Japan	1955Q3–2012Q3	1973Q1, 1991Q2
Hong Kong SAR	1973Q2–2012Q3	1988Q3
Korea	1970Q2–2012Q3	1997Q2
Singapore	1975Q2–2012Q3	
China	1992Q2–2012Q3	
India	1960Q2–2012Q1	1979Q4
Indonesia	1980Q2–2012Q3	1996Q4, 1998Q4
Malaysia	1991Q2–2012Q2	1997Q3
Philippines	1981Q2–2012Q2	1985Q3
Thailand	1993Q2–2012Q3	

Notes: Estimated break dates are based on Bai and Perron's (1998, 2003) sequential procedure. Breaks are significant at least at 10% level.

Relationship between MAOGs and subsequent four-quarter output growth

Table 2

	Sample period	Correlation
United States	1947Q2–2011Q3	–0.35
Australia	1959Q4–2011Q3	–0.22
New Zealand	1977Q3–2011Q3	–0.17
Japan	1955Q3–2011Q3	–0.19
Hong Kong SAR	1973Q2–2011Q3	–0.38
Korea	1970Q2–2011Q3	–0.17
Singapore	1975Q2–2011Q3	–0.03
China	1992Q2–2011Q3	–0.51
India	1960Q2–2011Q1	–0.27
Indonesia	1980Q2–2011Q3	–0.41
Malaysia	1991Q2–2011Q2	–0.29
Philippines	1981Q2–2011Q2	–0.55
Thailand	1993Q2–2011Q3	–0.17

Relationship between MAOGs and the unemployment rate

Table 3

	Sample period	Correlation
United States	1947Q2–2012Q3	–0.58
Australia	1978Q1–2012Q2	–0.42
New Zealand	1977Q3–2012Q3	–0.72
Japan	1955Q3–2012Q3	–0.03
Hong Kong SAR	1981Q4–2012Q3	–0.33
Korea	1993Q1–2012Q3	–0.76
Singapore	1987Q2–2012Q3	–0.48
China	1999Q4–2012Q3	–0.27
Malaysia	1997Q1–2012Q2	–0.21
Philippines	1985Q1–2012Q2	–0.14
Thailand	2001Q1–2012Q3	0.13

Relationship between MAOGs and capacity utilisation

Table 4

	Sample period	Correlation
United States	1967Q1–2012Q3	0.59
Australia	1989Q3–2012Q2	0.65
New Zealand	1977Q3–2012Q3	0.47
Japan	1978Q1–2012Q3	0.52
Korea	1980Q1–2012Q3	0.76
Indonesia	2003Q1–2012Q3	0.53
Malaysia	1999Q1–2012Q2	0.64
Philippines	2001Q1–2012Q2	–0.10
Thailand	1995Q1–2012Q3	0.52

Relationship between MAOGs and subsequent four-quarter change in inflation

Table 5

	Sample period	Correlation
United States	1960Q1–2011Q3	0.51
Australia	1959Q4–2011Q3	0.42
New Zealand	1977Q3–2012Q3	0.09
Japan	1971Q1–2011Q3	0.28
Hong Kong SAR	1973Q2–2011Q4	0.09
Korea	1970Q2–2011Q4	0.43
Singapore	1975Q2–2011Q4	–0.07
China	1992Q2–2011Q4	–0.41
India	1989Q4–2011Q3	0.14
Indonesia	2000Q3–2011Q4	0.19
Malaysia	1991Q2–2011Q4	0.25
Philippines	1981Q2–2012Q2	0.22
Thailand	1993Q2–2012Q4	0.23

Granger causality tests for MAOGs

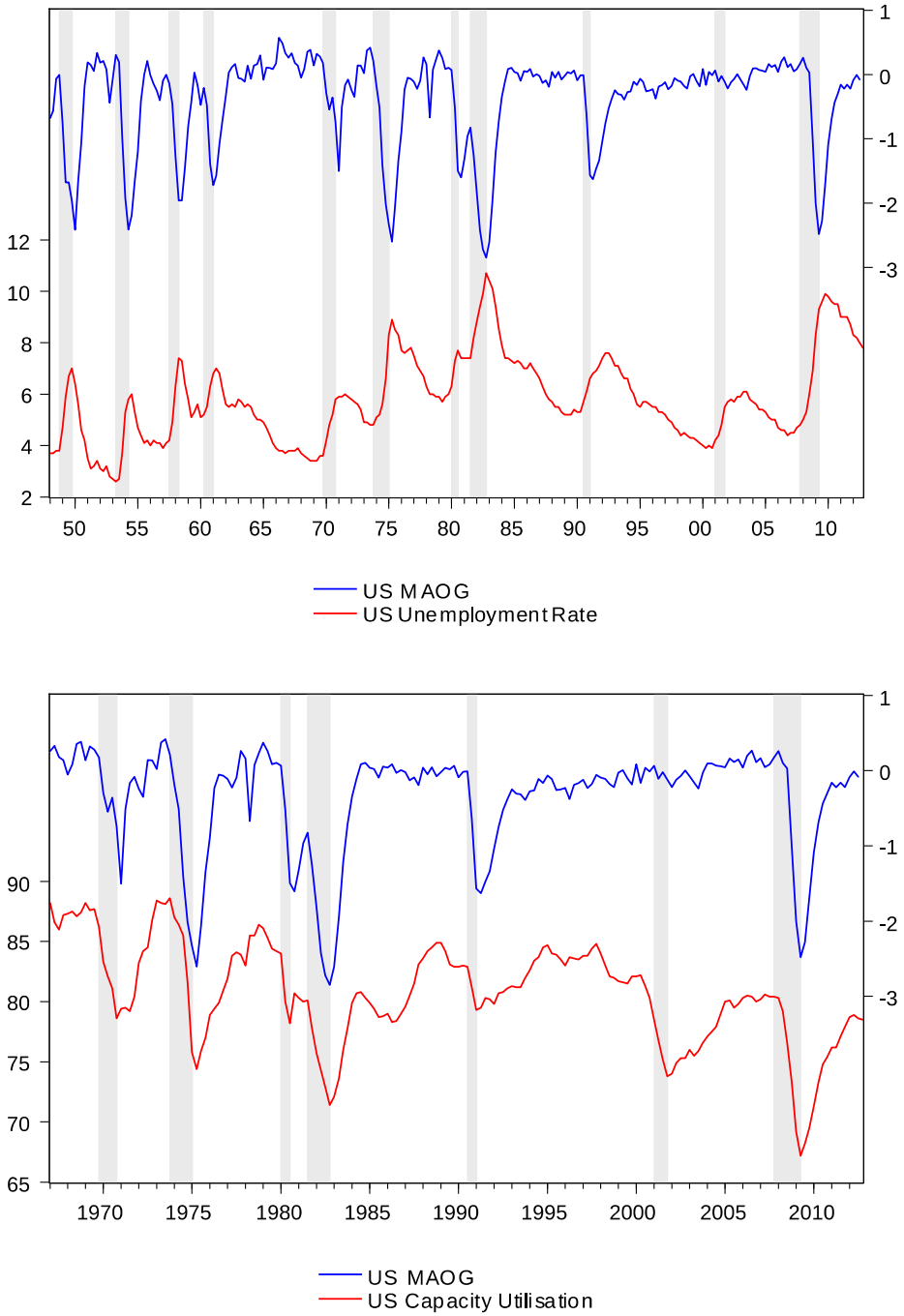
Table 6

	US	AU	NZ	JP	HK	KR	SG	CN	IN	ID	MY	PH	TH
US	•	✓			✓								
AU		•	✓						✓			✓	
NZ			•				✓	✓					
JP				•	✓							✓	
HK	✓			✓	•					✓	✓		✓
KR					✓	•			✓		✓		✓
SG			✓	✓	✓	✓	•				✓		✓
CN								•					
IN						✓			•				
ID						✓				•	✓		
MY											•		✓
PH									✓			•	
TH					✓						✓		•

Notes: Results are based on pairwise Granger causality tests at the 5% level with two lags of quarterly data. A checkmark denotes that the output gap in the row economy "causes" the output gap in the column economy. See the data description in the text for details on economy abbreviations. The pairwise regressions in each case are based on the shorter available sample period in Table 1.

MAOG, unemployment rate, and capacity utilisation for the United States
(NBER recessions shaded)

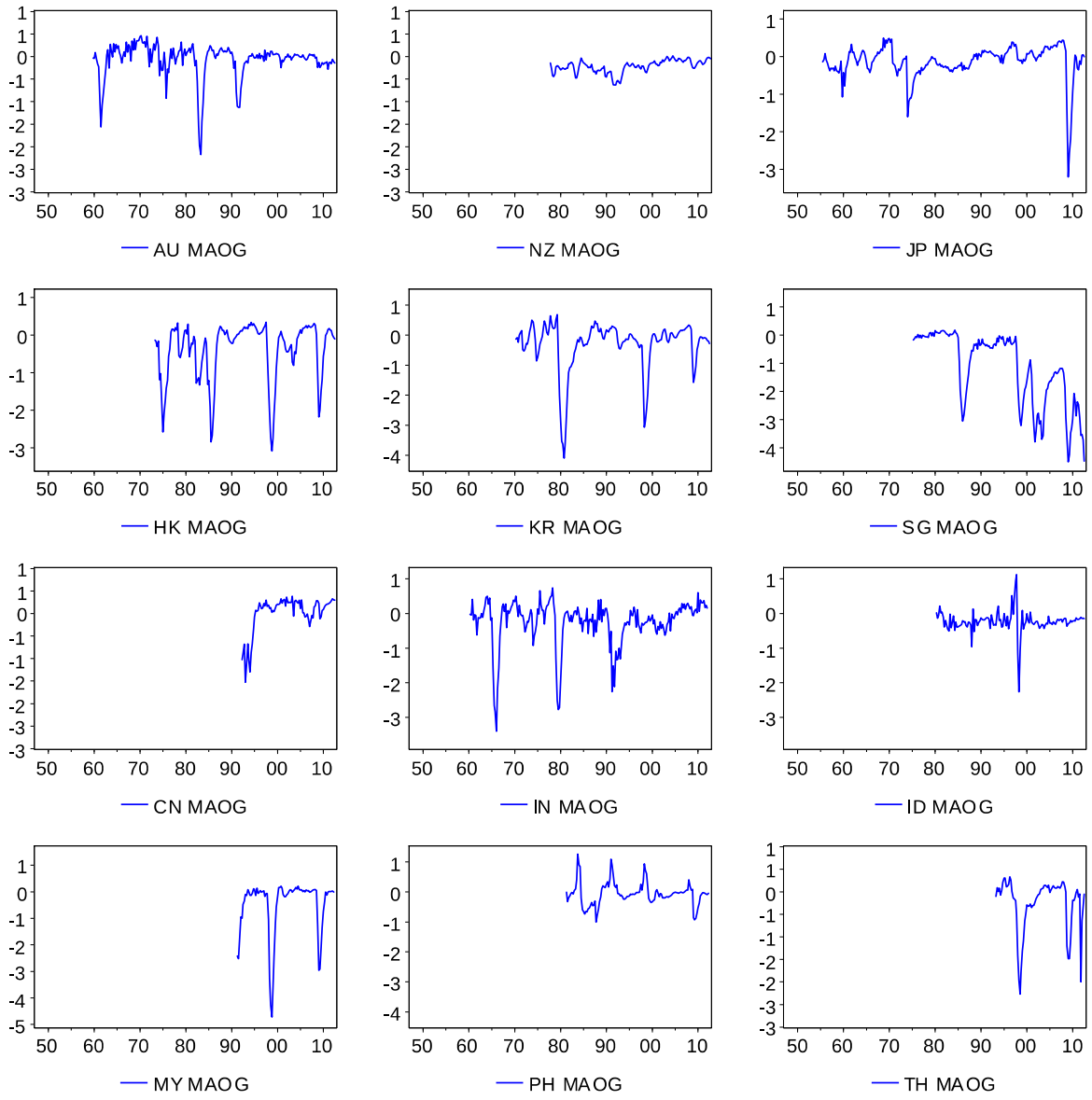
Figure 1



Notes: In the top panel, the model-averaged output gap for US real GDP for 1948Q1–2012Q3 is in blue (right axis) and the unemployment rate for the corresponding sample period is in red (left axis). In the bottom panel, the model-averaged output gap for US real GDP for 1967Q1–2012Q3 is in blue (right axis) and capacity utilisation for the corresponding sample period is in red (left axis). The output gap and the unemployment rate are in per cent.

MAOGs for selected economies in Asia and the Pacific

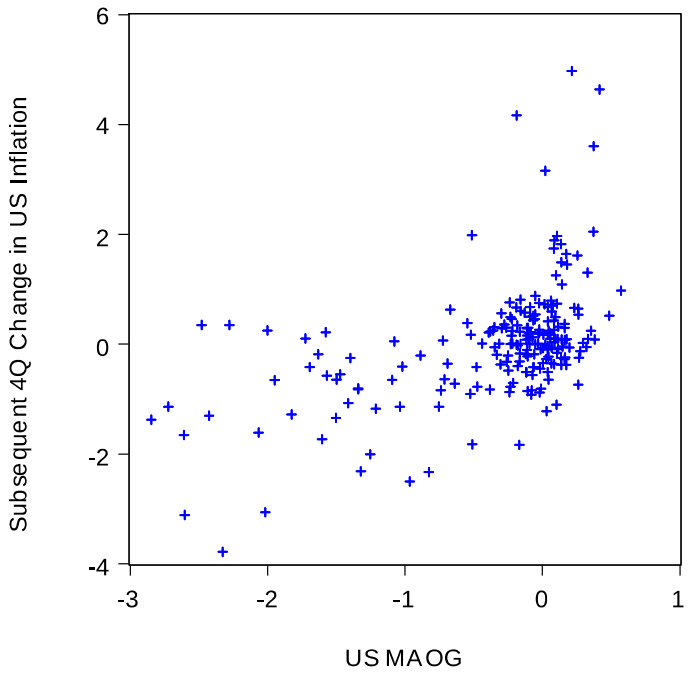
Figure 2



Notes: In per cent. From the top left and by row, the economies are Australia, New Zealand, Japan, Hong Kong SAR, Korea, Singapore, China, India, Indonesia, Malaysia, the Philippines and Thailand. The horizontal axis runs from 1947Q2–2012Q3. See Table 1 for details of the available sample period for each economy.

US Phillips Curve based on MAOG and core inflation

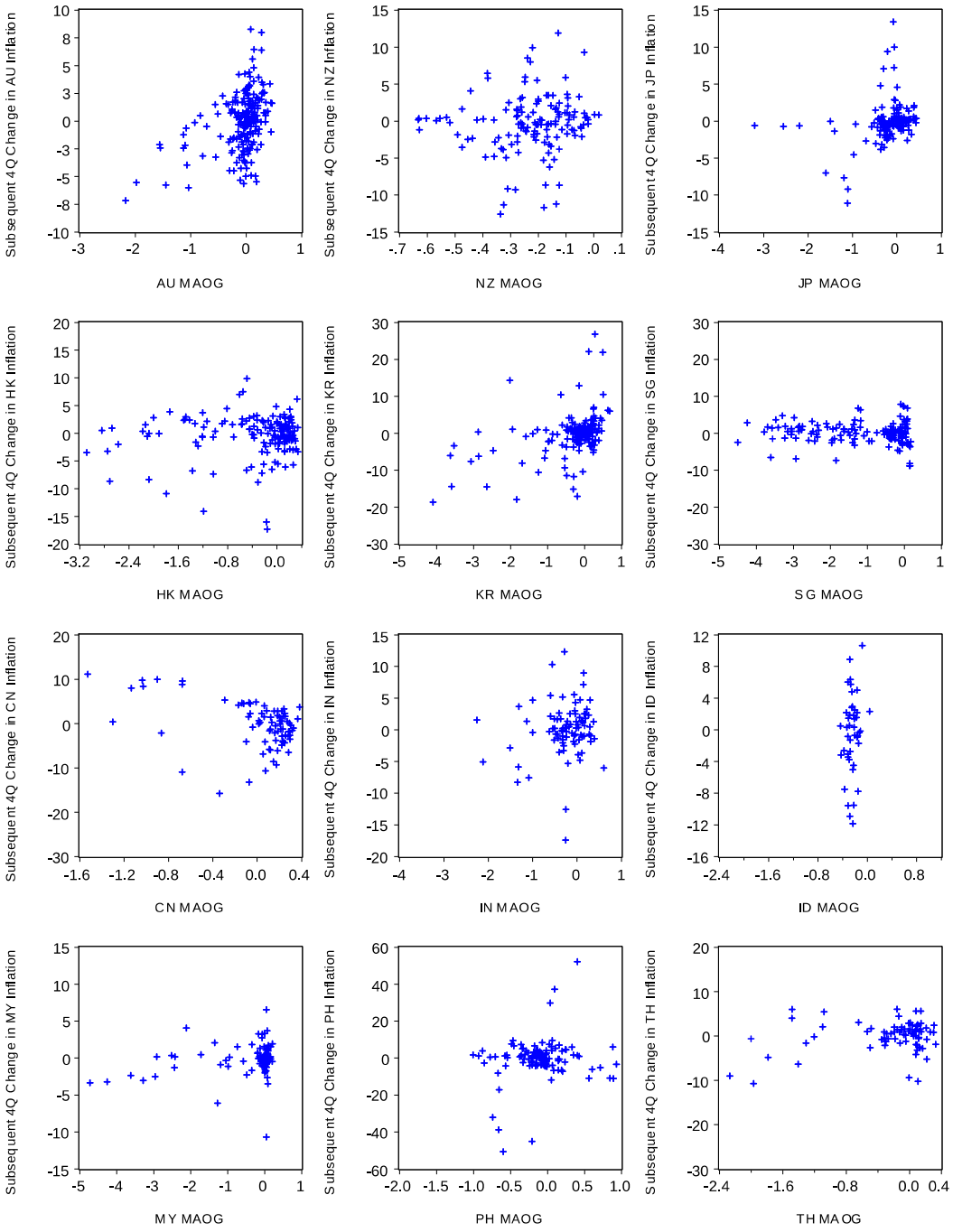
Figure 3



Note: The scatterplot is for the sample period of 1960Q1–2011Q3 based on availability of the core PCE deflator measure of US inflation. The change in inflation is in percentage points; the output gap is in per cent.

Phillips Curves based on MAOGs and inflation for selected economies in Asia and the Pacific

Figure 4



Notes: From the top left and by row, the economies are Australia, New Zealand, Japan, Hong Kong SAR, Korea, Singapore, China, India, Indonesia, Malaysia, the Philippines and Thailand. See Table 3 for details of the sample period for each economy and the data description in the text for the corresponding inflation measure. The change in inflation is in percentage points; the output gap is in per cent.

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Comments on James Morley's paper

Jun Il Kim[1]

Measuring or estimating economic slack has long been a challenge to central bank research and policymaking, particularly after a major economic event such as a financial crisis that might also affect the trend at which the economy normally expands. While it is still debatable which measure would best capture economic slack in conceptual terms, the output gap has been widely used by many. In this light, the paper by Prof. Morley is a good contribution not only to the current literature on the business cycle and monetary policy but also to practical policymaking in central banks. I believe it offers particularly useful information to some Asian central banks which, for various reasons, including data collection problems, can afford only a limited array of reliable cyclical indicators for their conduct of monetary policy.

Summary of the paper

The paper by Prof. Morley argues for a forecast-based model-averaged output gap (MAOG) as a better measure of output gap than others that can be obtained from a class of univariate models – both linear and nonlinear models. Moreover, in contrast to the Phillips curve-based framework for forecasting inflation (Liu and Rudebusch 2010, Stock and Watson 2009), the MAOG is estimated without imposing a Phillips curve (PC) relationship *a priori* so that it avoids the distortion that can arise from "assuming the answer". For the US data, the MAOG appears to perform better than other estimates of output gap from univariate models in the sense that it is more consistent with the (possibly convex) Phillips curve relationship, produces higher correlations of the expected sign with other key cyclical indicators (eg unemployment rate, capacity utilisation rate), and also theoretically correct correlations with future growth. When applied to the sample of 12 economies in Asia and the Pacific, the MAOG continues to show broadly desirable features as a measure of economic slack, although the results are not as strong as in the case of the US.

General comments

First, it is less obvious what criteria can or should be used to evaluate the relative performance of the MAOG over other estimates of the output gap given that the output gap is simply unobservable. A more stable PC relationship or higher correlations with observable business cycle indicators would in and of itself be a desirable feature from the macroeconomic point of view, but may fall short of being a useful criterion to evaluate the statistical performance or policy relevance of the

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estimated output gap. If the PC relationship changes over time as noted in the paper, a stable and positive output gap-inflation relationship would not necessarily render support for the MAOG. What if an estimate of the output gap is almost perfectly correlated with the unemployment rate? Many central banks would not sweat to estimate the output gap but instead look at the unemployment rate since the cost of ignoring the output gap would be small. Moreover, in many emerging economies in Asia and the Pacific (and also in other regions), there is no guarantee that the unemployment rate or the capacity utilisation rate is a more reliable business cycle indicator than real GDP. For these reasons, additional criteria are to be used. For example, one may examine how troughs and peaks of the MAOG and other estimates are related to specific economic events or episodes of monetary and/or fiscal policy changes, financial crisis, external shocks such as oil shocks, and so on. Such efforts would also help central banks to seek economic identification of the impact of macroeconomic policies on the business cycle.

Second, the paper would benefit if it further elaborated on the apparent asymmetry in MAOGs – particularly the seemingly negative sample mean of the MAOGs – which makes their economic interpretation somewhat difficult. If the output gap is a deviation from a trend, it should naturally have zero mean so that real GDP is as close to its trend as possible in the long run. If the output gap is negative on average (which seems to be the case for many economies in the sample, as shown in Figures 7 and 8 in the paper), then the trend around which the output gap fluctuates would no longer be considered a good representation of real GDP in the long run. On the technical level, the source of asymmetry in the MAOG is obviously nonlinear models – particularly those with bounce-back (BB) specifications – that are used in model averaging (note that the model averaging used equal weight between linear and nonlinear models). I wonder if such asymmetry with negative mean implies that higher-than-average growth over the expansion phase is largely driven by innovations in the trend. I also wonder if it would be possible to model the business cycle component as an asymmetric but mean-zero stochastic process.

Third (and related to the second), the MAOG estimates presented in the paper suggest that business cycles should have far greater welfare implications than one may think. A sharp fall in output for one or two years (as large as a 3 percent fall) during recessions with limited upside potential during normal or expansion periods would reduce welfare by a significant amount and may call for substantial precautionary saving by households.

Fourth, the estimated MAOG for the US which allows the structural break in the estimation (as shown in Figure 7) indicates that the depth of the Great Recession that followed the collapse of Lehman Brothers is less severe than previous recessions in the mid-1970s and the early 1980s, which is somewhat counterintuitive. By contrast, the MAOG with no structural breaks allowed suggests that the Great Recession is the most severe one in the post-war period. For Korea, the MAOG suggests that the 1980 recession was the most severe one and also significantly more severe than the 1998 recession that followed the financial crisis.

Finally, the results of the pairwise Granger-causality test for Asia and the Pacific seem counterintuitive in many cases. For instance, the output gaps of Indonesia, India and, to a lesser degree, Singapore turn out to Granger-cause Korea's output gap. This may well be explained by the fact that one-quarter of Korea's exports goes to the ASEAN market. But it is hard to explain that the output gaps of China, the US, and Japan do not cause Korea's despite high trade and financial linkages among the

four countries. To be sure, China accounts for one-quarter of Korea's exports and the US and Japan together account for about 20 percent.

Minor and technical comments

- *Sensitivity to structural breaks*: MAOGs for the US appear sensitive to whether structural breaks are allowed in the estimation or not, as shown in Figure 5 (perhaps both MAOGs in Figure 5 are sensitive to the end-point problem). Estimated structural breaks shown in Table 1 seem to be too few for the Asian economies that have not only registered high growth for decades but also undergone rapid transformation of the economic structure. For instance, Table 1 shows only one structural break for Korea at 1997Q2, which is near the Asian crisis. It is odd that no structural break was found for Thailand and the Philippines in 1997. Several event studies suggest more structural breaks for Korea, including 1980 and 1989. In light of the sensitivity observed for the US data, including more structural breaks may change the shape of MAOGs for the Asian economies.
- *Equal weighting versus Bayesian averaging*: The paper used equal weighting in model averaging for good reasons (Timmermann 2006). For a robustness check, it might nevertheless be useful to try alternative and equally simple weighting schemes. The computational cost would be quite high for full Bayesian averaging when applied to a large number of countries. As a low-cost alternative, for instance, one might attempt to use a simpler form of Bayesian averaging whereby the (inverse of) RMSEs of underlying univariate models are used as a weight in model averaging.
- *Granger-causality test versus factor analysis*: Trade and financial integration over the past several decades has increased interconnectedness among economies in Asia and the Pacific and also between major and emerging economies in the region. Against this backdrop, the results of the pairwise Granger-causality test could be usefully complemented by a principle component analysis or more generally a factor analysis. The share of the first principle component or a common factor in the total variation of MAOGs of the sample economies would convey useful information on the degree of interconnectedness or co-movement in Asia and the Pacific. One might also compare the common factor with the MAOG of the US to check any spillovers from the US to the region.
- *Convex Phillips curves*: The paper presents evidence of a convex PC relationship for the US and a few countries in Asia and the Pacific, including Korea (Figures 5 and 6). Such evidence, albeit limited to a small number of economies in the sample, is broadly in line with the findings of Barnes and Olivei (2003) and Peach et al. (2011), among others. But it could possibly be an artifact, for two reasons. First, the scatterplots span the long period of time (four decades or longer) during which the PC relationship could have changed significantly. The apparent convexity (and even lack of it in many other economies in the sample) may in fact be an illusion arising from multiple linear PCs of different slope plotted on the same space. As a check, PCs might be plotted for selected subsample periods. Second, asymmetric MAOGs with negative mean may create or accentuate convexity. Note that convexity derives mostly from the steep (almost vertical) portion of the PCs associated with small positive MAOGs.

As such, even moderate increases in inflation, if plotted against small positive output gaps, are likely to produce convexity.

Concluding remarks

The paper by Prof. Morley offers a very useful empirical technique to estimate the output gap with improved statistical and economic properties. The technique could be particularly useful to emerging market central banks that can afford only a limited array of business cycle indicators in their conduct of monetary policy. As always and for practical purposes, however, central banks may complement the suggested MAOGs with other available (and more conventional) estimates of the output gap.

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Keynote address

Is inflation (or deflation) "always and everywhere" a monetary phenomenon?

My intellectual journey in central banking

Masaaki Shirakawa

Introduction

I feel honoured to be invited to the People's Bank of China-BIS Research Conference in Beijing and to have the opportunity to talk before seasoned central bankers in the Asia and Pacific region. Although many things could be said along the theme of this conference, "Globalisation and Inflation Dynamics in Asia and the Pacific", I will take advantage of the liberty of being the keynote speaker, and discuss a few issues in a related but somewhat broader context.

During my tenure as the governor of the Bank of Japan, which ended last March, I fought to achieve price stability, which is obviously the core mission of a central bank. Needless to say, the same is true for central banks and central bankers around the globe. This is always a challenging job, as illustrated by the sober fact that we often don't know for sure about which we should worry more: inflation or deflation. For instance, in countries like India and Indonesia, inflation is definitely the principal concern. But in Japan, how to get out of deflation has been hotly debated over the years. And in China, while there have been intermittent concerns of overheating and related inflation over the decade, there is also recognition that persistently high levels of fixed asset investment might engender excess capacity, which could have a deflationary impact not only on China but also on the global economy.

There are ample episodes where policymakers and economists alike were not so prescient about future economic and price developments. Japan's deflation immediately comes to my mind. In the mid-1990s, economists, market participants and investors at home and abroad alike did not foresee Japan's deflation. Consensus forecasts one or two years ahead consistently overshot realised inflation in Japan (Figure 1, top panel), and longer-term inflation expectations remained over 1% until 1999 despite realised inflation being well below that level since 1994 (Figure 1, bottom panel). In markets, JGB yields remained at higher levels in the mid-1990s, even after three-month rates had plummeted (Figure 1, centre panel).

And as for our prescience with regard to the Great Financial Crisis, we just need to remember that ahead of it in the mid-2000s, the buzzword to describe the current economic and financial situation was the Great Moderation!

And so, humility is in order. Today, I am going to reflect on issues bearing on price stability,[1] in a fashion that recalls my intellectual journey in central banking from the days of a junior staffer at the Bank of Japan to the hectic days as governor. In doing so, I will mainly draw on the Japanese experience and, if needed, I will briefly refer to experiences in other countries or regions as well.

The reason for my drawing mainly on Japan's experience is not because I think Japan's experience is somehow universally applicable in drawing lessons, but because I am most familiar with the Japanese case, and I also want to highlight some issues which I think have not received sufficient attention, in the hope that these issues are examined more carefully in future research and policy analysis.

Friedman's proposition

Probably, the best way to begin retracing my journey is to ponder an oft-quoted proposition by Milton Friedman, whose last class at the University of Chicago I took in 1975. He said, "Inflation is always and everywhere a monetary phenomenon."[2] At the time, this expression was quite fresh and punchy for a student who was trained in a Japanese university dominated by the Keynesian tradition, and it didn't take long to persuade me. His succinct account of the Great Depression in the US was so convincing that I came to look at the economy through this "lens".[3] In terms of the Japanese economy, the supporting evidence was the observed correlation between money and prices, which was quite pronounced in Japan until the early 1980s (Figure 2). Although the Bank of Japan itself did not formally adopt money supply targeting, unlike other major central banks of the advanced economies, the Bank watched carefully the developments of monetary aggregates and succeeded in avoiding stagflation after the second "oil shock". Japan was praised by Friedman as a successful example of good management of monetary policy.[4]

[1] There are so many excellent speeches and writings on price stability and the role of central banks, obviously. Here, I will only mention the following speeches delivered this year:

- Paul Volcker, "Central banking at a crossroad", upon receiving The Economic Club of New York Award for Leadership Excellence, 29 May 2013.
- Ben Bernanke, "A century of U.S. central banking: goals, frameworks, accountability" at "The First 100 Years of the Federal Reserve: The Policy Record, Lessons Learned, and Prospects for the Future", a conference sponsored by NBER, Cambridge, Massachusetts, 10 July 2013.
- Raghuram Rajan, "A step in the dark: unconventional monetary policy after the crisis", Andrew Crockett Memorial Lecture delivered at the BIS on 23 June 2013.

[2] Milton Friedman, *Inflation Causes and Consequences*, Asian Publishing House, 1963.

[3] Milton Friedman and Anna J Schwartz, *A Monetary History of the United States, 1867–1960*, Princeton, N.J.: Princeton University Press, 1963.

[4] Milton Friedman, "Monetary policy: theory and practice", *Journal of Money, Credit, and Banking* 14, February 1982, pp. 98–118: "Internationally, those countries that have broadly followed the five-point monetarist policy have succeeded in controlling inflation and have done so while achieving relatively satisfactory economic growth. Among the advanced countries of the world, the outstanding example is Japan. In 1973, Japan's inflation rate was around 25 percent per year, following monetary growth at a similar rate. Japan brought the rate of monetary growth down drastically, to the neighborhood of 10 to 15 percent, and has continued to reduce it still further. After an intervening recession – by Japanese standards, not necessarily ours – of about eighteen months, inflation started to come down. It came down gradually and steadily, reached a level below

Although the relationship between money and prices itself was broken in many economies due to subsequent deregulation and technological change,[5] the central message of Friedman's proposition remains basically intact, if we shift our attention away from monetary aggregates, and look at interest rates or prices more generally.[6] After all, central banks play an essential role in achieving price stability. As a long-time central banker, I have held and still hold the same view.

Having said that, I also have come to view this proposition as somewhat loose and begun to wonder exactly what this proposition means in terms of actual policy formulation. The intellectual climate or mindset created by this proposition, which I would call the "omnipotent central bank view", is somewhat overstretched. The complexity of my feelings towards this proposition has been amplified by my experience over the past turbulent quarter century in Japan: a bubble, its collapse, a financial crisis and the emergence of mild deflation, among other phenomena. I have often voiced such reservations in various international meetings, but before the Great Financial Crisis reactions were rather muted. After all, Japan's experience tended to be regarded as something unique and arising from her own policy failures; in my view, it was not well understood by outside observers, with the notable exception of the BIS.[7] But, the Great Financial Crisis has changed the landscape.

Can we still say "Inflation is always and everywhere a monetary phenomenon"? Can we also say "Deflation is always and everywhere a monetary phenomenon"? The latter expression, replacing inflation with deflation, has been used quite often in Japan during the past 15 years. If we take the episode of hyperinflation in the early 1920s or deflation in the 1930s, the answer to both questions appears rather straightforward. But what about the past quarter century? To what extent do these propositions describe price and economic developments and serve as useful guiding principles for policy conduct by central bankers? These are the questions which I would like to address today.

In what follows, I would like to raise seven issues to illustrate why I have come to feel some uneasiness with Friedman's proposition, or more precisely, its popular interpretation.

Monetary phenomenon vs monetary policy phenomenon

The first issue I would like to take up is about the very meaning of "monetary phenomenon". My guess is that when hearing Friedman's proposition, most people take the expression of monetary phenomenon as synonymous with "monetary policy phenomenon".

5 percent, then temporarily went up after the most recent oil shock. Since then, it is starting to come back down again, and clearly seems under control. And the reduction of inflation has been accompanied by a growing economy."

[5] As Gerald Bouey, Governor of the Bank of Canada, put it in 1982: "[w]e didn't abandon the monetary aggregates, they abandoned us".

[6] Stephen G Cecchetti, "Five years in the tower", remarks prepared for the 12th BIS Annual Conference, Lucerne, Switzerland, 20–21 June 2013.

[7] William White and Claudio Borio, "Whither monetary and financial stability? The implications of evolving policy regimes", *BIS Working Papers* no 147, February 2004.

How different is monetary phenomenon from monetary policy phenomenon?

This further begs the question of what is monetary policy in the first place.[8] In this regard, it is worthwhile to revisit Friedman's well-known AEA presidential address, "The Role of Monetary Policy", in 1968.

Let me quote his description of the role of monetary policy.[9]

The first and most important lesson that history teaches about what monetary policy can do – and it is a lesson of the most profound importance – is that monetary policy can prevent money itself from being a major source of economic disturbance... There is therefore a positive and important task for the monetary authority – to suggest improvements in the [monetary] machine that will reduce the chances that it will get out of order, and to use its own powers so as to keep the machine in good working order... A second thing monetary policy can do is [to] provide a stable background for the economy... Our economic system will work best when producers and consumers, employers and employees, can proceed with full confidence that the average level of prices will behave in a known way in the future – preferably that it will be highly stable.

What is intriguing here is that Friedman used the term monetary policy in a much broader context than we define it now. At least until the advanced economies experienced the Great Financial Crisis, the term monetary policy was almost equivalent to "the control of interest rates aiming at price stability". Monetary policy in this sense has been studied intensively and refined both in theory and in practice. Yet in his address, Friedman pointed to the maintenance of smooth functioning of the financial system and markets as the first role of monetary policy, and the maintenance of price stability as the second role.

Of course, not much would be gained here by delving deeply into the precision of these definitions, but these words and the terms of Friedman strike a chord with central bankers for several reasons. First, although monetary policy in the conventional sense and financial system[s] policy are usually considered as different policy spheres, they become related in a complicated and delicate manner at critical points. Second, while policy instruments employed by a central bank essentially aim at providing or allocating liquidity, such instruments are not earmarked for each policy and its objective, namely, price stability or financial stability. The distinction between price and financial stability policies is often not that clear, which I will turn to in a few minutes.

Friedman succinctly points to the importance of maintaining financial system stability in a crisis. How a central bank acts as a lender of last resort, especially in a crisis, is an important factor affecting price developments. This point is clearly shown in a comparison between the US in the 1930s and Japan since the late 1990s. In the former case, the price level declined by around 30% within a few years. There are many causes for that sharp decline in the US, but the single most important one was that the Federal Reserve did not act aggressively enough as a lender of last

[8] Masaaki Shirakawa, opening speech at 2008 International Conference "Frontiers in Monetary Theory and Policy" hosted by the Institute for Monetary and Economic Studies, Bank of Japan, in Tokyo on 28 May 2008.

[9] Milton Friedman, "The role of monetary policy", *American Economic Review*, 58 (1), 1968, 1–17.

resort.[10] But in the recent case of Japan, the CPI has declined by [a mere] 4% over the past 15 years (Figure 3). The key to understanding this notable difference lies in the functioning of the financial system.

In my experience, the most illuminating example of this role of the central bank was the Bank of Japan's decision to provide an unlimited amount of liquidity to Yamaichi Securities after massive off-balance sheet losses were revealed at the brokerage in the fall of 1997.[11] Yamaichi, which had assets of 3.7 trillion yen or 30 billion US dollars at that time, could be regarded as the Japanese equivalent to Lehman Brothers in 2008. Yamaichi also had a sizeable presence internationally, especially in European capital markets. At the time, Japan did not have a bankruptcy law that enabled an orderly resolution of securities companies. Given such circumstances, the Bank of Japan decided to provide an unlimited amount of liquidity to the firm. This measure essentially enabled an orderly resolution by effectively replacing all exposures of domestic and overseas market participants against Yamaichi with exposures against the Bank of Japan. The materialisation of systemic risk was thus prevented.

The decision to provide unlimited liquidity to Yamaichi was truly a tough one for the Bank of Japan. It was made without knowing whether the institution was solvent or insolvent. While the Bank of Japan eventually suffered some losses, I would say that the benefit of preventing the systemic risk from materialising far exceeded these costs: in contrast to the global economy after the collapse of Lehman Brothers (Figure 4), Japan did not experience a sharp and significant plunge in economic activity. If the Bank of Japan had been hesitant about acting as a lender of last resort, Japan would have suffered from a deflation analogous to that observed in the US in the 1930s. This experience is best understood as underscoring the importance of the first role of monetary policy in Friedman's formulation cited above, namely, the lender of last resort.

Price stability vs financial stability

The second issue I would like to take up is how a central bank, in carrying out its mission, should balance its price stability mandate against its financial stability mandate. In other words, how the first and second roles of monetary policy in Friedman's formulation are interrelated.

The ultimate objective of macroeconomic policy is to ensure economic stability, and central banks can contribute to this by achieving price stability. This has not always been well understood, and the experience of the Great Inflation in the 1970s was a bitter lesson, not least in Japan, which suffered from double-digit inflation. To be sure, inflation in Japan was much more controlled after the second oil shock, so much so that Friedman, as noted above, referred to Japan favourably in the early 1980s as a successful example of good monetary management.

[10] Milton Friedman and Anna J Schwartz, *A Monetary History of the United States, 1867–1960*, Princeton, N.J.: Princeton University Press, 1963. Ben Bernanke, "On Milton Friedman's ninetieth birthday", remarks at the Conference to Honor Milton Friedman, University of Chicago, Chicago, Illinois, 8 November 2002.

[11] Masaaki Shirakawa, "Deleveraging and growth: is the developed world following Japan's long and winding road?", lecture at the London School of Economics and Political Science, 10 January 2012.

But success creates its own problems. An odd reality is that the "Lost Decade(s)" (though I think this phraseology is somewhat misleading) was preceded by much praised price stability. During the bubble period of the mid- and late 1980s, the rate of inflation of the consumer price index (CPI) was quite subdued at about 1% (Figure 3). This was followed, as we all know, by a period of sub-par growth, financial crisis and deflation. This bears striking similarities with the Great Moderation experienced by many industrial economies in the mid-2000s; namely, a period of benign price developments that was followed by severe economic downturn and financial crisis.

I don't mean to say that price stability itself creates problems or bubbles, but there exists a subtle link between the two.[12] A prolonged period of high growth coupled with low inflation gives rise to optimistic sentiment, which is at least partly responsible for fostering financial bubbles. In addition, low inflation tends to justify prolonged monetary easing, which in turn can become one of factors contributing to the formation of bubbles.[13]

We should not treat these experiences lightly. We have to start by recognising this odd reality of bubbles being accompanied by price stability, yet then followed by instability of the financial system, subsequently bringing about low growth and often inflation that is lower than desired. From such a long-run perspective, we have to admit that central banks that have accommodated asset price bubbles failed to achieve economic stability, given that both financial and price stability are essential elements of economic stability. We also cannot separate the bubble period from its damaging aftermath, intertwined as they are through leverage and deleverage and through overly optimistic pricing followed by its correction. We certainly cannot say that problems can be solved by focusing solely on the latter period. We have to think deeply about how best to relate the price stability mandate to financial stability when the central bank conducts monetary policy.

In this regard, the pre-crisis orthodoxy was that price stability leads to financial stability and thus there is no inherent conflict. However, this position is no longer tenable and central banks are now increasingly paying more attention to financial stability when formulating monetary policy at least relative to the pre-crisis orthodoxy.[14] What this new intellectual climate exactly implies in terms of optimal policy has to be clarified further.

There exists a general consensus that supervision and regulation of financial institutions as well as macroprudential policy measures are the primary instruments assigned to financial stability. What remains to be clarified is a response function for monetary policy. In other words, how should central banks lean against the wind? In fairness, I should note that even before the global financial crisis, policymakers were

[12] Masaaki Shirakawa, "Revisiting the philosophy behind central bank policy", speech at the Economic Club of New York, 22 April 2010.

[13] For the discussion on the relationship between monetary stability and financial stability, see Mervyn King, "Twenty years of inflation targeting", The Stamp Memorial Lecture, London School of Economics, 9 October 2012.

[14] Bernanke said in the recent speech: "Today, the Federal Reserve sees its responsibilities for the maintenance of financial stability as coequal with its responsibilities for the management of monetary policy, and we have made substantial institutional changes in recognition of this change in goals. In a sense, we have come full circle, back to the original goal of the Federal Reserve of preventing financial panics." ("A century of U.S. central banking: goals, frameworks, accountability", 10 July 2013.)

not neglecting financial conditions and, for that matter, financial stability. Financial conditions have been taken into consideration to the extent that they affect price developments. If we were to change the way in which monetary policy is conducted, I think there would be two possible routes of doing so:

The first approach would be to carefully examine and pay more attention to the effects emanating from the financial side of the economy on price developments. This could be done over the conventional time horizon of inflation targeting, say, a two- to three-year horizon. However, based upon past experience, I think it is highly unlikely that, solely due to financial pressures, the inflation rate would be anticipated to go up within that time horizon so much as to justify monetary tightening. Alternatively, we could further lengthen the time horizon of inflation targeting. Formally speaking, this could still be called "inflation targeting" or "flexible inflation targeting", though the longer time horizon might not correspond to the natural connotation of the term "targeting". The framing issue aside, I wonder whether a forecasted path of inflation in a main scenario is sufficient to capture all the major risks to economic stability, and whether such a forecasted path, even if it were to be accurate, could convince the population at large that monetary tightening was needed.

The second approach would be to place more emphasis on "tail risk" relative to the "main scenario" in our forecasts. Or we could simply say that the central banks are watching the economic and financial situation carefully from both price stability and financial stability perspectives. What would we best call this kind of approach? It may sound like a problem of semantics but I would have difficulty in calling such an approach "flexible inflation targeting", since it does not attach overarching importance to an inflation number.

Price stability and "maximum employment"

The third issue I would like to take up is how a central bank should weigh price stability against short-run economic stabilisation or employment. As he explained in his AEA address, Friedman's view was that if interest rate policy was conducted in order to achieve low and stable inflation, there was no trade-off between price stability and full employment, or "maximum employment" in the language of the Federal Reserve Act. Nevertheless, what we are now witnessing in the US and the euro area is high unemployment despite the fact that the inflation rate is low and stable, and inflation expectations are anchored. In fact, it is readings of labour market conditions that have been most scrutinised in the recent policy debate in the US over the timing and degree of "tapering" of asset purchases, and, further down the line, exit from exceptionally low policy rates.

How and to what extent should central banks care about employment? There is no central bank that ignores fluctuations in economic output or employment. After all, that is why the monetary policy responses of central banks in many countries have been well described by the simple Taylor rule. This means that, regardless of how the mandate of a central bank is crafted in central bank law – single mandate or dual mandate or some variant – real-life central banks have been, more or less, operating in a "dual mandate" world.

In this regard, Japan's experience with deflation and unemployment may shed considerable light on the grounds central banks have for concern about deflation

and how monetary policy is conducted as a result.[15] As I have noted many times elsewhere, Japan's price decline over the 15 years or so contrasts starkly with the global episode of deflation in the 1930s both in terms of the severity of the price decline and the associated rise in unemployment. Japan's CPI started to decline from 1998, and the cumulative decline of CPI since then has been a bit less than 4% (Figure 3).

Although Japan has been frequently described over this period as having experienced exceptional economic malaise, Japan's labour market conditions have been rather stable, particularly compared with what happened in the major advanced economies after the bursting of the global credit bubble in the late 2000s. Japan's unemployment rate has long been low and its rise during the latest crisis was rather modest (Figure 5).

It follows that if we evaluate the performance of the Japanese economy based upon a "dual mandate" rather than a "single mandate", it fares not too badly in international comparisons. This can be verified by calculating the so-called "misery index", the original definition of which is a sum of the inflation rate and the unemployment rate. For the purpose of today's presentation, I sum the unemployment rate with the absolute value of the inflation rate so as to treat inflation and deflation in a symmetrical manner. In Figure 6, we see that since 2000, Japan recorded the lowest number of the "misery index" when compared with the US, the euro area and the UK. Even were we to penalise deflation more by measuring the degree of misery due to price changes as the gap between the actual and the desired rate of inflation, say 2%, the conclusion does not change materially.

Japan's relatively good score reflects the combination of mild deflation as well as low unemployment. But we should not forget that these two outcomes are intimately related. Namely, Japan's employment practices are one of the main factors behind low inflation rates in Japan relative to other economies. Nominal wage downward rigidity is not observed in Japan, which contrasts starkly with the US and Europe. Japanese society since the second half of the 1990s has prioritised employment over wages: it effected reductions in labour costs, [which is employment multiplied by wages,] largely by cutting back wages. Consequently, wages declined in absolute terms and prices fell (Figure 7).

To put it differently, mild deflation has been, to some extent, a price that Japanese society has paid to secure "maximum employment". This observation suggests that the desired level of inflation for any country does not exist in a vacuum, and a deeper and more holistic examination of price stability which pays due attention to differences in institutional factors across countries and time is in order.

[15] See Kenji Nishizaki, Toshitaka Sekine and Yoichi Ueno, "Chronic deflation in Japan", *Bank of Japan Working Paper Series* No.12-E-6, July 2012; Takeshi Kimura and Kazuo Ueda, "Downward nominal wage rigidity in Japan", *Journal of the Japanese and International Economies*, 15, 2001, pp 50–67.

The effectiveness of unconventional monetary policy under the zero lower bound and ongoing balance-sheet adjustment

The fourth issue I would like to take up is whether monetary policy or interest rate policy is always and everywhere effective. More specifically, what is the effectiveness of unconventional monetary policy under the zero lower bound? The proposition "Inflation is always and everywhere a monetary phenomenon" implies that a massive increase in central bank money can bring about inflation or turn deflation into inflation. In Japan, central bank money more than doubled since 1997 but, as I said earlier, CPI declined by 4%. After the collapse of Lehman Brothers, we saw massive increases in central bank money in the major advanced economies including Japan, but again there was no sign of increases in the inflation rate (Figure 8). Of course, we could reinterpret Friedman's proposition as implying that the central bank is capable of affecting the inflation rate through changing financial conditions rather than simply positing a mechanical link between money and prices. This is true qualitatively. The issue here is how and to what extent the central bank can affect the inflation rate by changing financial conditions in an economy under the zero lower bound and ongoing balance sheet adjustment.

The Bank of Japan has deployed all sorts of unconventional monetary policy measures ahead of other major central banks. Japan has been living in a world of zero interest rates for almost all of the past 15 years (Figure 9). The Bank of Japan hugely expanded its balance sheet, purchased non-traditional assets or risk assets such as stocks held by banks, commercial paper, corporate bonds, exchange-traded funds (ETFs) and real estate investment trusts (REITs), and adopted forward guidance on future policy. It is not an exaggeration to say that almost all the policies adopted by other central banks after the Great Financial Crisis, though often described as "innovative", were policy measures which the Bank of Japan had "invented" much earlier, in uncharted waters, and without textbooks or precedents. When I was involved in first implementing these unconventional monetary policy measures at the Bank, in my days before becoming Governor, I never once thought of a situation where central banks in other major advanced economies might someday be also implementing the same sort of policy measures.

How does Friedman's proposition fare in an economy constrained by the zero lower bound and ongoing balance sheet adjustment? The two mechanisms through which monetary policy can potentially affect inflation are either through narrowing the output gap or through raising inflation expectations. The issue is whether or not such mechanisms actually work under the zero lower bound and balance sheet adjustment. Although it is too early to draw any definitive conclusions, the emerging consensus seems to be that even though unconventional monetary policy affects prices of financial assets, its effect on real economic activity and hence the output gap is rather limited and uncertain.[16] In this regard, the so-called "plug-in" approach that is often employed in estimating the effect of unconventional monetary policy is grossly misleading. Under this approach, the effect on real economic activity is assumed to be the products of the estimated impact of

[16] Takeshi Kimura and Jouchi Nakajima, "Identifying conventional and unconventional monetary policy shocks", *Bank of Japan Working Paper Series*, May 2013.

unconventional monetary policy on the long-term interest rate and the estimated response of real economic activity to interest rate changes in a normal period. This approach, however, assumes away any decline in the effectiveness of monetary policy.

In this regard, an interesting observation is the comparison of post-bubble periods in Japan and the US. If we compare the paths of real GDP following the collapse of Japan's bubble in the early 1990s, and the collapse of the US bubble in the late 2000s, Japan's GDP growth was actually a bit better than that of the US, despite supposedly much more "aggressive" monetary policy in the latter (Figure 10).

It is posited that favourable financial conditions engendered by unconventional monetary policy can positively influence economic activity by encouraging spending by economic entities that are not constrained by balance sheet problems. Whether or not this kind of mechanism has worked recently is an empirical question, and the answer appears to vary across economies depending on the size of the initial bubble, the flexibility of the economic system, including the environment for startups, and the share of economic entities subject to balance sheet constraints.

What about the expectations channel? If narrowing the output gap is not a promising route, the hoped-for change in expectations might conceivably be brought about through arithmetical increases in inflation reflecting increases in central bank money, although Chairman Bernanke himself has recently been dismissive of the existence of such a mechanism.[17]

Monetary phenomenon and real factors

The fifth issue I would like to take up concerns the role played by "real factors". In my view, the effectiveness of unconventional monetary policy also depends critically on real factors. More specifically, it depends on the ability to create a gap between the natural rate of interest and the market interest rate. If, after the collapse of a bubble, the natural rate of interest declines and remains depressed for an extended period of time, the effectiveness of unconventional monetary policy is diminished, compared to its effectiveness in a world without such declines in the natural rate.

Particularly relevant in the light of Japan's experience is the implication of a decline in the natural rate of interest which is secular in nature. The rationale for unconventional monetary policy is that if we can just succeed in lowering the long-term real interest rate, we will stimulate demand and thus return the path of economy to full employment. But the implicit assumption here is that the economy has only been hit by a temporary demand shock or is in a Keynesian situation of demand deficiency. In this case, unconventional monetary policy at least in theory should be effective by bringing future demand to the present. On the other hand, what if the economy is faced with a secular decline in the natural rate of interest? In this alternative case, the longer we rely on this mechanism, the less demand to be

[17] Bernanke said in his press conference on 12 December 2012: "We want to be sure that there's no misunderstanding, that there's no effect on inflation expectations from the size of our balance sheet."

brought forward from the future there is and the less effective the intertemporal substitution mechanism will be.

Japan is now experiencing rapid ageing, at a pace that is unprecedented in modern economic history. Rapid ageing or, more precisely, the rapid rise in the "dependency rate", is one of factors lowering potential growth and hence the natural rate of interest.[18] It is noteworthy that there is a clear correlation between the potential growth rate and the long-term expected inflation rate in Japan (Figure 11). I can only say that we cannot fully understand Japanese macroeconomic performance without understanding its demography, and how it interacts with the economy and society.

To be sure, demography is one of the real factors that could affect inflation dynamics by affecting the natural rate of interest, but there are other real factors such as changes in the terms of trade. The way in which such real factors affect inflation dynamics varies across countries and time. Also, their importance relative to monetary factors depends on the degree of variation of the real factors.

Fiscal issues and government solvency

The sixth issue I would like to take up is the relationship of monetary policy to government finance. When government solvency is threatened, there are only three possible ways out of the situation.

One option is to improve the fiscal balance, which includes not only "austerity measures" but also efforts to increase tax revenue by enhancing growth potential. Needless to say, this is the most desirable option. In a democratic society, however, it requires a difficult political process of forming a nationwide consensus on the need to take the necessary steps, such as cutting fiscal expenditure, increasing tax rates and social security contributions, and implementing institutional reforms to strengthen the growth potential of the economy.

The second option, which is definitely undesirable, is outright default. Because government bonds are widely held by financial institutions as safe and convenient financial assets, a default would damage financial institutions' capital positions and subsequently destabilise the financial system. Instability in the financial system would trigger a negative feedback loop in which the adverse impact on the real economy would invite a further deterioration in the fiscal balance and damage the entire financial system.

The third option, which is also undesirable, is inflation. This essentially aims to compensate for a decline in the government's repayment capacity by increasing seigniorage through a significant increase in currency issuance, or in other words, fiscal monetisation by the central bank. The problem here is that giving up on price stability as a policy goal will impair the basis for sustainable growth and social stability.

When government solvency is undermined, unless necessary economic and fiscal structural reform measures are taken, the economy will inevitably face a harsh

[18] Daisuke Ikeda and Masashi Saito, "The effects of demographic changes on the real interest rate in Japan", *Bank of Japan Working Paper Series*, 27 February 2012.

trade-off between financial system instability and inflation. The unfolding of the European debt crisis vividly demonstrated the negative feedback loop involving government finance, financial system and real economic activity. Doubts about fiscal sustainability affect financial institutions that hold sizeable amounts of government debt, which in turn weigh on real economic activity. All this can threaten price stability as well. Of course, the actual economic outcome could vary significantly depending on several factors, such as how the public assesses the extent of government solvency impairment, how a central bank acts when the financial system is on the verge of a crisis, and how private agents anticipate responses by the central bank.

A critical issue here is whether central banks can actually stop this negative feedback loop. In theory, two views are offered on how the inflation rate is determined: monetary dominance or fiscal dominance. According to the former view, the government conducts fiscal policy that is consistent with the goal pursued by the central bank. It is the perceived path of monetary policy set by the central bank that determines the price path. But, if the government does not implement fiscal reforms despite deteriorating finances, the central bank is forced into a position of choosing between two evils: inflation or financial system instability. In this case, it is the perceived fiscal path and the central bank's reaction that determines the price path.

The issue here is how the central bank can avoid being trapped in a situation of fiscal dominance. Friedman's proposition unfortunately does not address such difficulties and challenges which central bankers are faced with in the real world. In such situations, the supporting logic and perceptions of the central bank's monetary policy regime are important as well.

International dimension

The seventh and final issue I would like to take up is the international dimension of Friedman's proposition. How does Friedman's proposition fare in an open economy? The standard argument is that central banks can pursue an independent or autonomous monetary policy aiming at price stability, as long as they adopt a flexible exchange rate system. According to this view, global factors do not affect the domestic inflation rate, at least in the long-run. To the extent that global factors do affect the domestic inflation rate, it is due to the authorities' resistance against currency appreciation.

This logic is quite forceful and persuasive when I recall the consequences of attempts to stem the appreciation of the yen: both during the 1971–73 period which engendered double-digit inflation, and then after the Louvre Accord in 1987, which expanded the bubble. In both periods, attempts to stem the appreciation of the yen exchange rate were important contributors to the subsequent economic instability. These were valuable lessons for Japan about the problems with attempts to resist currency appreciation. Similar lessons could also be found in other advanced economies, and thus policymakers in major advanced economies often explain the importance of flexibility of exchange rates to emerging economy peers who resist currency appreciation.

Until relatively recently, I did not have any additional thoughts on this issue. But, as events have unfolded, I have come to realise that the story is much more

complicated. Events that influenced my thinking have been the growth of the yen carry trade and the experience of the zero interest rate policy in multiple countries.

In the mid-2000s, Japan was the only country which had adopted a zero interest rate policy, which widened interest rate differentials between Japan and the rest of the world, particularly amidst high growth. Coupled with low volatility of exchange rates, this encouraged the yen carry trade, which in turn resulted in a depreciation of the yen in the mid-2000s (Figure 12). In those days, when I attended international meetings, I often heard complaints about appreciation pressures from countries with high-yielding currencies in the Asia and Pacific region.

At the time, I was not convinced by their argument. My reaction was the textbook argument: if you are uncomfortable with inflows of capital due to the carry trade, you can discourage it by allowing your currency to appreciate and adjust your monetary policy stance to reflect domestic economic conditions. On top of that, I was sceptical about the continuation of massive carry trades on the ground that it violated the principle of uncovered interest rate parity.

Some years later, I have come to realise that my argument was a bit one-sided for several reasons. First of all, the carry trade has become even more prevalent. Second, it is clear that the size of capital inflows and subsequent outflows can be quite large relative to the financial markets of recipient countries. Third, the implications for the global economy can be quite different depending on whether only one country adopts the zero interest rate policy or multiple countries adopt such a policy. To the extent that the effect of the exchange rate channel in the advanced economies is mutually offset and to the extent that those economies are constrained by balance sheet adjustment, the spillover effects of aggressive monetary policies by the advanced economies to the rest of the world cannot be negligible. Equally, spillover effects can also result from the inflexibility of exchange rates in emerging economies. As emerging economies become large, the possible adverse effects of exchange rate inflexibility on other emerging economies as well as the global economy could become large as well.

Every policy decision may be reasonable from the perspective of the individual economy, but the aggregate effects or cross-border spillovers might point towards a global easing bias. With the deepening of globalisation, no responsible policymaker can now dismiss the importance of cross-border spillovers and feedbacks from their policies.[19] At the same time, it is unrealistic to hope that central banks fully "internalise" those effects in their policy decisions, given that each central bank is governed by central bank law in its jurisdiction that focuses on "domestic stability".[20] At any rate, the monetary phenomena of Friedman's proposition have become more global.

[19] Masaaki Shirakawa, "The consequences of the great financial crisis: five years on", remarks at the Institute of International Finance (IIF) 30th Anniversary Annual Membership Meeting in Tokyo, 12 October 2012.

[20] Charles Bean, "Global aspects of unconventional monetary policies", panel remarks at the Federal Reserve Bank of Kansas City Economic Policy Symposium, Jackson Hole, Wyoming, 24 August 2013.

My current thinking and some conclusions

So far, I have reviewed seven issues showing the difficulties and challenges which central banks have been faced with, under the broad framework of Friedman's proposition, and offered my personal reflections as an economist and central banker. You might wonder where I now stand, after a long intellectual journey, in terms of understanding the determination of prices and monetary policies aimed at price stability. I think my views can be summarised in the following six statements.

First, central banks play an important role in achieving price stability and have to fully recognise their responsibility. Whether a country experiences severe inflation or deflation crucially depends on the determination and actions of the central bank. This means that central banks must properly conduct monetary policy in the broad sense – both interest rate policy, which can include "leaning against the wind", and acting as a lender of last resort.

Second, price stability is a medium- to long-run concept, not a short-run concept, and sustainability is the key. High inflation or sharp deflation is easily identifiable as an unsustainable phenomenon and central banks know what they should do in such situations in a technical sense, even though actual implementation in some cases may be politically difficult. More difficult perhaps is a situation in which sustainability is being threatened, even though price stability is being attained on the surface. Bubbles and their collapse will result in a state in which price stability is not attained in the medium to long run, even though in the initial phases inflation may be quite subdued and sometimes negative. How to recognise the financial imbalances threatening sustainability is a daunting task but is crucially important. After all, deposit money, which has a major share in broad money, is created as a product of maturity mismatches and leverage of private financial institutions. Friedman's term – "monetary phenomenon" – should be understood as a broad concept including accumulation of financial imbalances.

Third, in order to achieve price stability on a sustained basis, cooperation among various policymakers is imperative. Viewing the central bank at all times as an omnipotent institution is misleading and sometimes could be perilous. Maintaining fiscal sustainability, implementing good supervision and regulation of financial institutions, and nurturing prudent behaviour are all important. To fully recognise the essential roles and responsibilities of central banks is one thing, and to recognise their limits and the need for cooperation is another. Such cool-headed recognition of their powers and limitations is what is needed for truly responsible central banks.

Fourth, international cooperation is important. Global financial conditions are becoming important as a determinant of the global economy and thus also as a determinant of the domestic economy and prices. At the same time, it is also true that each central bank is governed by the central bank law in each country. With the deepening of globalisation, however, no responsible policymaker can now dismiss the cross-border spillovers and feedbacks of their policies. In this environment, at a minimum, deliberate efforts to consider the external effects of domestic monetary policies and their feedback effects are quite important. And actually, discussions at BIS meetings and joint research projects under BIS initiatives like the one we are observing in this conference are not only useful but also becoming indispensable.

Fifth, inflation dynamics can vary across countries and time. We should not dismiss factors unique to each country, which includes "real factors". Labour market practices including the degree of downward nominal wage rigidity, rapid changes in demographics and terms-of-trade changes are examples of factors unique to each country. Japan's deflation cannot be well understood without considering such real factors. Based upon my observations on the evolving debate on Japan's deflation, I think we must make more deliberate efforts to incorporate such factors to better understand inflation dynamics. There are many issues which are worthy of further examination. Considering that a vast supply chain network has emerged and continues to evolve in East Asia, studies on the effects of its development on inflation dynamics in the region are one possible avenue for research.

Sixth and finally, how to frame issues on price stability and policy is quite important and proper consideration for this aspect of policy is needed in the communication of monetary policy and the design of the policy framework. A case in point is the evolution of inflation targeting and the debates surrounding it. The adoption of inflation targeting was effective in bringing down inflation and anchoring it at a low level in those economies that suffered from high inflation, in that it succeeded in making people focus on inflation, which was one of the core problems. But, this simplicity can backfire, if the intellectual climate or mindset created under inflation targeting makes central banks become inattentive to financial stability.

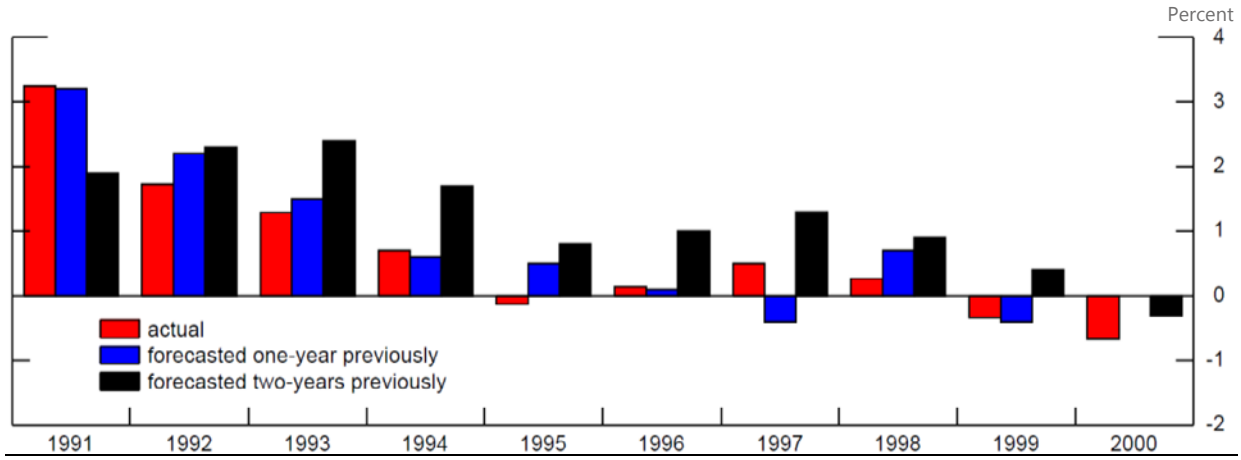
Each of these issues is demanding in its own right, but the recognition of the challenges is the starting point. I hope that central banks in this region and the BIS, together with the assistance of prominent academic researchers, will continue to make significant progress in furthering our understanding of inflation dynamics and their policy implications.

Thank you for your attention.

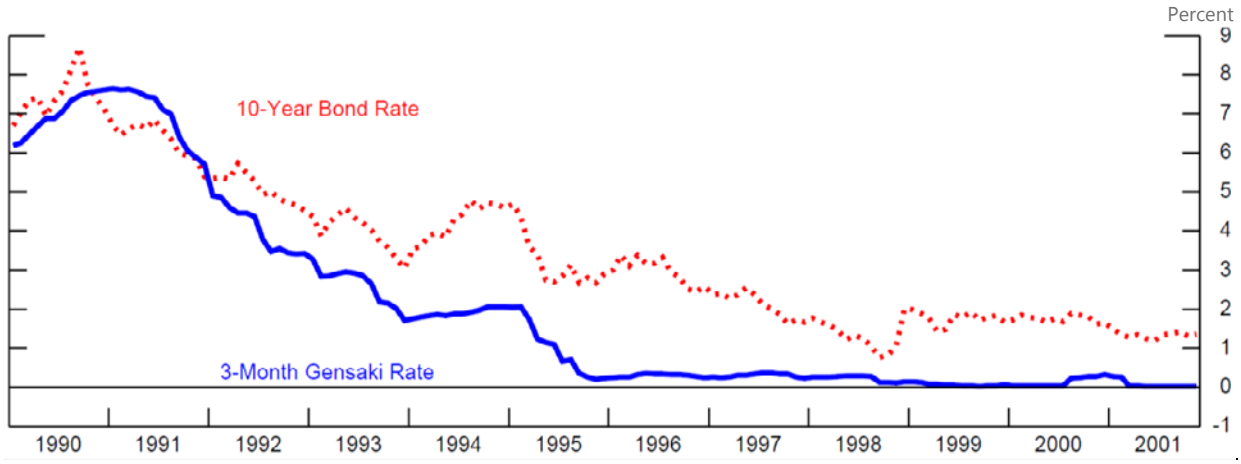
Graphs

Inflation expectations from Consensus forecast[1]

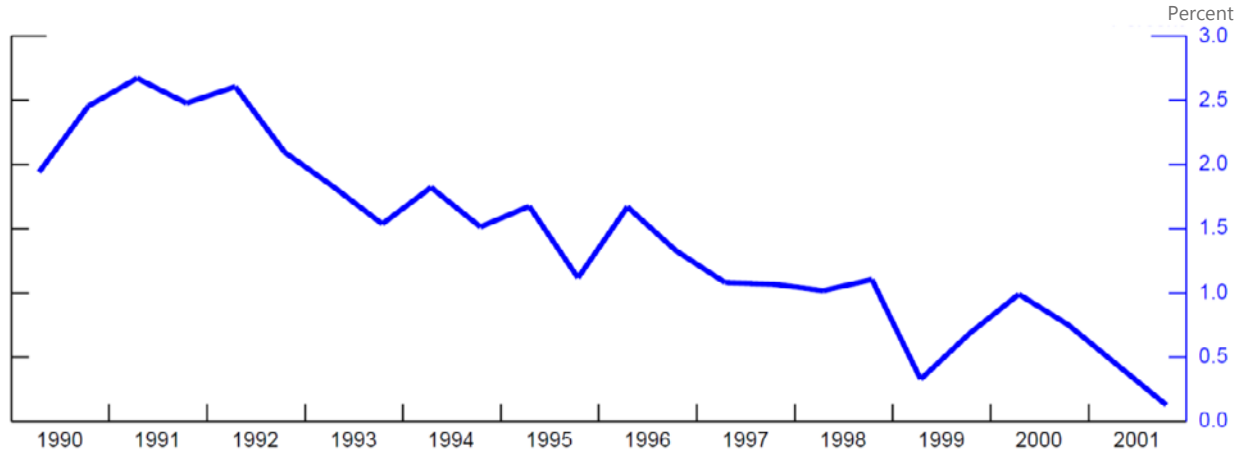
Figure 1



10-year and 3-month Gensaki rates



10-year inflation expectations[2]



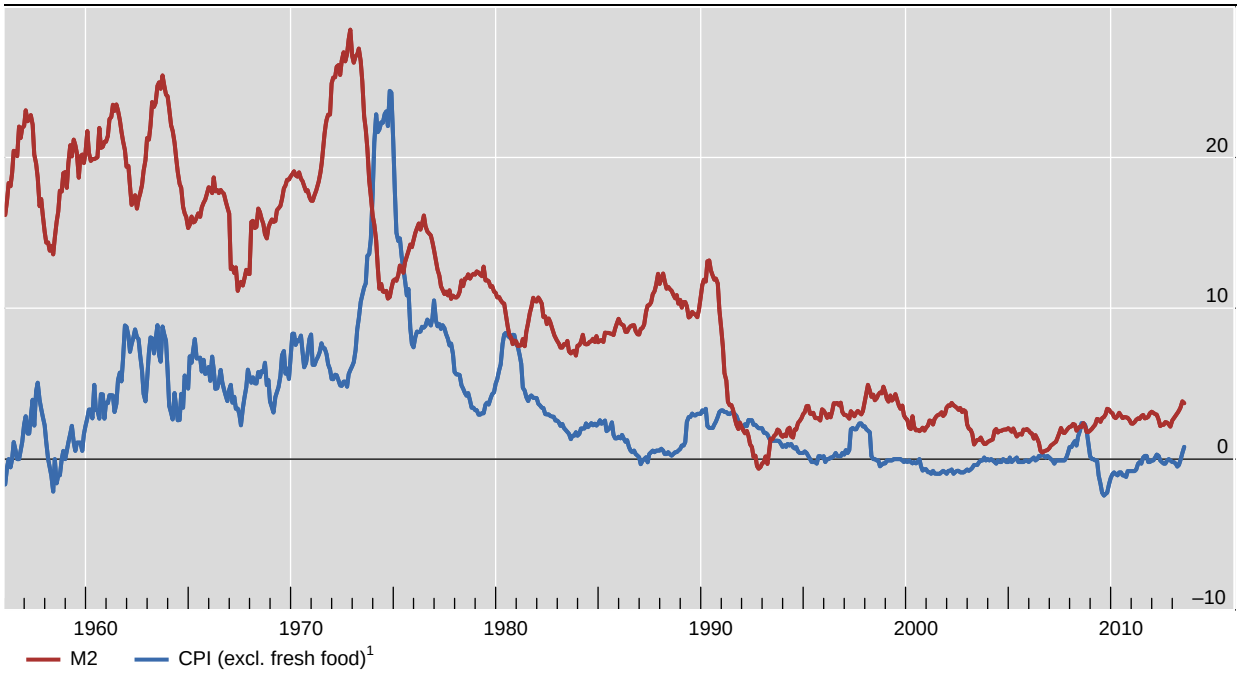
[1] Change in CPI on a year-average-over-year-average basis (Q4/Q4 not available), adjusted from April 1997 through March 1998 for consumption tax increase. [2] Consensus Economics forecast of average CPI inflation (year-average-over-year-average basis) for the next ten years.

Source: Alan G. Ahearne; Joseph E. Gagnon; Jane Haltmaier; Steven B. Kamin (June 2002) "Preventing Deflation: Lessons From Japan's Experience in the 1990s", International Finance Discussion Papers, 2002–729.

Broad money and CPI in Japan

Year-on-year percentage change

Figure 2

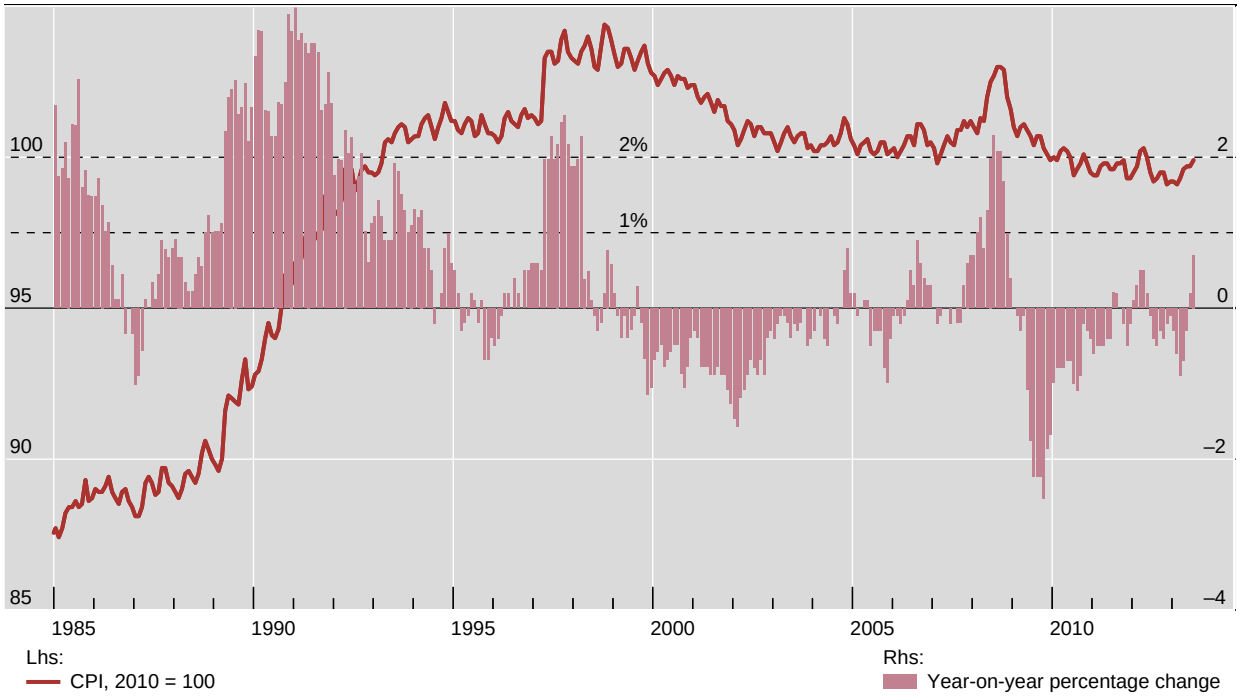


[1] Backdated from 1956 to 1969 with CPI excluding imputed rent.

Sources: CEIC; Datastream; national data.

CPI inflation in Japan

Figure 3

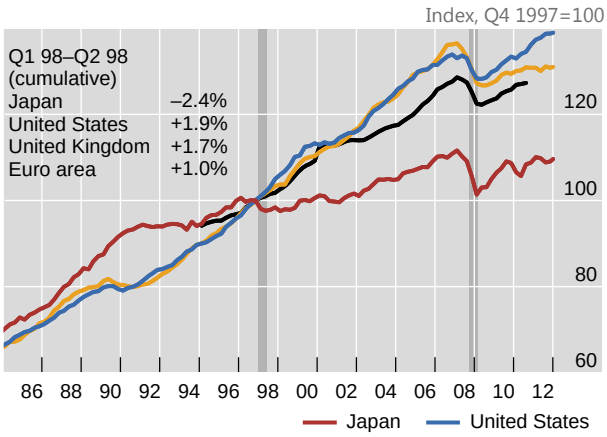


Source: National data.

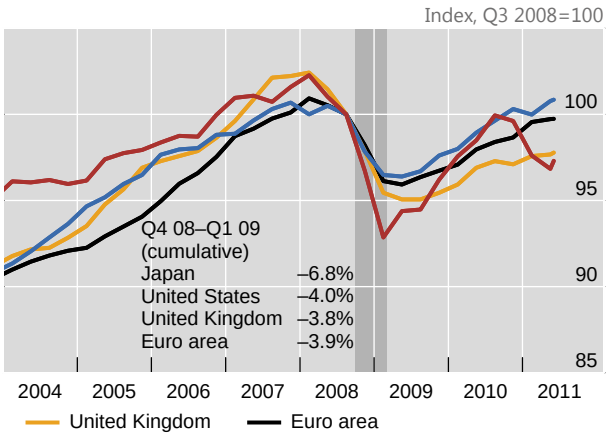
Comparison of GDP following financial turmoil in Japan in 1997 and US in 2008

Figure 4

Following the financial turmoil in Japan



Following the failure of Lehman Brothers

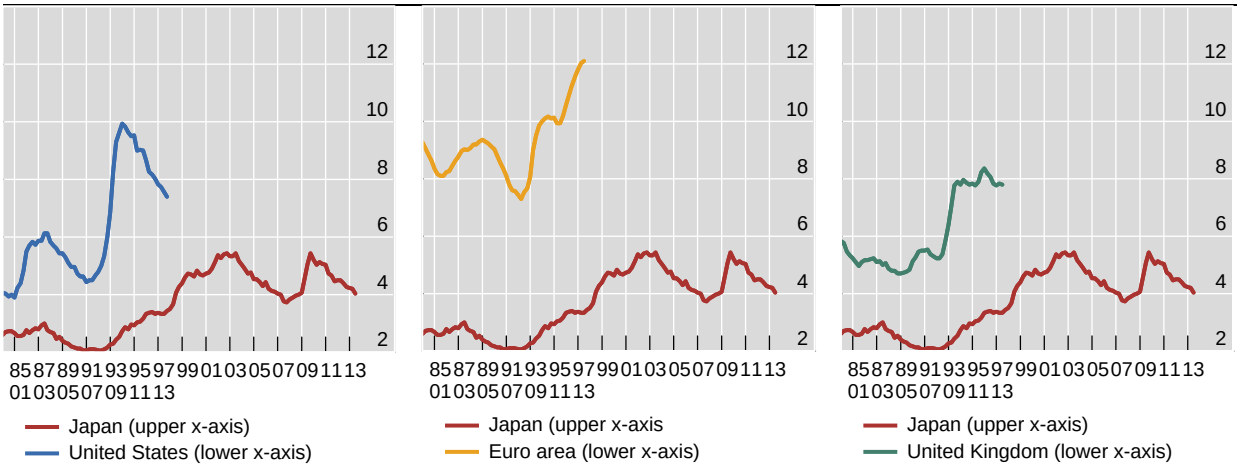


Sources: National data; author's calculations.

Unemployment rate after the collapse of the bubble

In per cent, seasonally adjusted

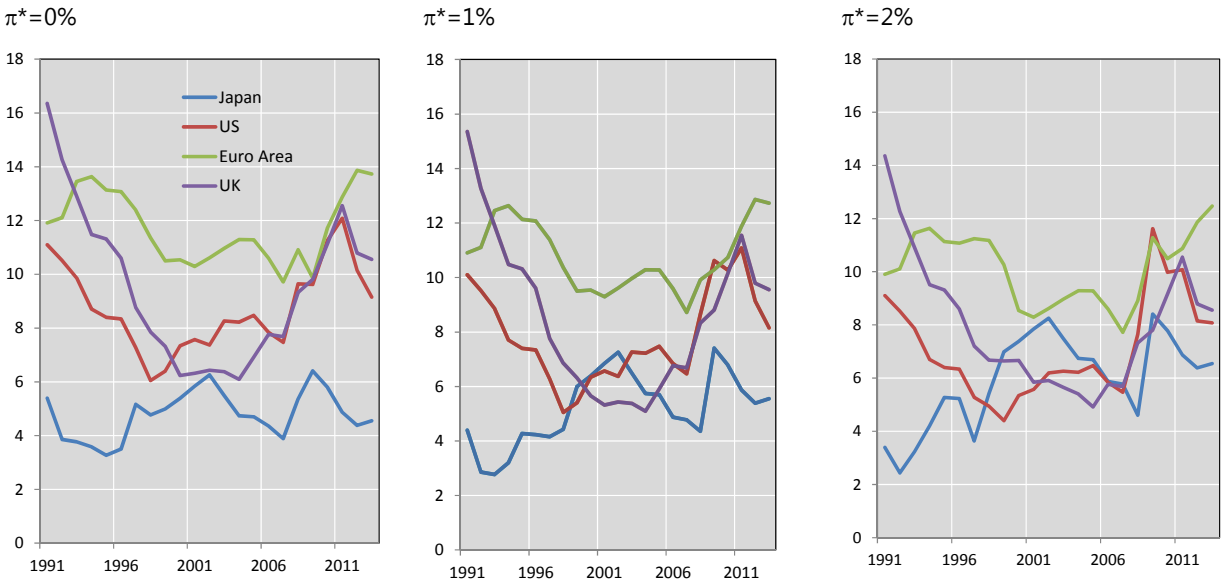
Figure 5



Sources: Datastream; national data.

Misery index[1]

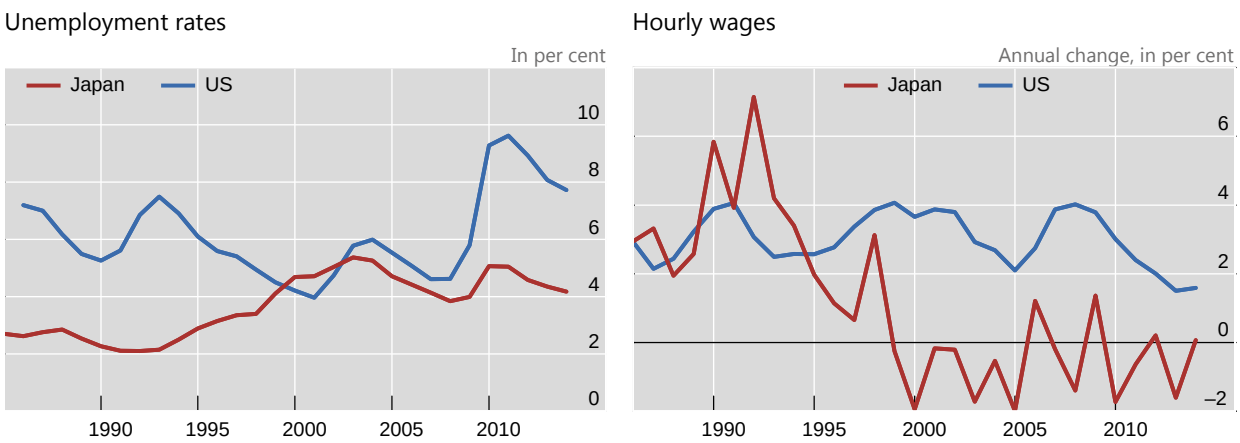
Figure 6



[1] Misery index is calculated as $|\pi - \pi^*| + u$, where π is actual inflation rate, π^* is desired inflation rate and u is actual unemployment rate.

Unemployment rates and hourly wages

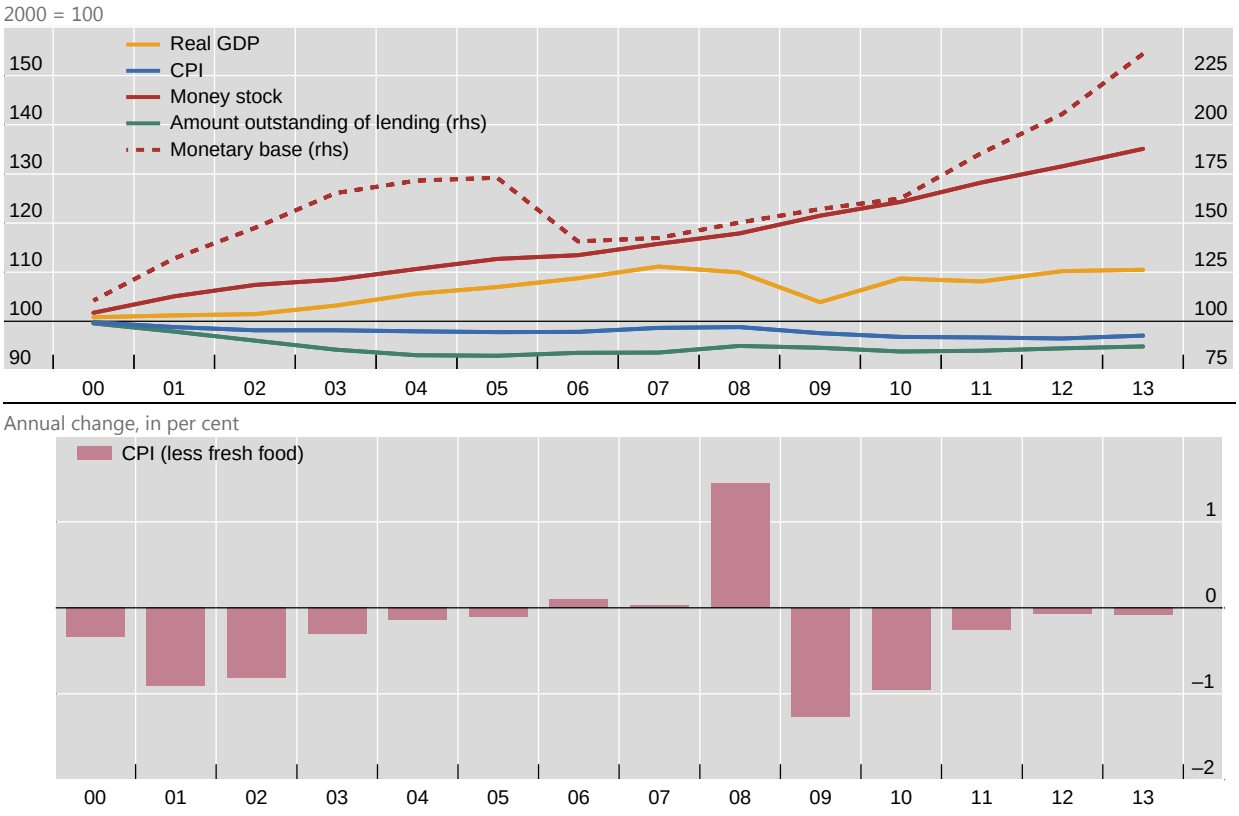
Figure 7



Sources: CEIC; Datastream; national data.

Growth of monetary base and inflation rate in Japan

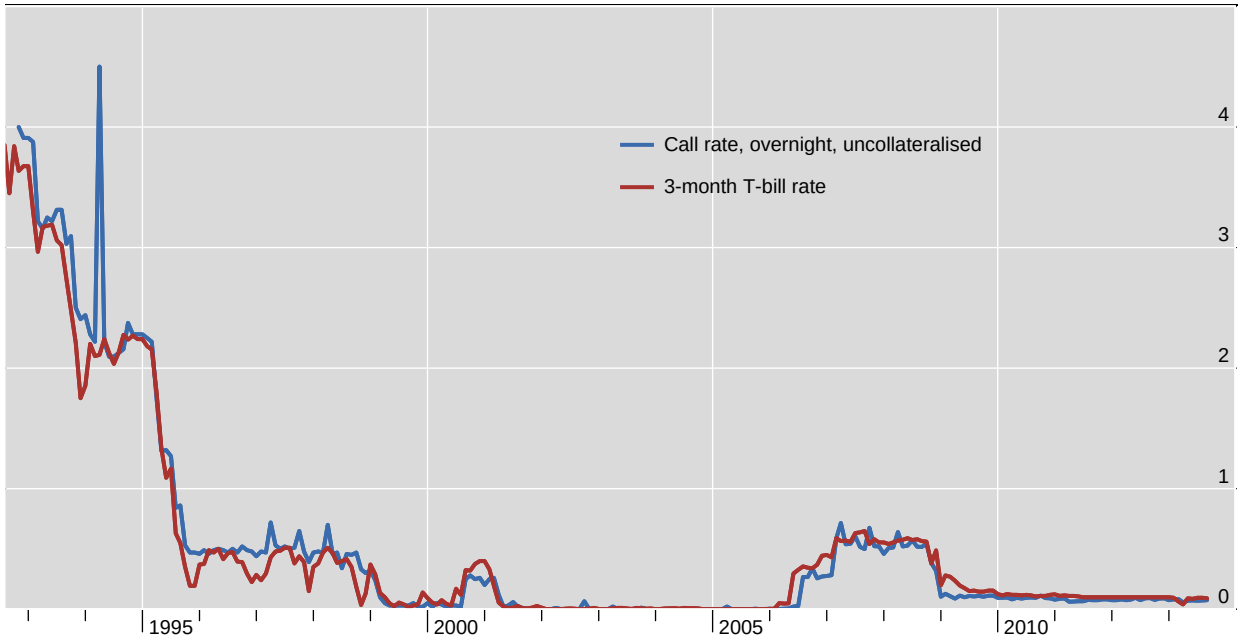
Figure 8



Sources: CEIC; Datastream; national data.

Development of short-term interest rates in Japan

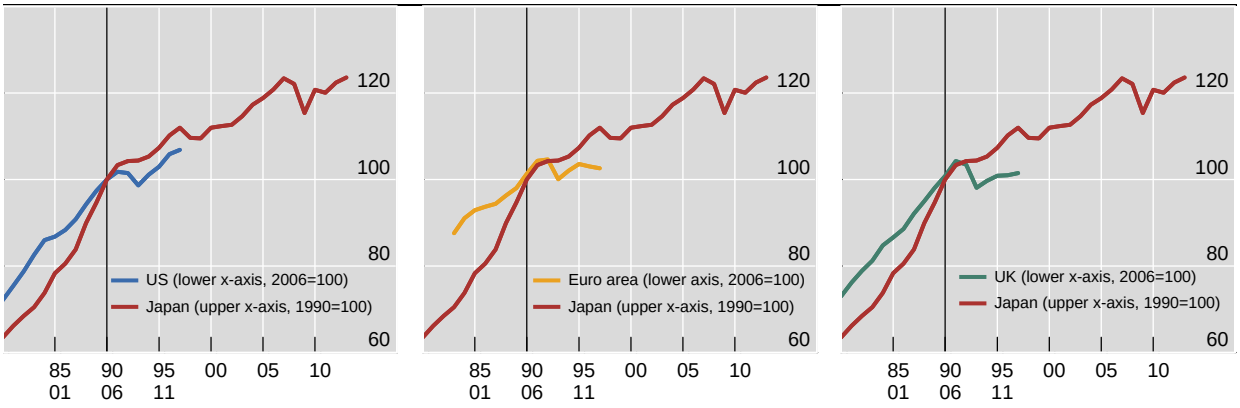
Figure 9



Source: Bloomberg.

Real GDP in advanced economies after the bursting of bubbles

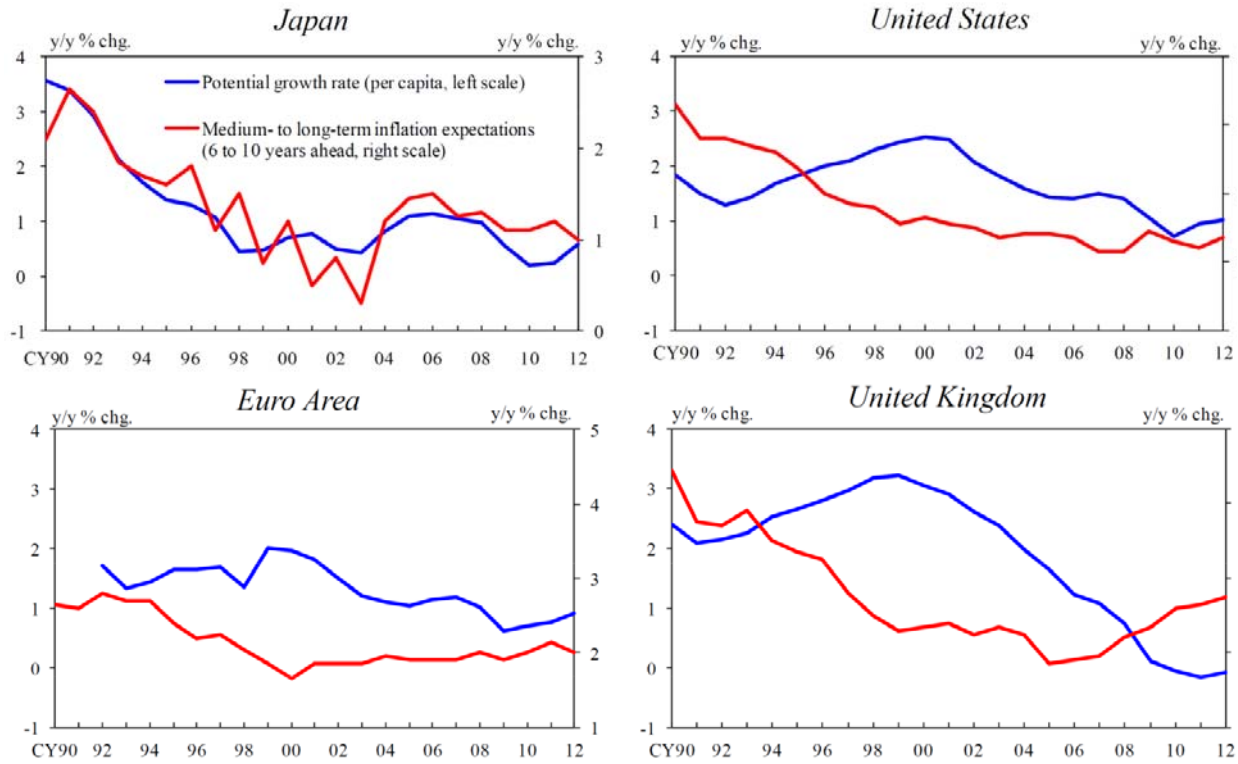
Figure 10



Sources: Datastream; national data.

Correlation between inflation expectations and potential growth rate

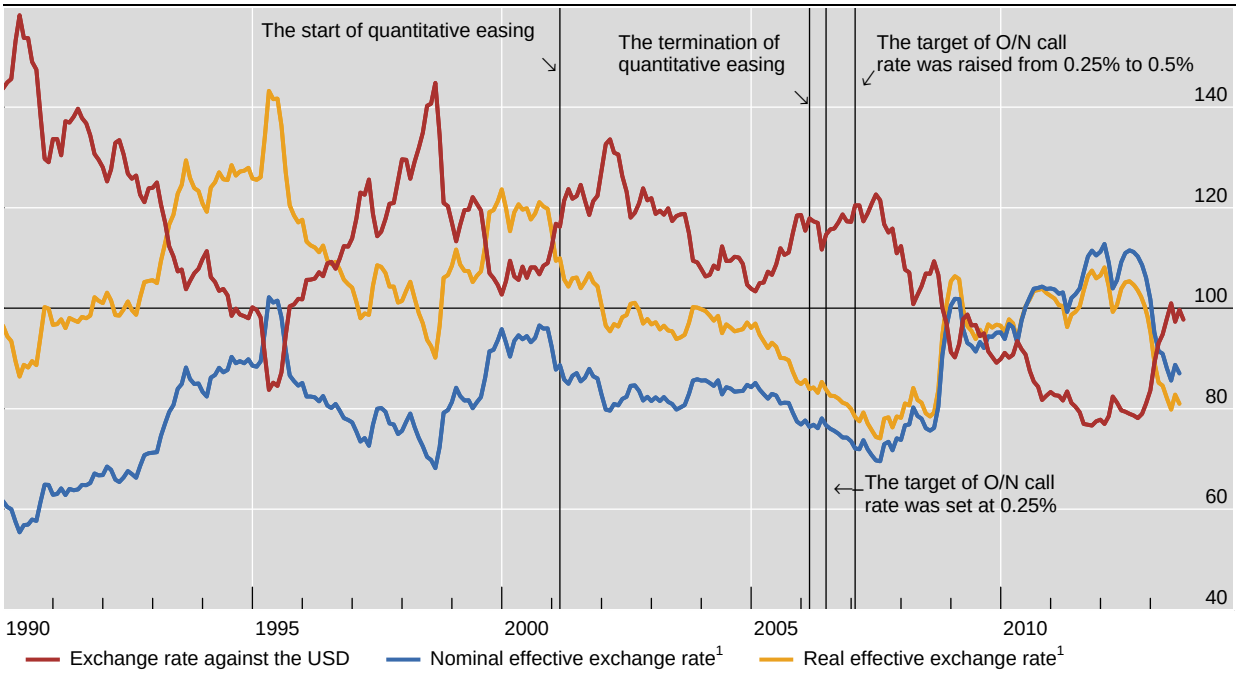
Figure 11



Source: Masaaki Shirakawa, "Toward strengthening the competitiveness and growth potential of Japan's economy", speech at the Executive Member Meeting of the Policy Board of Nippon Keidanren (Japan Business Federation) in Tokyo, 28 February 2013.

Japanese yen exchange rates

Figure 12



[1] BIS narrow index, 2010 = 100.

Sources: Datastream; BIS.

Session 2

Real globalisation and price spillovers in Asia and the Pacific[1]

Raphael A Auer[2] and Aaron Mehrotra[3]

Abstract

In economies and sectors tightly connected by trade linkages, the increased use of intermediate imported inputs could be expected to lead to greater transmission of cross-border cost shocks. This paper presents some results from on-going research investigating cross-border price spillovers to sectoral producer prices within the Asian manufacturing supply chain (Auer and Mehrotra, 2014). Our results suggest that real integration through the supply chain matters for domestic price dynamics.

Keywords: globalisation, inflation, Asian manufacturing supply chain, price spillovers

JEL classification: E31, F62, F14

[1] The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank for International Settlements or the Swiss National Bank. Bat-el Berger, Emese Kuruc and Pierre-Yves Deléamont provided superb research assistance. We are grateful to Eli Remolona, Toshitaka Sekine and James Yetman, as well as other participants at a seminar at the Bank for International Settlements and the People's Bank of China-BIS Research Conference on Globalisation and Inflation Dynamics in Asia and the Pacific, for helpful comments and suggestions.

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Recent research shows that inflation is increasingly a global phenomenon, whereby an important share of the dynamics of domestic inflation are common across economies (eg Borio and Filardo, 2007; Ciccarelli and Mojon, 2010; Monacelli and Sala, 2009; Auer and Sauré, 2013a). In general, inflation co-movement could stem from common shocks to inflation, such as commodity price fluctuations, productivity shocks or simultaneous changes in the conduct of monetary policy (see eg Henriksen et al, 2008; Rogoff, 2003).

The increasingly global nature of inflation has occurred at the same time as economies have become progressively more integrated through international trade in goods and services. Most of the literature on the effects of globalisation on inflation has focused on implications for the advanced economies, treating Asian economies as low-cost exporters that may potentially cause downward pressure on prices in the developed markets (Auer and Fischer, 2010; Auer et al, 2013; Holz and Mehrotra, 2013; Lipińska and Millard, 2012). Such an impact could arise directly through lower import prices, but also through a competitive effect whereby increased openness reduces mark-ups (see, for example, Melitz and Ottaviano, 2008, Atkeson and Burstein, 2008; Chen et al, 2009).

When economies are already closely integrated, the disinflationary consequences of further integration are probably limited. For eight out of 12 economies in Asia and the Pacific, intra-regional trade now accounts for over half of the total international trade.[4] In economies and sectors tightly connected by trade linkages, the increased use of intermediate imported inputs could be expected to lead to greater pass-through of cross-border cost shocks and possibly to more co-movement of inflation rates.[5] This provides another perspective as to how globalisation affects inflation, beyond the impact that arises from more intense import competition.

In ongoing work, we evaluate the cross-border price spillovers to and within the manufacturing supply chains in the Asia-Pacific region (Auer and Mehrotra, 2014), where multi-jurisdiction production structures are particularly important. These supply chains have become a topic of increasing research interest. For example, Baldwin and Lopez-Gonzalez (2013) discuss the global patterns in supply-chain trade, and IMF (2013) finds a positive correlation between participation in global supply chain networks and economic growth. However, the implications for price spillovers, or inflation developments more generally, have not been investigated.

An important source of data for our study is the novel World Input-Output Database that provides detailed information on trade linkages at the sectoral level (WIOD, 2012). Our research builds on the framework by Auer and Sauré (2013b), who construct a theoretical model of the global supply network capturing the channels through which spillovers occur and then estimate equilibrium price spillovers in this network. We document the magnitude of regional price spillovers. More specifically, we quantify the importance of cross-border cost shocks on sectoral producer prices in the manufacturing supply chains in the Asia-Pacific

[4] These are the 12 economies in the region that are members of the BIS: Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore and Thailand.

[5] The importance of imported intermediate inputs in affecting consumer prices is also highlighted by Goldberg and Campa (2010).

region. Our findings highlight the importance of imported intermediate inputs in driving the price changes that arise from supply chain linkages.

This paper motivates and describes our ongoing research work on the topic and related studies. In Section 1, we present the modelling framework and discuss some pertinent data issues. Section 2 presents selected results from our empirical analysis, and Section 3 closes the paper with policy implications.

1. Empirical framework and data issues

The impact of trade linkages on inflation co-movement could in principle be investigated in a cross section of countries, using only aggregate data, thus abstracting from any supply chain linkages. One possibility would be to follow the approach by Mumtaz and Surico (2012). These authors use a factor model to identify the global and country-specific factors driving the inflation process. They then regress these factors on variables such as trade openness.[6]

Indeed, there are theoretical arguments suggesting that trade linkages matter for inflation co-movement. Consider, for example, the two-country open-economy New-Keynesian model by Engel (2011). Home CPI inflation is defined as the weighted average of inflation of home-produced goods and that of foreign-produced goods, with the weights determined by the utility that consumers derive from the consumption of home versus foreign goods (a proxy for openness).[7] Then, under producer currency pricing, there is a mechanical link between foreign consumer price inflation and home inflation, and this link is stronger the more open the home economy is to trade.

But capturing such channels empirically with country-level data is challenging, given the importance of controlling for other factors that could potentially matter for price co-movements, such as monetary policy. There could also be concerns about reverse causality. Such considerations motivate the use of sectoral data. Sectoral data allow us to evaluate the importance of real integration in a *relative* sense, by comparing how price spillovers depend on the intensity with which different sectors use imported intermediate inputs, other things constant. Moreover, the use of sectoral data highlights one possible mechanism through which real integration matters for price spillovers.

While a larger pass-through of shocks is an intuitive outcome for a sector that intensively uses intermediate imports, some elements of the supply chain may actually limit the pass-through. Amiti et al (2012) show, using data for Belgian firms, that large exporters are simultaneously large importers. This diminishes the impact of exchange rate shocks on profits, as import prices move in an opposite direction to that of export revenues. Moreover, the large exporters appear to be the most profitable firms, setting high mark-ups and moving these mark-ups actively in response to cost shocks. Using this argument in a tightly connected supply chain, if external shocks affect import costs and export revenues by roughly similar

[6] In their analysis, money growth emerges as a particularly important explanatory variable for the global inflation factor.

[7] Dynamics of home-produced goods inflation are determined by the excess of real wages over the marginal product of labour, together with an expectations term.

magnitudes, the pass-through to domestic prices may be limited. This ultimately renders the extent of pass-through in a supply chain an empirical question.

An important source of data for our project is the World Input-Output Database that became public in April 2012 (WIOD, 2012; see also Timmer et al, 2013 a and b). The WIOD is basically an extension of the national input-output tables. Its construction was motivated, inter alia, by the aim of analysing the impact of globalisation on trade patterns. Importantly for our purposes, the WIOD specifies the foreign industry in which an imported input was produced. As an example, the database tells us how large a share of the intermediate imports in China's automobile industry originates from the machinery industry in Thailand. Similarly, the WIOD documents how the exports of a country are used, by which foreign industry or by a final end user.

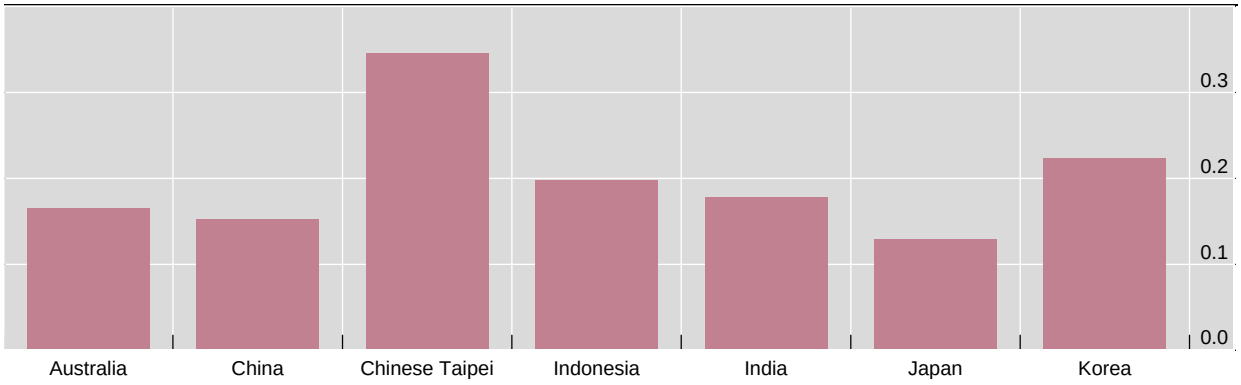
The WIOD covers a total of 40 economies, 27 of which are member states of the European Union, with the sample running from 1995 to the end of 2009. Our focus is on those seven economies in the Asia-Pacific region that are included in the database: Australia, China, Chinese Taipei, India, Indonesia, Japan and Korea.[8] Despite this regional focus, all the WIOD's economies are included in the analysis as trading partners, and their exchange rates affect trade-weighted exchange rate movements of economies in the Asia-Pacific region. This is important, as exchange rate movements are potentially a very important source of cost shocks.

The WIOD data allow us to compute the share of intermediate inputs in the total output of a sector. In addition, using import prices, as well as information on domestic production costs collected by Auer and Sauré (2013b), we can then calculate the cost shares of intermediate imported inputs in a sector's total variable costs. For the mean sector in our data, this cost share is 17%. Computed as averages across the economies, the sectoral intermediate import cost shares are in most cases close to 20%. This means that roughly one fifth of the sectors' variable costs are accounted for by costs of imported inputs. To provide just two examples, the cost share of intermediate imported goods is 16% in the textile and 27% in the computer industry.

Graph 1 shows the intermediate input cost shares in 2008 for the seven economies in the Asia-Pacific region that are included in the WIOD. These are computed as simple averages of the sectoral cost shares, for each economy. The intermediate input cost share in our sample is highest in Chinese Taipei, at 35%. The share of China, at 15%, may at first sight appear relatively low, given the importance commonly attributed to China in the Asian supply chains. However, it is consistent with large economies producing a significant share of intermediate inputs themselves. Indeed, Goldberg and Campa (2010) show evidence for industrialised economies, where the share of intermediate inputs in costs of tradable goods production is lowest for the United States (10%), but exceeds 40% in Austria, Belgium and Estonia, for example.

[8] In WIOD (2012), "Asia and Pacific" is defined as also comprising Russia and Turkey.

Average imported input cost share, 2008 Graph 1



Source: Authors' calculations based on WIOD (2012).

In our framework, as in Amiti et al (2012), the presence of intermediate goods implies that the exchange rate affects the domestic costs of production. Importantly, as in Auer and Schoenle (2013), we allow for variable mark-ups, so domestic prices need not respond fully to cost shocks.

Our empirical framework essentially links changes in costs of production to changes in producer prices in the different sectors. We assume that costs that a firm n faces are comprised of local costs paid in local currencies ($c^L_{n,t}$) and imported intermediate inputs ($c^I_{n,t}$):

$$c^D_{n,t} = c^I_{n,t} + c^L_{n,t} \,. \quad (1)$$

Denoting percentage changes with a hat, and assuming no changes in quantities, costs change if the prices of imported ($p^I_{n,t}$) or local inputs ($p^L_{n,t}$) change:

$$\hat{c}^D_{n,t} = \theta^I_{n,t} * \hat{p}^I_{n,t} + \left(1 - \theta^I_{n,t}\right) * \hat{p}^L_{n,t} + \hat{\epsilon}_{n,t} \,, \quad (2)$$

where $\epsilon^C_{n,t}$ are firm-specific cost shocks and $\theta^I_{n,t}$ is the imported-input cost share, $\theta^I_{n,t} = \frac{c^I_{n,t}}{c^D_{n,t}}$. It is intuitive that the price changes of imported inputs more strongly affect the firms that more intensively use imported inputs. Thus, $\theta^I_{n,t} * \hat{p}^I_{n,t}$ assumes an important role in our results.

$\theta^I_{n,t}$ is constructed using data from the WIOD and other sources. The price index for intermediate imported inputs, $\hat{p}^I_{n,t}$, is from Auer and Sauré (2013b), who construct it using import price indices and information on the sectoral composition of inputs.

2. Some results

Our econometric exercise documents the extent to which domestic producer prices react to changes in the costs of intermediate inputs. The estimated panel specifications include sector fixed effects (k^D_s below) in order to capture any sector-specific changes, such as structural transformation. A specification that is illustrative of our analysis can be written as:

$$\hat{p}^D_{s,t,t-1} = k^D_s + \alpha \widehat{IIPI}_{s,t,t-1} + \beta \theta^I_{s,t} \widehat{IIPI}_{s,t,t-1} + \gamma \theta^I_{s,t} + \hat{\epsilon}_{s,t} \,. \quad (3)$$

The dependent variable, $\hat{p}^{D}_{s,t,t-1}$, is defined as the monthly change in the (log of the) sectoral producer price index of the importer, with *s* denoting the sector. $\widehat{IIPI}$ denotes the change in the intermediate imports price index, and θ^{I} is the intermediate input cost share. Note that in this specification, we interact the sectoral import price index with the sector-importer-specific cost share.

Estimating (3) across the available 40 sector-economy combinations, and 5,996 monthly observations, we obtain an estimate for the interaction coefficient β of 0.34, while α is estimated to be 0.13. What do these coefficient estimates imply? Consider two sectors with input intensities of 0.04 and 0.49, respectively. These correspond to the 5th and 95th percentiles of the imported intermediate input cost share in our sample. When the input intensity amounts to 0.04, a 1% increase in the $IIPI$ will lead to a 0.14% increase in domestic producer prices (0.14% = 0.13% + 0.04*0.34%). But for the sector where roughly half of variable costs stem from imported intermediate inputs, the same increase in the $IIPI$ will lead to a 0.30% increase in domestic producer prices (0.30% = 0.13% + 0.49*0.34%). Therefore, the spillover to domestic prices is over twice as large for the sector that intensively uses imported intermediate inputs.

We also consider specifications where the imported intermediate price index is replaced by the trade-weighted exchange rate, computed for each sector. Such a specification is of interest, as it implicitly takes into account the fact that inputs are priced to market and thus do not co-move one-to-one with the exchange rate (as documented in Fauceglia et al, 2013). It also allows us to extend the sample. Indeed, not all the Asia-Pacific economies included in the WIOD publish sectoral import price indices, but they all publish sectoral producer prices. Moreover, from an economic perspective, these specifications capture the notion that it is exchange rate fluctuations that are largely behind movements in the intermediate import prices, and those changes then lead to fluctuations in sectoral producer prices.

The results with the exchange rate variable are generally consistent with those presented with the $IIPI$ as in equation (3) above. In particular, the interaction between the exchange rate and the input cost share again appears with an economically and statistically significant coefficient. This implies that external shocks that affect the trade-weighted exchange rate have the strongest impact on producer prices in those sectors that more intensively use imported intermediate inputs in production.

Note also that the model presented in (3) does not contain any lagged variables on the right-hand side. But if there is nominal price stickiness of any sort, such as that resulting from menu costs, it is likely that any changes in costs only have a lagged impact on sectoral producer prices. Then, a better representation of the interaction between the variables is likely one where lags of the right-hand variables are included. In Auer and Mehrotra (2014), we document for example that when six months of lags are considered, imported input use can explain over half of the estimated correlation between exchange rate changes and producer price movements for the mean sector in our data.

In general, our results should be regarded as approximating the first-round impacts of external cost shocks on domestic producer prices. At the same time, we are able to control for some second-round effects that are important, such as firms switching the sources of imports when intermediate goods originating from a trading partner become more expensive. We do not, however, capture the second-round network effects with our empirical approach.

3. Conclusion and policy implications

In ongoing research, we examine the evidence for cross-border price spillovers among economies participating in the Asian manufacturing supply chain (Auer and Mehrotra, 2014). In our framework, the presence of imported intermediate goods implies that the exchange rate affects domestic costs of production. Moreover, mark-ups are variable, so firms may not fully pass cost shocks through to prices. In the empirical analysis, we evaluate the extent to which domestic producer prices react to changes in costs of imported intermediate inputs.

In the sectoral analysis, we draw on the novel World Input-Output Database that provides detailed data on sectoral trade linkages in the region. We show that the share of imported intermediate inputs in total variable costs is roughly 17% on average for the seven Asia-Pacific economies for which data are available in the WIOD database. We also show that the impacts through higher costs of imported intermediate inputs on domestic producer prices are statistically and economically significant for economies participating in the supply chain. A crucial role is played by the importance of imported inputs as a fraction of a sector's total variable costs.

But a focus on sectoral prices could also be seen to limit the applicability of the results, as the implications for aggregate inflation are not explicitly investigated. Do the cross-border spillovers on *sectoral* producer prices matter for policymakers? If only relative prices are affected, there need not be any impact on aggregate inflation. In the presence of menu costs, Ball and Mankiw (1995) argue that if the relative price shocks are large and affect the distribution of relative price changes, they will have an impact on aggregate inflation.[9] On the other hand, Bryan and Cecchetti (1999) provide evidence that the sample mean-skewness correlation suffers from small sample bias.

An interesting question is whether supply chains have led to greater inflation volatility in the Asia-Pacific region. We provide some first evidence for this in Auer and Mehrotra (2014), as we find that it is large cost shocks that matter for producer prices, whereas small shocks do not. This would imply that during times when the cross-border shocks are large, perhaps during periods of great exchange rate volatility, supply chains could act as shock amplifiers in the region. A related issue is the implication of exchange rate volatility for trade within the supply chain. Using data for Asia, Tang (2011) finds that exchange rate volatility is particularly harmful for trade in intermediate goods. But further research is needed to investigate these questions.

In sum, our results suggest that real integration through the supply chain matters for domestic price dynamics in the Asia-Pacific region.

[9] Sekine (2009) and Auer and Fischer (2010) provide evidence about the disinflationary influence of large relative price shocks as a result of globalisation.

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Comments on Raphael Auer and Aaron Mehrotra's paper

Toshitaka Sekine[1]

Relationships with the existing literature

In this paper, the authors have examined impacts of globalisation in the form of closer integration of trade. Specifically, they show (i) the inflation rates of Asian and Pacific countries have come to co-move more closely and (ii) the domestic inflation of these countries has become more sensitive to overseas factors. These questions are highly relevant for the Asia-Pacific region where trade integration has been rapid.

In the literature, a number of papers discuss the impacts of globalisation including a chapter of the latest World Economic Outlook (IMF, 2013). The structure of these papers can be broadly summarised as follows:

- First, the papers define "globalisation" as a process of ***trade integration*** or that of ***financial integration***.
- Second, they examine impacts on various variables such as ***output growth***, ***inflation*** and/or ***asset prices***.
- Finally, typical questions asked are (i) whether globalisation has made these variables ***co-move*** more closely, (ii) whether globalisation has made these variables more sensitive to ***overseas factors***, or (iii) whether globalisation has raised or reduced ***volatilities*** of these variables.

This paper fits into this pattern such that:

- It defines globalisation as a process of ***trade integration***
- It focuses on impacts on ***inflation***
- It tests the first two questions (***co-movement*** and ***overseas effects***), but not the last one (***volatility***).

Main comments

The first comment is related to co-movement. One of the tests the authors use is a panel co-integration test, which takes an error correction form of this type:

$$\Delta^2 p_{it} = \alpha(\Delta p_i - \Delta p_j)_{t-1} + \phi t + u_t$$

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If α is significantly negative, then the deviation between inflation in country i and that of country j is supposed to be corrected in the long run. That is, they have a tendency of co-movement. The authors find that this is the case for the sample period of 1992–2012, but not for 1980–91. This is consistent with a hypothesis that, because of globalisation taking place since the 1990s, the inflation rates of sample countries have come to show a greater degree of co-movement.

In this regard, the authors could more carefully treat an underlying assumption of the co-integration test. If they claim inflation rates are co-integrated with each other, they implicitly assume that these inflation rates are I(1) variables. Then, first, the authors need to check that assumption itself by unit root tests. Second, if that is really the case, the authors should address an issue of consistency with the other regressions in the paper, which implicitly assume inflation is I(0). Third, in order to avoid this sort of comment and also for the sake of a robustness check, the authors might instead estimate a dynamic common factor model such as that outlined in Ciccarelli and Mojon (2010).

The second comment is regarding impacts from overseas economies. The following two equations are key findings of the paper.

$$\Delta ppi_{i,n,t} = 0.128^{***}\Delta iipi_{i,n,t} + 0.342^{***}\Delta iipi_{i,n,t}\theta_{i,n,t} + 0.0127\theta_{i,n,t} \quad (1)$$

$$\Delta ppi_{i,n,t} = -0.0138\Delta exr_{i,n,t} + 0.157^{***}\Delta exr_{i,n,t}\theta_{i,n,t} \quad (2)$$

These equations come from specifications (2) in Table 4 and (5) in Table 5. Pooling all data for sample countries in the region and all sample industries, the authors find the coefficients on interaction terms positive and statistically significant, which means that pass-through from import prices or exchange rates becomes larger, when trade share θ takes higher values.

In this respect, in addition to pooled results, the authors could provide estimates of individual countries or industries (perhaps using SURE) and compare key coefficients. Pooled estimates give coefficients as an average across all countries and all industries. From a policymaker's point of view, however, it would be much more interesting to see what these coefficients of each country look like compared with others, because this might give us more insights such as why they are different, if there are differences. This cross-country comparison would also work as a robustness check. In a similar vein, it would also be interesting and prudent to conduct cross-industry comparison, given the heterogeneity of the sample industries.

The third comment is whether the authors could extend their analysis to an issue of volatility. As seen above, some studies in the literature examine whether globalisation has raised or reduced the volatility of a variable of interest. If we applied the same thought, then a question could be something like whether the Asian supply chain network has increased or contained volatility of inflation in the region.

In the case of globalisation in terms of financial integration, its impacts on volatilities of financial asset prices are supposed to be non-linear. For instance, Haldane (2013) said recently "Within limits, connectivity acts as a shock-absorber. … But when shocks are sufficiently large, the same connectivity serves as a shock-transmitter. Risk-sharing becomes risk-spreading."

If we can apply the same logic to trade integration in the region, then it might be the case that during normal periods, the volatility of inflation is reduced by a

shock-absorbing mechanism, whereas during abnormal periods, volatility is amplified by a shock-transmitting mechanism.

In fact, volatility is closely related to pass-through. Suppose we run a regression of a less volatile series on a quite volatile one, then we get a smaller coefficient. If we suppose that trade integration has reduced the volatility of inflation during normal times, then the pass-through coefficient becomes smaller. This corresponds to the case of footnote 6 of the paper to the effect that "a supply chain may decrease the sensitivity of prices to exchange rate changes." Furthermore, if trade integration has increased volatility of inflation during abnormal times, then the pass-through coefficient becomes larger. Specifications (7) and (8) in Table 6, in fact, seem to indicate this nonlinearity.

As such, if the authors could extend an issue of globalisation to cover volatility of inflation, then they could provide another interpretation of pass-through.

More about pass-through

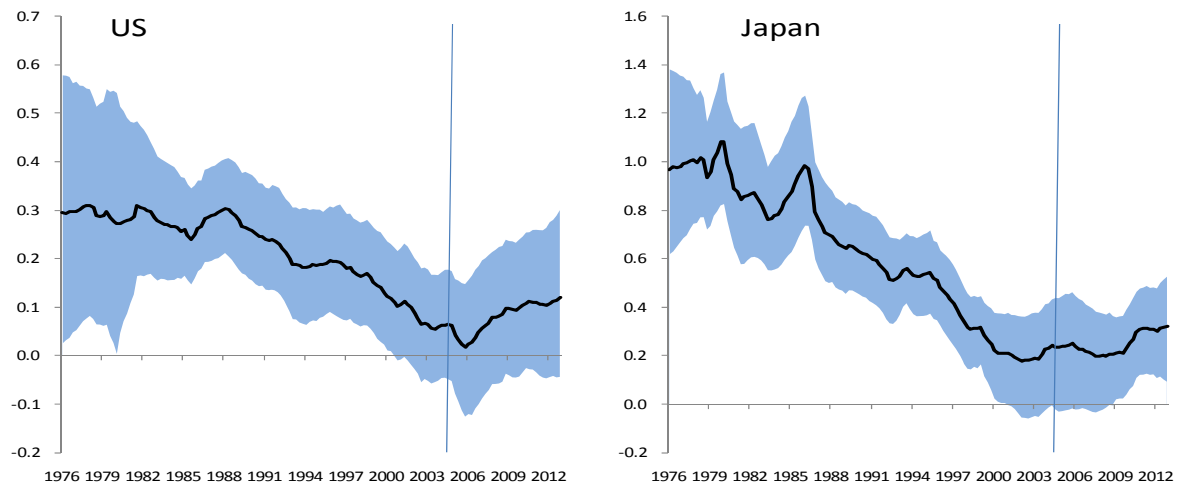
When we talk about pass-though, presumably we have various stages of pass-through in our mind, along a chain of price setting such that a change in exchange rates feeds into import prices, then to producer prices and finally to consumer prices. Equations (1) and (2) above can be interpreted as pass-through from either import prices or exchange rates to producer prices.

Related to this issue, using data up to 2004 and employing a then exotic estimation technique of a time-varying parameter model with stochastic volatility, Sekine (2006) estimated the pass-through of advanced economies, where first stage pass-through is defined as that from exchange rates to import prices, and then second stage pass-through as that from import prices to consumer prices.

Figures 1 and 2 are updates of first and second stage pass-through for the United States and Japan, both of which are located in the Asia-Pacific region and have experienced the rapid globalisation of trade integration.

First stage pass-through

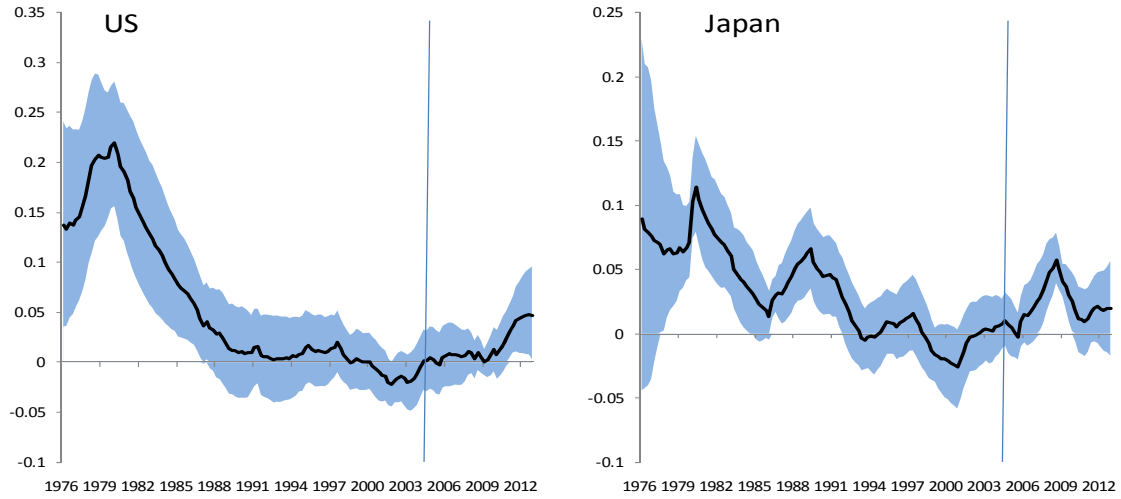
Figure 1



Note: The shaded areas indicate 25th/75th percentile ranges (same as Figure 2).

Second stage pass-through

Figure 2



The vertical lines correspond to 2004, which is the end of the sample period in Sekine (2006). Up to that time, pass-through had declined. Although we need to be extremely careful in reading end-point estimates of time-varying parameter models, after the middle of the 2000s, there are some rebounds in both countries. This is consistent with Shioji (2014), who also finds that exchange rate pass-through has rebounded in Japan in recent years.

Then the natural question is why pass-through has rebounded. A recent rebound would suggest inflation has become less firmly anchored because of greater trade linkage, as argued by the authors. Or it might be because monetary policy has become less inflation-centric, since the central banks in these countries are busy dealing with the aftermath of the Lehman crisis and the implementation of all kinds of unorthodox monetary policy.

Depending on which view is taken, the policy implications may differ. In the former view, pass-through will not come down unless trade integration is reversed. In the latter view, presumably pass-through might come down once these central banks are able to exit from their unorthodox monetary policy.

Summing up

The paper is very good and very carefully crafted. It raises many interesting and important questions including a discussion of how to interpret the recent rebound in exchange rate pass-through.

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Responding to exchange rates in a globalised world

Michael B Devereux and James Yetman[1]

Abstract

How should monetary policy respond to nominal exchange rates? How does this change as economies become increasingly globalised? In this paper, we address these questions for Asia, focusing on structural changes that may influence the optimal policy response to exchange rates. We also summarise some new results based on an analytical model outlined in Devereux and Yetman (2014b) designed to address these issues. We show that sterilised intervention can be a potent tool that offers policymakers an additional degree of freedom in maximising global welfare. We illustrate how the gains to sterilised intervention can be sensitive to various aspects of goods and financial market structure. When financial internationalisation is high, the gains to sterilised intervention fall. And at the limit of perfect financial integration, the gains from sterilised intervention are entirely eliminated. Unsterilised intervention may also have a role to play, and may continue to work even in cases where sterilised intervention is rendered ineffective.

Many central banks in Asia have actively used sterilised foreign exchange intervention as a policy tool for smoothing exchange rate movements. This is a policy that appears to have served the region well. But, over time, structural changes in the region, including increased goods market integration, declining exchange rate pass-through and ongoing internationalisation of financial markets are likely to reduce the efficacy of sterilised intervention. More generally, these structural changes may call into question the appropriate role of exchange rates in monetary policy setting in the region.

Keywords: globalisation; foreign exchange intervention; exchange rate pass-through.

JEL classification: E58, F62.

[1] The opinions in this paper are those of the authors and are not necessarily shared by the Bank for International Settlements. We thank Lillie Lam, Pablo Garcia-Luna, Giovanni Sgro and Bat-el Berger for excellent research assistance and Aaron Mehrotra for helpful comments. Conference participants at the PBC-BIS conference on "Globalisation and Inflation Dynamics in Asia and the Pacific", and especially our discussant, Ippei Fujiwara, provided valuable input. Any remaining errors are solely our responsibility.

Introduction

How should central banks respond to exchange rate changes? Across the Asia-Pacific region we see a wide variety of responses. For example, in Australia and New Zealand, the exchange rate is allowed to float relatively freely and the central banks hold low levels of foreign exchange reserves. At the other extreme, Hong Kong SAR enjoys a de facto fixed exchange rate due to its currency board mechanism, and domestic monetary policy is effectively subordinated to maintaining a stable external value of the currency relative to the US dollar. But for most of the other economies in the region, monetary authorities appear to lean against changes in the exchange rate using foreign exchange intervention. Further, as we will see, this intervention appears to have been effectively sterilised: significant growth in foreign currency assets on the balance sheets of central banks has not coincided with any corresponding change in domestic currency in circulation, or a loss of domestic inflation control.

There is a considerable literature that addresses the role of stabilising exchange rates in an optimal monetary policy framework.[2] For example, Taylor (2001) reviews the literature on including the exchange rate in monetary policy reaction functions and finds that this can result in only modest improvements (or even a deterioration) in terms of output and inflation outcomes in standard small open economy macro models. Garcia et al (2011) argue that a central bank response to exchange rates may be desirable, especially in financially vulnerable economies. Sutherland (2005) shows that the optimal variance of exchange rates depends on a variety of factors, including the degree of pass-through, the size and openness of the economy, the elasticity of labour supply and the volatility of foreign producer prices.

Engel (2011) argues that, in a model with currency misalignments, monetary policy should respond to those misalignments. Currency misalignments cause inefficient outcomes because home and foreign households pay different prices for the same goods. Responding to exchange rates can then play a role in reducing the cost of that distortion. Corsetti and Pesenti (2005) argue that using monetary policy to reduce exchange rate volatility may be welfare-enhancing, even if it leads to increased output gap volatility. This is because risk-averse foreign exporters are likely to reduce average mark-ups in response to decreased exchange rate volatility. And Devereux (2004) demonstrates that, in a world with nominal rigidities, perhaps due to incomplete international financial markets, then, even if a flexible nominal exchange rate would serve as a perfect shock absorber, fixed exchange rates may be preferable. Effectively, flexible exchange rates can lead to inefficient output responses to demand shocks in that output may be too stable.

Returning to Asia, working to stabilise the external value of the currency appears to have served many economies in the region well. In this paper, we question whether that is likely to continue to be the case in future. First, we provide evidence that many central banks in the region have actively used sterilised intervention. Second, we discuss various structural changes that are occurring in the region that may affect the benefits of stabilising exchange rates, or the costs of the tools required to achieve that policy end. Third, we summarise some results from a

[2] See Mussa et al (2000) for a summary of the various factors that may influence the optimal choice of exchange rate regime.

recent paper (Devereux and Yetman, 2014b) that we have developed to address these issues. Finally, we conclude.

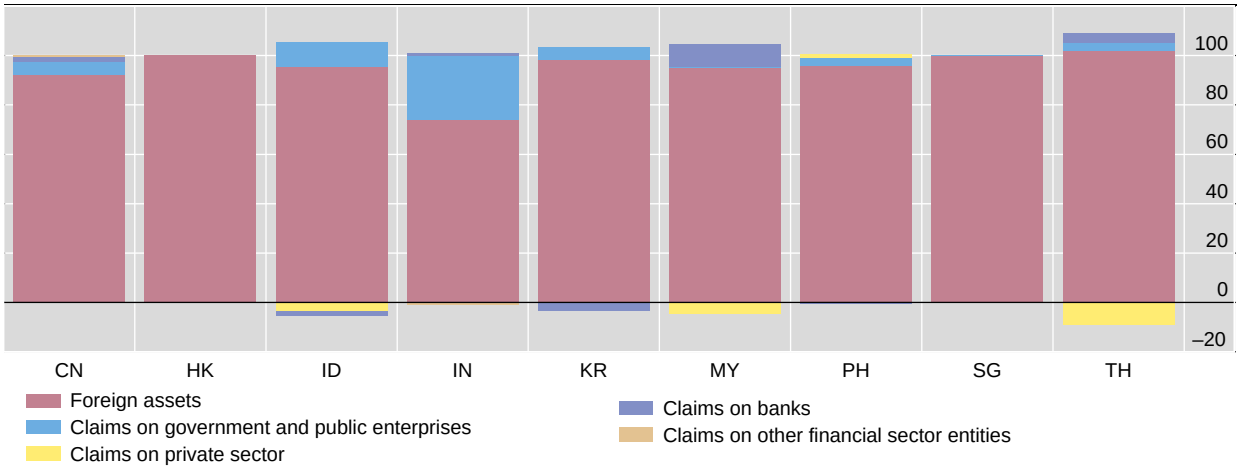
How have central banks in Asia responded to exchange rates?

In many Asian economies, a common response to exchange rate fluctuations has been foreign exchange intervention, intended to smooth the path of exchange rates. In some cases, the policy response to exchange rates has been found to exceed the response to either inflation or the output gap (Mohanty and Klau, 2004). In a recent paper, Filardo et al (2011) provide a summary of how emerging market economy central banks respond to exchange rates and report that central banks managed the value of their currencies more actively in the aftermath of the international financial crisis than before.

Perhaps the most important policy tool used to stabilise exchange rates in Asia has been direct intervention in foreign exchange markets. One consequence of this is the massive expansion of foreign exchange reserves on central bank balance sheets in the region. The overall size of the central bank balance sheet has increased dramatically over the past decade, and lies at around 100% of GDP in the case of Hong Kong SAR and Singapore, and more than 30% of GDP in China, Korea, Malaysia, the Philippines and Thailand. Changes in foreign exchange reserves account for nearly all of the change in the size of the overall central bank balance sheet for these economies (Graph 1).

Change in composition of central bank assets in emerging Asia, 2002–12

As a percentage of change in total assets — Graph 1



CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; KR = Korea; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand.

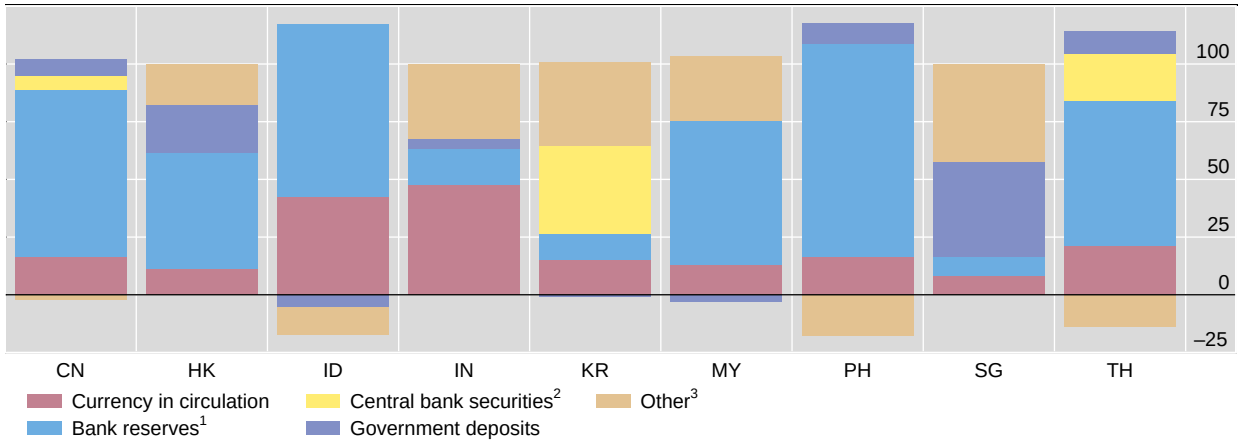
Source: IMF *International Financial Statistics*.

The accumulation of foreign exchange reserves must be financed in some way. We can determine how this takes place by looking at the other side of the balance sheet, to see the corresponding changes in liabilities that coincide with the asset growth. As shown in Graph 2, only a small portion of the increase in foreign

exchange reserves has been financed via an increase in the amount of currency in circulation. Instead, increased required reserves and the issuance of sterilisation instruments have been used to effectively sterilise the effects of the increase in foreign exchange reserves, allowing policymakers to maintain domestic monetary control.[3] Hence, despite the large increases in the size of the balance sheet, there appears to have been no loss of domestic monetary policy control. Indeed, the period since the Asian financial crisis may be accurately described as a period of relatively high and stable growth and low inflation for the region as a whole.

Change in composition of central bank liabilities in emerging Asia, 2002–12

As a percentage of change in total liabilities — Graph 2



CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; KR = Korea; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand.

[1] Reserves and deposits of banks. [2] Central bank bonds and securities. [3] Including other liabilities (foreign liabilities, loans and other net items) and equity capital.

Source: IMF, *International Financial Statistics*.

Going forward, one possibility would be for policymakers to continue with past practice, and lean against any ongoing exchange rate pressures with foreign exchange intervention. However, there are reasons to believe that this may be becoming a less attractive policy option. First, the already large holdings of foreign exchange reserves are very costly to the central banks in the region, and are only likely to become more so as they grow larger, as would occur if appreciation pressures remain dominant.

Table 1 offers a simple illustration of the possible costs of large reserves, under the simplifying assumption that all reserves are held in short-term US treasury bills and are financed (or, equivalently, sterilised) via the sale of short-term sterilisation bills with an interest cost equal to the domestic deposit rate.[4]

One component of this is carrying (or sterilisation) costs. Typically, domestic interest rates in Asia are higher than the yields central banks earn on their reserves. The difference between these two is a loss to the central bank, and may be as much

[3] See the discussion in Filardo and Yetman (2012).

[4] See also the discussion in Cook and Yetman (2012).

as 1.2% of GDP per year for some economies. Another, potentially much larger, cost could result from an appreciation in the domestic currency. For illustrative purposes, the table considers a 10% appreciation against the basket of currencies that reserves are held in and indicates that the mark-to-market losses as a percentage of GDP for the central banks in the region would be considerable. As a comparison, the table also displays central bank equity, which is available to absorb central bank losses, again as a percentage of GDP, and illustrates that this is low relative to potential losses in many cases. While a central bank can in principle continue to operate with low, or even negative, capital, this is unlikely to be desirable in the long run. More importantly, any loss on the central bank's balance sheet that results from excessive foreign exchange reserves may be viewed as a loss in welfare to society.

Estimates of sterilisation costs and valuation losses from domestic currency appreciation

As of December 2012 Table 1

	FX reserves (USD billions)	Deposit rate (%)	Central bank equity[1, 2]	100% sterilisation cost[1, 3]	Valuation loss for a 10% appreciation of domestic currency (%)[1]
AU	44.94	3.17	0.13	0.10	0.29
CN	3331.12	3.78	0.04	1.11	4.04
HK	317.23	0.40	31.17	–0.31	12.30
IN	270.59	8.74	0.07	0.73	1.39
ID	106.04[4]	4.92	2.02	0.64[4]	1.18[4]
JP	1227.15	0.28	0.00	0.05	2.05
KR	323.21	2.89	0.88	0.90[4]	2.81
MY	137.75	3.21	0.01	1.22	4.48
NZ	17.58	2.64	1.30	0.39	1.05
PH	73.48	0.83	0.55	0.89	3.05
SG	259.09	0.31	20.49	–0.12	9.67
TH	173.33	2.93	2.61	0.98	4.60

[1] As a percentage of nominal GDP. [2] Capital and reserves for AU and NZ; provisions and other liabilities for SG; net worth or own capital for others. [3] Assumes entire FX reserve is invested in one- to three-year US government bonds and the funding rate is the domestic deposit rate. [4] As of September 2012.

Sources: IMF, *International Financial Statistics*; Bloomberg; Datastream; BIS calculations.

The second reason to reconsider the historical response to exchange rates is that the region is undergoing structural change. As a result, policy measures that were effective in the past may become less so in future. In the next section we will outline the nature of some of these structural changes, before we discuss some results from a model that we have developed to analyse their effect on monetary policy.

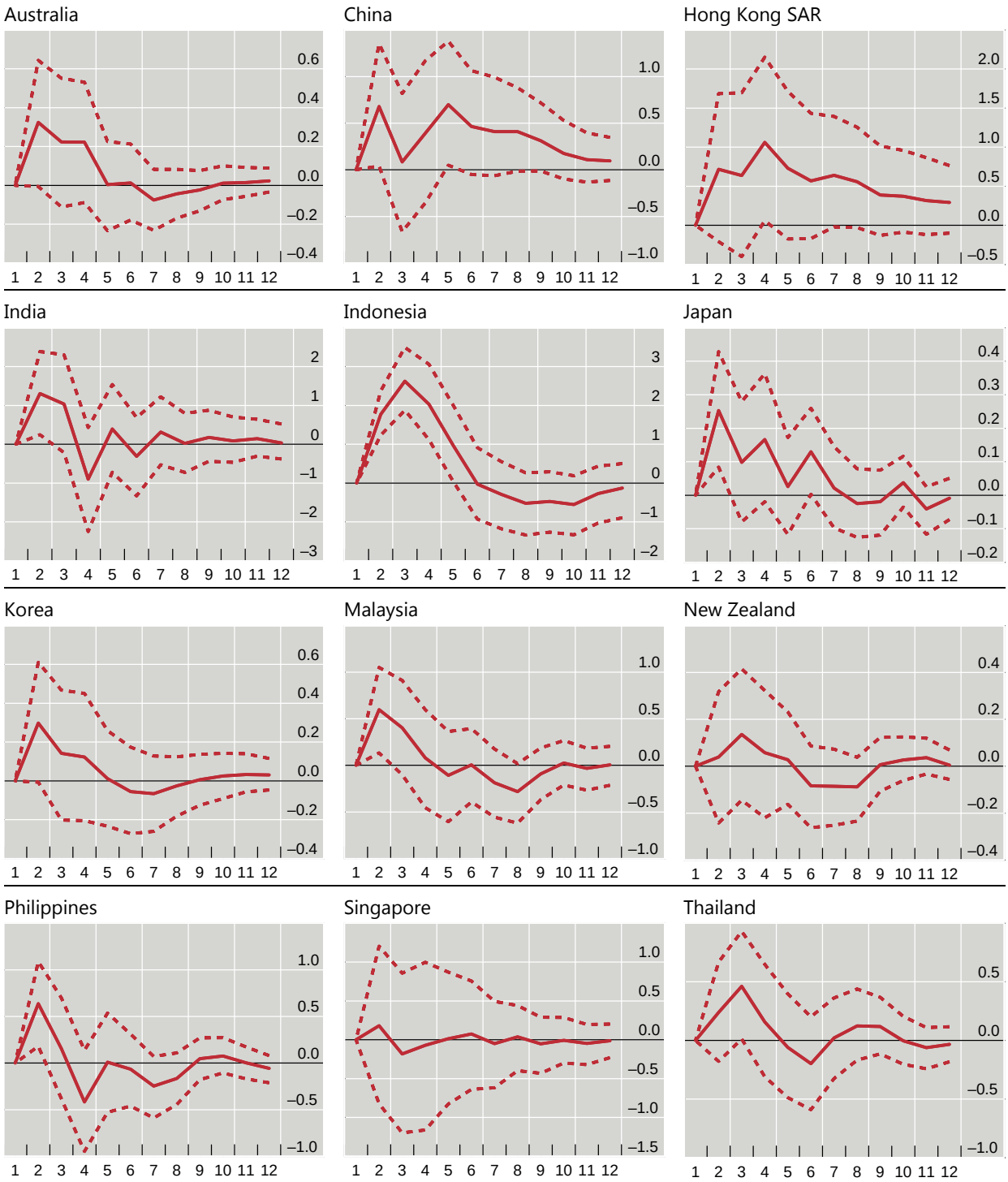
The evolution of emerging Asian economies

Recent decades have witnessed a wide range of changes in the structure of Asian economies. Four factors are of particular relevance to the traditional desire by central banks in the region to stabilise nominal exchange rates.

Impulse response of CPI inflation to NEER shock

10% depreciation

Graph 3



Vertical axis in per cent. Dashed lines display 80% confidence bands.

Source: Authors' estimates.

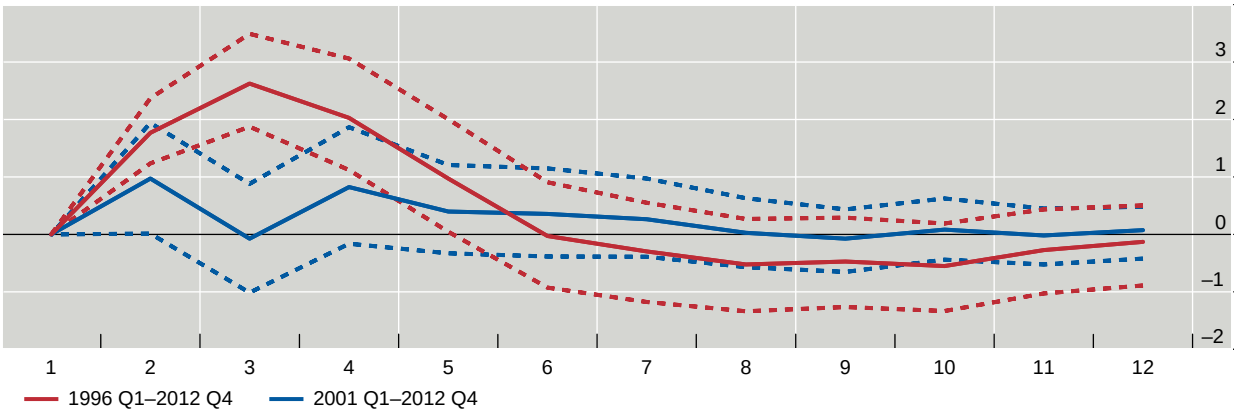
First, exchange rate pass-through to inflation appears to now be low. We provide evidence for this in Graph 3. We estimate a simple vector autoregression,

economy by economy, on quarterly data, consisting of real GDP growth, inflation, the change in the policy rate and the change in the nominal effective change rate, in that order.[5] We also include four seasonal dummies and three lags. The model is identified by orthogonalising the reduced-form errors by means of a Choleski decomposition of the variance-covariance matrix. We then compute the impulse response of inflation, in per cent, to a 10% depreciation shock to the nominal effective exchange rate. We use Monte Carlo methods and plot, in the graph, the median projection along with the 10th and 90th percentiles (as confidence bands), for the longest period for which all our data are available.[6]

The results suggest that exchange rate pass-through for many economies in Asia-Pacific has been low for some time. The point-estimate of the peak increase in inflation following a 10% depreciation in the nominal effective exchange rate is 0.7% or lower for most economies. The only exceptions are Hong Kong SAR (1.1%), China (1.3%) and Indonesia (2.6%). However, the relatively high rate of pass-through in Indonesia is driven entirely by observations around the time of the Asian financial crisis. If we instead start the data sample in 2001, the peak increase in inflation drops to 1.0% (Graph 4).

Exchange rate pass-through in Indonesia

Response of CPI inflation to a 10% depreciation shock to the NEER; different sample periods — Graph 4



Source: Authors' estimates.

We are not the first to question the received wisdom that exchange rate pass-through remains much higher in emerging market economies than in advanced economies. Brun-Aguerre et al (2012), for example, find that short-run pass-through in emerging market economies is low and close to that for advanced economies.[7]

[5] Our variables are defined as the quarter-on-quarter change in the log of the level for real GDP, the CPI and the nominal effective exchange rate, and the change in the level for the policy rate.

[6] Sample periods vary between 1994Q1–2012Q4 (Australia, China, Hong Kong SAR, Japan, Korea, Malaysia, Philippines, Thailand), 1994Q1–2012Q3 (New Zealand, Singapore), 1996Q1–2012Q4 (Indonesia) and 1996Q2–2012Q3 (India).

[7] See, also, Ca'Zorzi (2007) and Mihaljek and Klau (2008).

The literature offers a number of possible explanations for declining exchange rate pass-through that are likely to apply in the Asian context. For example, improved inflation control, leading to declines in both the level and volatility of inflation, is associated empirically with lower levels of exchange rate pass-through, as prices become more sticky (Devereux and Yetman 2010; Choudry and Hakura, 2006; Gagnon and Ihrig, 2004).[8] For Asian economies with a history of high inflation, the improvement in inflation outturns has been substantial. Average inflation in China and Indonesia, for instance, declined by almost one half from 1993–2002 to 2003–12. Hong Kong SAR, Korea, Malaysia, the Philippines and Thailand have also seen substantial, although smaller, declines in inflation between these same two periods.[9]

Changes in the composition of import bundles are also likely to play an important role in the decline in pass-through. The elasticities of pass-through for manufactured goods and food products are generally lower than for commodities and energy, as Campa and Goldberg (2005) argue. Choi and Cook (2013) provide industry-level evidence that suggests that increased concentration on final goods trade helps to explain low exchange rate pass-through in Asia. Wealth increases in the region may have seen changes in import patterns towards goods that typically exhibit low levels of pass-through.

The upshot of declining pass-through is that the effectiveness of exchange rate control as a policy lever may be declining, for two reasons. First, declining pass-through implies a weakening link between exchange rate stability and inflation stability. To the extent that exchange rate movements are a source of macroeconomic volatility, then, less exchange rate pass-through reduces the domestic macroeconomic benefits from stabilising the exchange rate. And second, where exchange rates are actively used as a tool for domestic business cycle management to offset other shocks, if domestic prices fail to adjust, there will be little expenditure-switching in response to exchange rate changes, as Devereux and Engel (2003) discuss. Adjusting the exchange rate in response to shocks in a low pass-through environment will have smaller effects on the demand for domestically produced goods than in a high pass-through environment.

A second changing dynamic that may influence the role of the exchange rate is the ongoing integration of goods markets. Graph 5 illustrates the growth in trade volumes over time. One consequence of this is that consumption bundles are becoming increasingly similar across economies over time. As we will see, the mechanics of international risk-sharing depend in part on the degree to which consumption bundles overlap between economies.

A third characteristic that may be important for the policy trade-offs that central banks face between exchange rate stability and inflation control is the

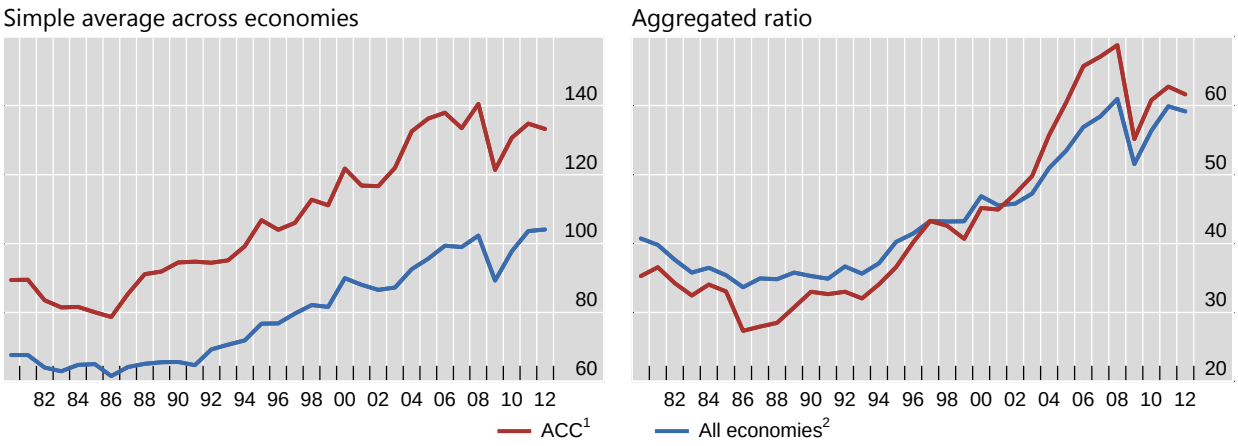
[8] Care should be taken in giving a decline in pass-through a structural interpretation, however. Improved inflation outcomes are likely to present as evidence of declining pass-through regardless of any underlying structural changes. This is because, the more stable inflation is, the less correlated inflation will tend to be with any potential explanatory variables, including exchange rates, as Parsley and Popper (1998) argue. Similarly, Reyes (2007) argues that successful currency intervention to smooth exchange rate changes may result in the appearance of reduced pass-through, even if pricing behaviour is unchanged.

[9] A related potential cause of declining pass-through is less volatile exchange rates. Brun-Aguerre et al (2012) find that pass-through is higher in response to large exchange rate shocks than small ones.

increasing degree of financial internationalisation. One simple metric of this is gross investment positions as a share of GDP, given in Graphs 6A and 6B. Without question, these have grown dramatically in recent years, in spite of a noticeable correction at the time of the international financial crisis. Further, in the latest available data, gross international positions as a share of GDP are at all-time highs for most regional economies.

Trade integration

Imports and exports of goods and services as a percentage of GDP — Graph 5

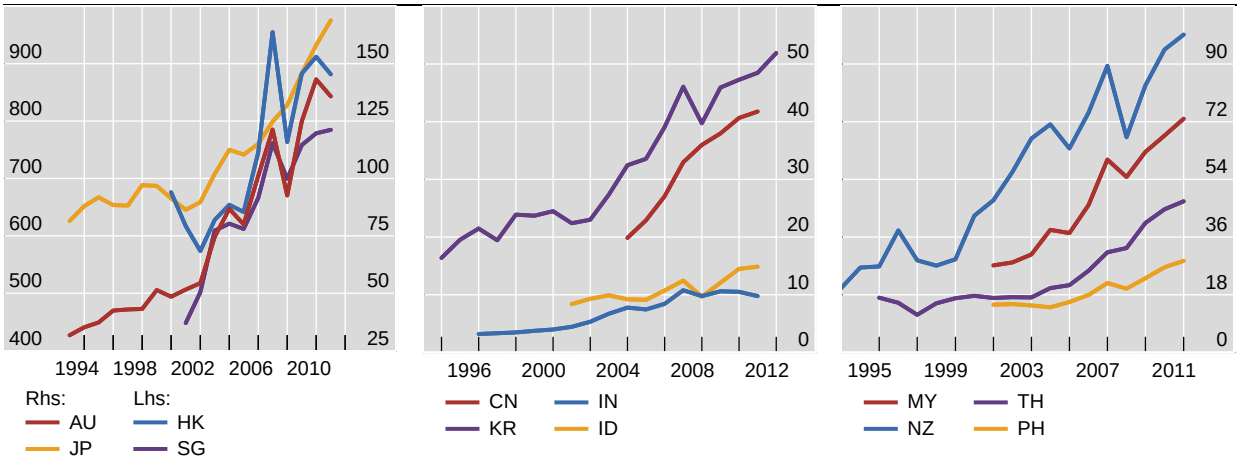


[1] BIS Asian Consultative Council: Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore and Thailand. [2] Aggregation of 50 major economies.

Source: IMF, *World Economic Outlook*, April 2013.

International investment position

Gross assets as a percentage of GDP at PPP exchange rate — Graph 6A



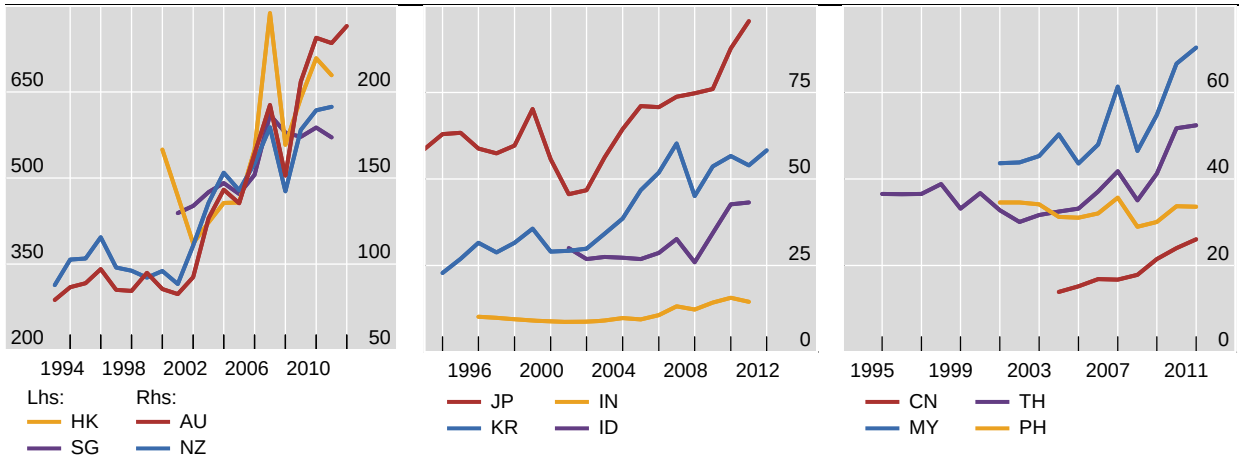
AU = Australia; CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MY = Malaysia; NZ = New Zealand; PH = Philippines; SG = Singapore; TH = Thailand.

Source: IMF *International Financial Statistics*; IMF *World Economic Outlook*; CEIC.

The international links between banking systems globally, based on BIS data and illustrated in Graph 7, tell a similar story. The size of the circles is proportional to total cross-border positions of banks in a given geographical area, and the thickness of the lines proportional to the cross-border positions between regions where at least one of the counterparties is a bank. "Asia-Pac" refers to China, Chinese Taipei, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines and Thailand. "Asia FC" consists of Hong Kong SAR, Macau SAR and Singapore.

International investment position

Gross liabilities as a percentage of GDP at PPP exchange rate — Graph 6B



AU = Australia; CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MY = Malaysia; NZ = New Zealand; PH = Philippines; SG = Singapore; TH = Thailand.

Source: IMF *International Financial Statistics*; IMF *World Economic Outlook*; CEIC.

The Asia-Pacific region has seen a substantial increase in the size of cross-border positions over time. And while there was a pull-back in the aftermath of the international financial crisis, as with gross investment positions, the strength of current links involving banks are at, or near, all-time highs.

Devereux and Sutherland (2008) examine whether increased international asset positions in themselves influence optimal monetary policy. After all, when international positions are large, exchange rate movements may have considerable wealth effects. However, they show that when large asset positions are the result of efficient portfolio choices, so that the increase in asset positions represents an increase in international risk-sharing, movements in the exchange rates are an important ingredient in ensuring the optimal sharing of risk. Then large international positions per se do not support the need for exchange rate stability.

More generally, however, our graphical evidence is suggestive that the economies in emerging Asia are increasingly internationalised and integrated into global financial markets. One practical implication of this is that the scope for policymakers' use of sterilised foreign exchange intervention to stabilise exchange rate movements may be becoming more limited. Indeed, in the limit, if financial markets are fully integrated and asset markets are complete, the implications of the policy trilemma are likely to become stark.

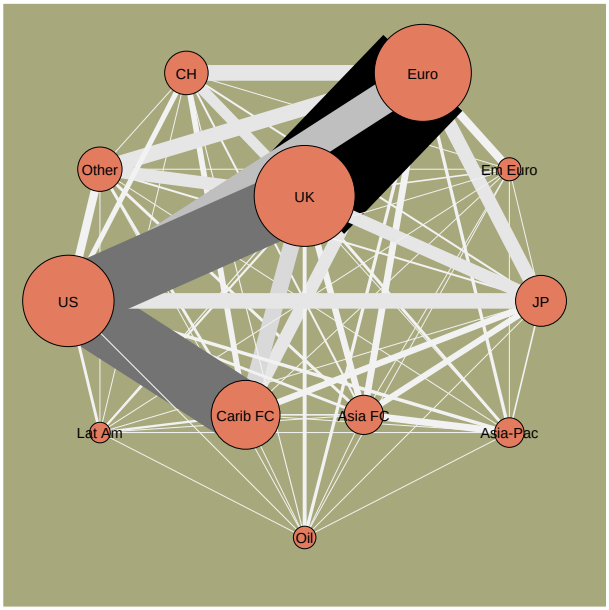
While such a stylised model of efficient markets and full risk-sharing is unlikely to match reality, the underlying principle of reduced effectiveness of foreign

exchange intervention as financial internationalisation increases is likely to be a practical constraint on policymakers' actions. Effectively, central bankers may still be able to influence exchange rates as financial internationalisation increases, but not without having to sacrifice some degree of domestic monetary control. In practical terms, as we will later model, increased financial openness reduces the possibility of sterilised intervention – where the exchange rate can be controlled without changing domestic interest rates – while leaving open the possibility of unsterilised intervention.

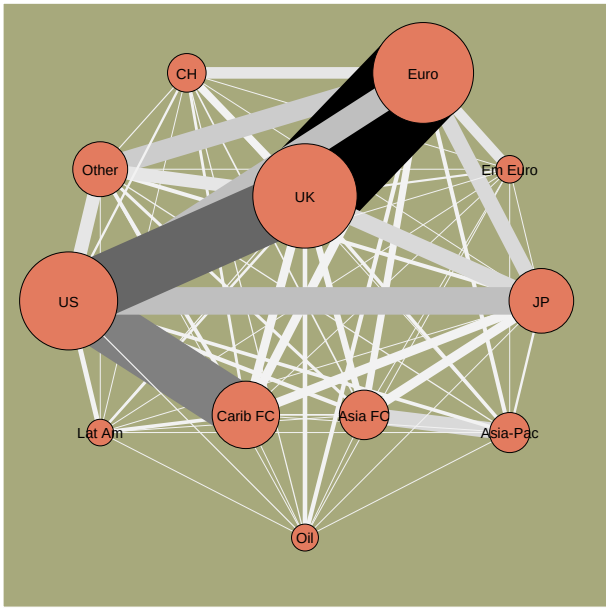
Stock linkages in the international banking system

Graph 7

Q2 2007[1]



Q3 2012[1]



Asia FC = Asian financial centres (Hong Kong SAR, Macao SAR and Singapore); Asia-Pac = China, Chinese Taipei, India, Indonesia, Korea, Malaysia, Pakistan, Philippines and Thailand; Carib FC = Caribbean financial centres (Aruba, Bahamas, Bermuda, Cayman Islands, Curaçao and Panama); CH = Switzerland; Em Euro = emerging Europe (Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, Turkey and Ukraine); Euro = euro area member states excluding Cyprus, Malta, Slovakia and Slovenia; JP = Japan; Lat Am = Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela; Oil = OPEC member states plus Russia; Other = Australia, Canada, Denmark, New Zealand, Norway and Sweden; UK = United Kingdom; US = United States.

See I Fender and P McGuire, "Bank structure, funding risk and the transmission of shocks across countries: concepts and measurement", *BIS Quarterly Review*, September 2010, pp 63–79.

[1] The size of each circle is proportional to the stock of cross-border claims and liabilities of reporting banks located in that geographical region. Some regions include non-reporting economies. The thickness of a line between regions A and B is proportional to the sum of claims of banks in A on all residents of B, liabilities of banks in A to non-banks in B, claims of banks in B on all residents of A, and liabilities of banks in B to non-banks in A. Note that the two panels are not perfectly comparable due to the addition of Malaysia, Indonesia and South Africa to the sample between the two dates.

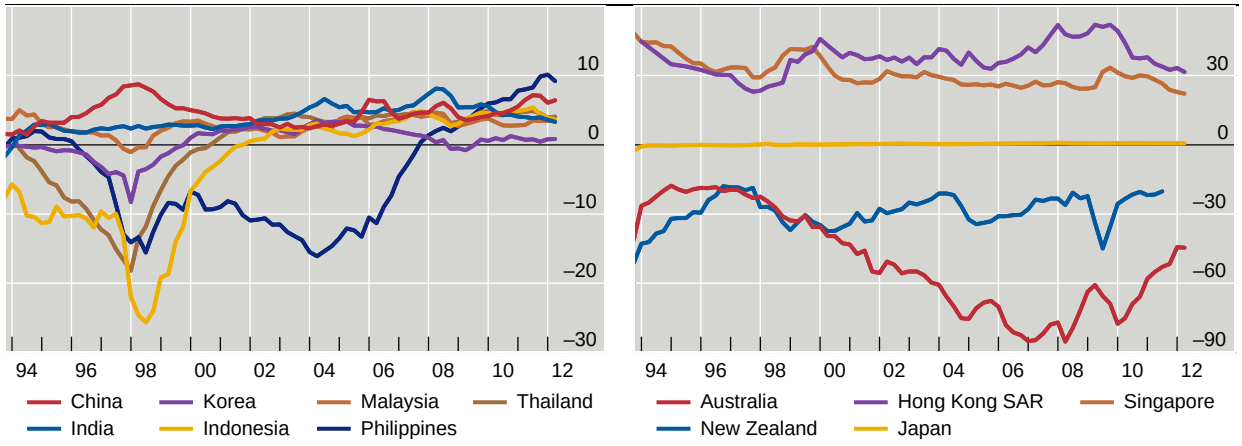
Sources: BIS locational banking statistics by residence; authors' calculations. © Pajek.

This leads us to a final important factor that is likely to weigh heavily on the minds of policymakers in emerging Asia when considering the need to stabilise exchange rates. That is the interaction between exchange rate stability and financial stability. Central to this concern is the degree of mismatch on private sector balance sheets. Suppose that the growing gross international financial positions displayed in Graph 6B represent banks and corporations borrowing heavily in foreign currencies to finance domestic spending rather than efficient international risk-sharing, for example. Then any significant depreciation of the domestic currency may threaten the solvency of firms and banks and, ultimately, the stability of the financial system.

This currency mismatch was a central element explaining the propagation and severity of the Asian financial crisis of 1997–99.[10]

There are a variety of possible measures of currency mismatch. We present one specific measure in Graph 8, based on Goldstein and Turner (2004). It is constructed as the product of two variables: the foreign currency share of total debt and net foreign currency assets vis-à-vis non-residents.

Aggregate effective currency mismatch (AECM)[1] Graph 8



[1] The AECM is the product of the economy's net foreign currency asset position (as a percentage of GDP) and the "mismatch ratio", ie the foreign currency share of aggregate debt relative to export (or imports)/GDP ratio. Hence an economy with a net foreign currency liability position has a negative AECM; the larger this is in absolute magnitude, the greater the effective currency mismatch.

Sources: IMF, *International Financial Statistics*; Datastream; national data; BIS locational banking statistics; BIS international debt securities statistics; BIS domestic debt securities statistics; Goldstein and Turner (2004).

From the graph, there is a strong correlation between the degree to which economies were affected by the Asian financial crisis and the size of the AECM measure in 1997. More recently, the degree of currency mismatch has changed dramatically. With the exceptions of Australia and New Zealand, all the regional economies represented here have had positive measures of currency mismatch for at least the last two years, indicating that exchange rate depreciation would increase the overall net worth of these economies in domestic currency terms, while an appreciation would reduce it, in sharp contrast to earlier periods.

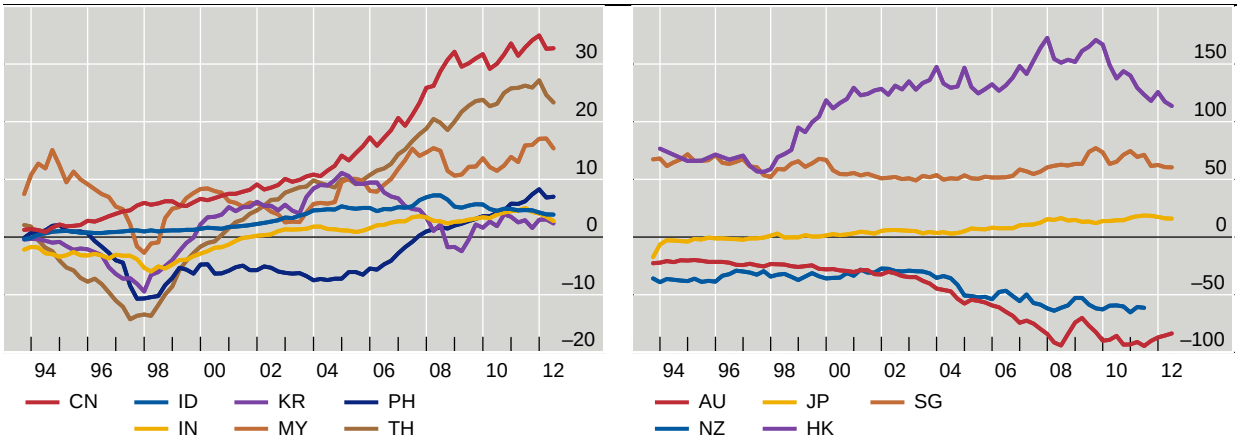
Graphs 9 and 10 represent the main components of the AECM, the net foreign currency asset position and the foreign currency share of aggregate debt, separately. These tell a consistent story. Whereas many economies had considerable net negative asset positions in 1997, they are generally positive and trending up today (Graph 9). Thus the implications of exchange rate movements for financial stability are likely to be less severe than in the past. Given the large (gross and net) stock of foreign assets owned by domestic residents, any sudden rush for the exits from assets denominated in domestic currencies are more likely to be met with inflows as domestic residents repatriate their wealth. This offsetting dynamic was generally not present in the past, and may reduce the macroeconomic fallout from a sudden stop, as well as the need to increase policy rates during a crisis in order to

[10] For related discussion, see Calvo (2002).

support the domestic currency. Meanwhile, the foreign currency share of debt has been steady or declining in most regional economies (Graph 10).

Net foreign currency assets

As a percentage of GDP at PPP exchange rate — Graph 9



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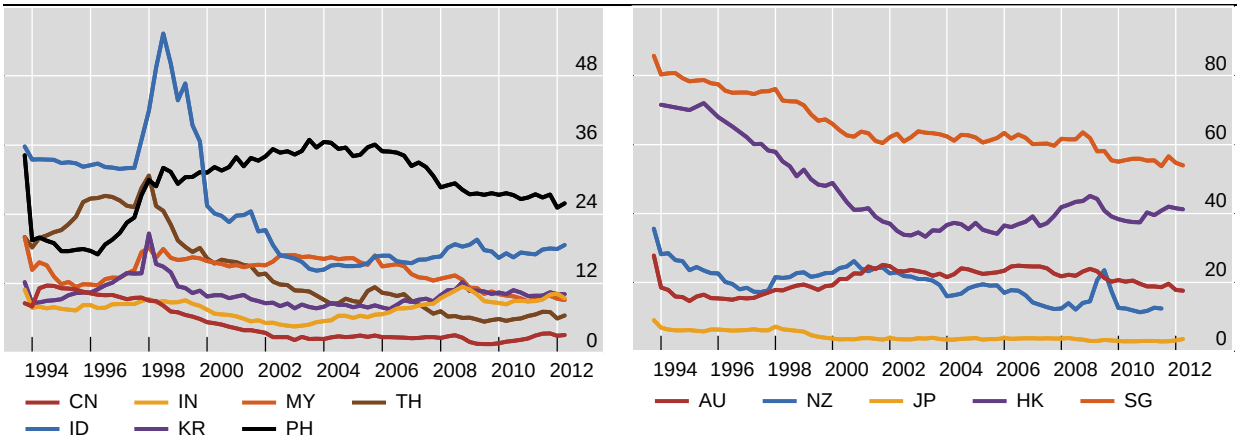
Sources: IMF, *International Financial Statistics*; BIS locational banking statistics; BIS international debt securities statistics; BIS domestic debt securities statistics.

Foreign currency share of total debt outstanding

In per cent — Graph 10



AU = Australia; CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MY = Malaysia; NZ = New Zealand; PH = Philippines; SG = Singapore; TH = Thailand.

Sources: IMF, *International Financial Statistics*; BIS locational banking statistics; BIS international debt securities statistics; BIS domestic debt securities statistics.

One contributing factor to this decline in currency mismatch is the continued development of domestic financial markets. For example, local currency bond markets have grown consistently in emerging Asian economies in recent years,

though in some cases from a low base. Domestic borrowers can increasingly find sources of funding without taking on currency risk.[11]

Taking all our arguments together, there is increasing evidence that most of the historical motivations for what have lain at the heart of the so-called "fear of floating" (Calvo and Reinhart, 2002), or the reluctance of policymakers to allow nominal exchange rate flexibility, have declined. Improved inflation performance, indicating increased policy credibility, declining currency mismatch, decreased exchange rate pass-through and ongoing internationalisation, may now allow for a reassessment of the importance of exchange rate stability in achieving monetary policy goals.

In the next section we summarise some analytical results from a model we have developed to address some of these issues.

A summary of model results

We now summarise the key results of Devereux and Yetman (2014b), which we developed to analyse the effect of certain structural changes on the optimal monetary policy response to exchange rates. The model is based on a standard two-country New Keynesian DSGE framework, with a mixture of producer currency pricing and local currency pricing and some degree of home bias.[12] We add one new element to the model. We allow for varying degrees of financial market integration via the following equation:

$$\left[\left(\frac{C_t^{-\sigma}}{C_t^{*-\sigma}}\right)\left(\frac{S_t P_t^*}{P_t}\right)\right]^{\lambda}\left[\frac{\overline{P}_t Y_t - \Delta(FR_t)}{P_t C_t}\right]^{1-\lambda} = 1. \qquad (1)$$

Here, C is consumption, P is the price level, S is the nominal exchange rate (defined as number of units of domestic currency per unit of foreign currency so that an increase is a domestic currency depreciation), σ is the inverse of the elasticity of inter-temporal substitution, Y is total domestic production, $\overline{P}$ is the price index for domestically produced goods, FR is the total stock of foreign exchange reserves, measured in domestic currency, and an asterisk (*) indicates a variable for the foreign economy.

The beauty of this equation is that a single parameter, λ, captures the degree of financial integration. For $\lambda = 1$, we have the standard condition for fully integrated financial markets and perfect risk-sharing. On the other hand, for $\lambda = 0$, we have the equivalent condition for economies that trade with each other but have completely closed financial markets (with the exception of changes in foreign exchange reserves). And for $0 < \lambda < 1$, we can examine intermediate cases in a

[11] Aghion et al (2009) report empirical evidence that exchange rate volatility results in negative growth outcomes in economies with low levels of financial development. In contrast, for financially advanced economies, they find no relationship.

[12] The model is also similar to Engel (2011, 2013a and 2013b).

simple, tractable framework.[13] Further, this equation embodies the trilemma. Clearly, given condition (1), with full risk-sharing ($\lambda = 1$), changes in the stock of foreign exchange reserves will have no effect on the exchange rate nor on the real economy, since foreign exchange reserves only enter via the second square-bracketed term on the left-hand side of the equation.

We combine condition (1) with a standard New Keynesian open-economy model where we can vary the degree of home bias in consumption (to capture the level of goods market integration) and the degree of local currency versus producer currency pricing (to capture the degree of short-run exchange rate pass-through).

We also allow the policymaker to respond to exchange rate changes in two ways. First, we assume that interest rates respond to the change in the nominal exchange rate in the home country, in addition to CPI inflation. One may think of this as being a form of unsterilised foreign exchange intervention, since interest rates are affected by policy actions intended to influence exchange rates.

Second, we allow policymakers to intervene directly in foreign exchange markets by adjusting foreign exchange reserves in response to changes in the nominal exchange rate. This will directly affect the solution to equation (1) above. One may think of foreign exchange intervention of this nature as a form of sterilised intervention, as interest rates are not directly affected by such policy actions that influence the exchange rate.

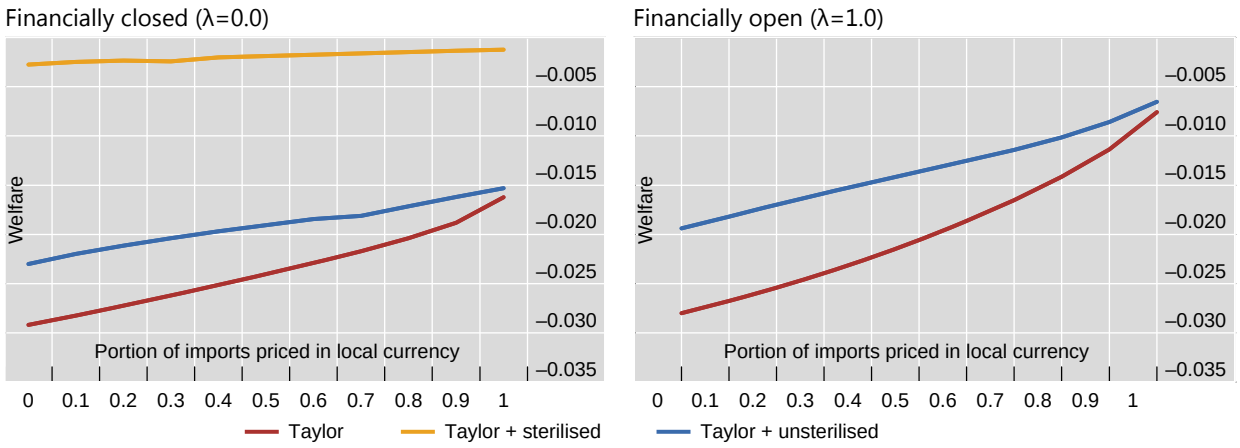
We then evaluate the welfare effects of following different monetary policy rules based on a second-order approximation to the welfare function, in the spirit of Woodford (2003). As in Engel (2011), this welfare function depends on the output gaps (that is, output relative to where it would be if prices were flexible), inflation rates and exchange rate misalignment. One important element of our approach is that we abstract away from strategic considerations to focus on the cooperative optimal policy that maximises global welfare. Thus we do not take into account any advantages that an undervalued exchange rate might offer due to "beggar-thy-neighbour" effects.

We compute the maximum achievable level of global welfare under four different assumptions about how monetary policy is set. First, monetary policy is characterised by a simple Taylor-type rule, where interest rates in both countries respond linearly to domestic CPI inflation (labelled "Taylor" in the graphs that follow). Second, monetary policy is characterised by a Taylor-type rule, but where interest rates in the home country also respond linearly to the change in the nominal exchange rate ("Taylor + unsterilised"). Third, monetary policy is characterised by a Taylor-type rule in both countries, but the home country monetary authority can also make use of sterilised intervention in foreign exchange markets, where the change in foreign exchange reserves is a linear function of the change in the nominal exchange rate in log terms ("Taylor + sterilised"). Finally, we also compute the optimal Ramsey outcome, where the responses of interest rates in both countries, and the change in foreign exchange reserves in the home country, are chosen optimally so as to maximise global welfare. This is used as a benchmark to compare the other policy solutions against.

[13] Devereux and Yetman (2014a) show that this condition can be derived based on a tax on the financial returns from investing in foreign assets which takes the form $(1+t_t) = \left(PC_t / (\overline{PY}_t - \Delta(FR_t))\right)^{(1-\lambda)/\lambda}$.

Graph 11 illustrates the effectiveness of different policy rules at achieving optimal welfare in response to productivity shocks. The horizontal axis is the proportion of imports that are priced in the local currency, δ. The left-hand panel is under financial autarky ($\lambda = 0$), and the right-hand panel with complete financial internationalisation ($\lambda = 1$). In-between levels of financial internationalisation are qualitatively similar to the autarky case. All welfare levels are relative to the Ramsey outcome.[14]

Welfare effects of productivity shocks — Graph 11



Source: Authors' calculations.

Perhaps the most important result here is that, with less-than-complete financial internationalisation, a combination of sterilised intervention and following a simple Taylor rule where the coefficient is chosen optimally comes closest to achieving the optimal Ramsey outcome (ie welfare is close to zero). However, there is little substitutability between sterilised and unsterilised intervention. This is because, with unsterilised intervention, any improvement in outcomes is the result of a trade-off: a single policy instrument (interest rates) is being used to respond to an additional variable. In welfare terms, that trade-off is barely worth making: the paths of all nominal and real variables are little changed whether the central bank responds only to inflation or to both inflation and exchange rate changes optimally. In contrast, unsterilised intervention represents an additional policy tool that does not compromise the effectiveness of interest rates in responding to other variables.

In general terms, monetary policy and exchange rate control can be effective in our model for two reasons. First, they can help to alleviate the effects of nominal rigidities. Second, they can enhance international risk-sharing. Here, interest rates can be used to substantially reduce the effects of nominal rigidities. Meanwhile, for $\lambda < 1$, sterilised intervention can be used as a separate instrument to increase international risk-sharing by partially mimicking the effects of asset allocations that would result under complete markets.

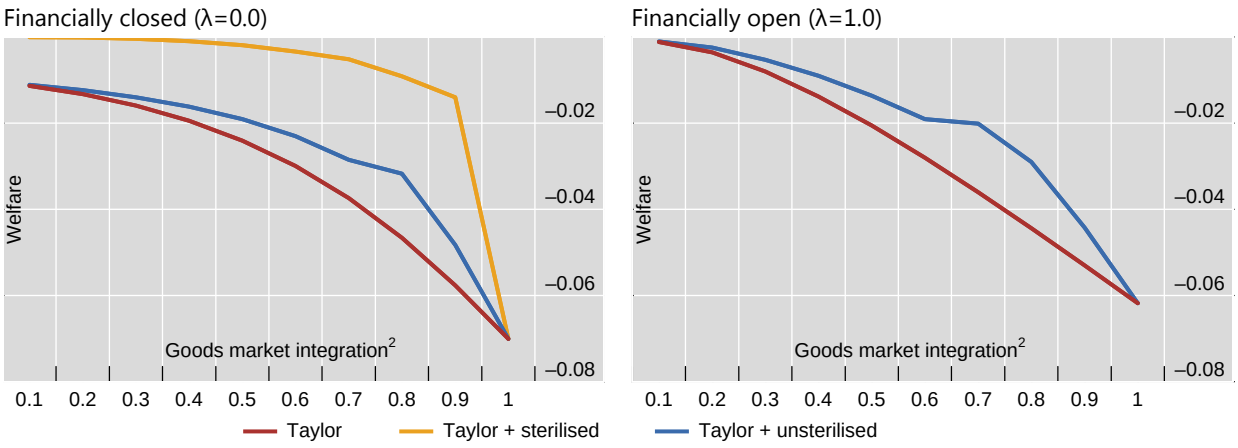
[14] That is, if a policy achieves the same level of welfare as the Ramsey policy, it would be indicated by zero.

In a world of complete financial internationalisation, sterilised intervention is no longer effective. Instead, the only avenue for policymakers seeking to influence the exchange rate is unsterilised intervention. And when policymakers cannot use sterilised intervention as a secondary policy tool, they cannot get as close to the Ramsey outcome, *conditional* on the level of financial internationalisation.

Graph 12 repeats the same exercise but with the degree of short-run exchange rate pass-through fixed such that half of imports are priced in the producer currency, and half in the local currency. Instead, the degree of goods market integration is varied from almost closed (on the left of the horizontal axis) to no home bias in consumption (on the right). All welfare measures are again relative to those under the Ramsey policy. Note that the levels of welfare across different values of goods market integration are not directly comparable, since the degree of home bias is a preference parameter. Instead, the purpose of the exercise is to focus on the relative performance of the different policy measures at given levels of goods market integration.

Welfare effects of productivity shocks

Mixture of local and producer currency pricing[1] Graph 12



[1] Half of all import varieties are assumed to be priced in the local currency and half in the producer currency. [2] Goods market integration is defined as $2\text{-}\upsilon$.

Source: Authors' calculations.

With high levels of home bias, sterilised intervention, if feasible, is an especially potent tool for achieving close to the first-best outcome. Without sterilised intervention, a positive domestic productivity shock would cause the domestic currency and terms of trade to depreciate, distorting consumption decisions. The appropriate use of sterilised intervention can be used to prevent this.

The effectiveness of sterilised (and unsterilised) intervention in response to productivity shocks relies on some degree of home bias. In the limit of no home bias in consumption, at the extreme right of the panels in the above graph, provided the monetary policy response to inflation is optimal, there are no gains to intervening in foreign exchange markets in response to productivity shocks. (This is independent of the degree of exchange rate pass-through and financial internationalisation). The optimal response to inflation via the Taylor rule is sufficient to fully stabilise inflation and, when consumers in both countries have

identical preferences over both home and foreign goods, this also fully stabilises the nominal exchange rate. Given that inflation and the exchange rate are fully stabilised, and therefore deviations from the law of one price are fully eliminated, the welfare costs of nominal rigidities are entirely eliminated. More generally, if goods markets are not fully integrated, then even if inflation in both countries is stabilised, the price of imported goods will tend to behave differently from the price of domestically produced goods, and the exchange rate will vary in response to productivity shocks. In that case, sterilised intervention can be effective.

One interesting outcome across all our results is the relative unimportance of the degree of financial internationalisation. Visually, for all levels of $\lambda < 1$, the graphs look similar to the financially closed ($\lambda = 0$) case presented in the left-hand panels of the graphs above. As λ increases, provided it remains below 1.0, there is little impact on the achievable level of welfare. But once we move to a world of perfect financial internationalisation, then, by construction, sterilised intervention no longer plays a role.

One limitation in this interpretation of our results is that we do not capture the potential costs of volatile reserves in our model, discussed in Section 2. As the level of financial internationalisation increases, but remains incomplete, central banks are able to achieve almost the same outcome with ever increasing foreign exchange intervention. But this implies that the volatility of foreign exchange reserves is increasing in the level of financial internationalisation.

Clearly policymakers would ascribe a negative welfare impact to highly volatile foreign exchange reserves. While explicitly modelling the cost of volatile reserves is beyond the scope of the current paper, we address this issue by adding an additional term to the welfare function of $(fr_t - fr_{t-1})^2$, where fr_t is the log of foreign exchange reserves, with a weight of negative one. In Graph 13 we present analogous results to those presented previously in Graph 11 for a range of levels of financial internationalisation, but incorporating this negative welfare effect of foreign reserves volatility. This has the intuitive effect of lowering the gains available from pursuing sterilised intervention, such that unsterilised intervention dominates sterilised intervention long before the economies are fully financially internationalised.

Conclusions

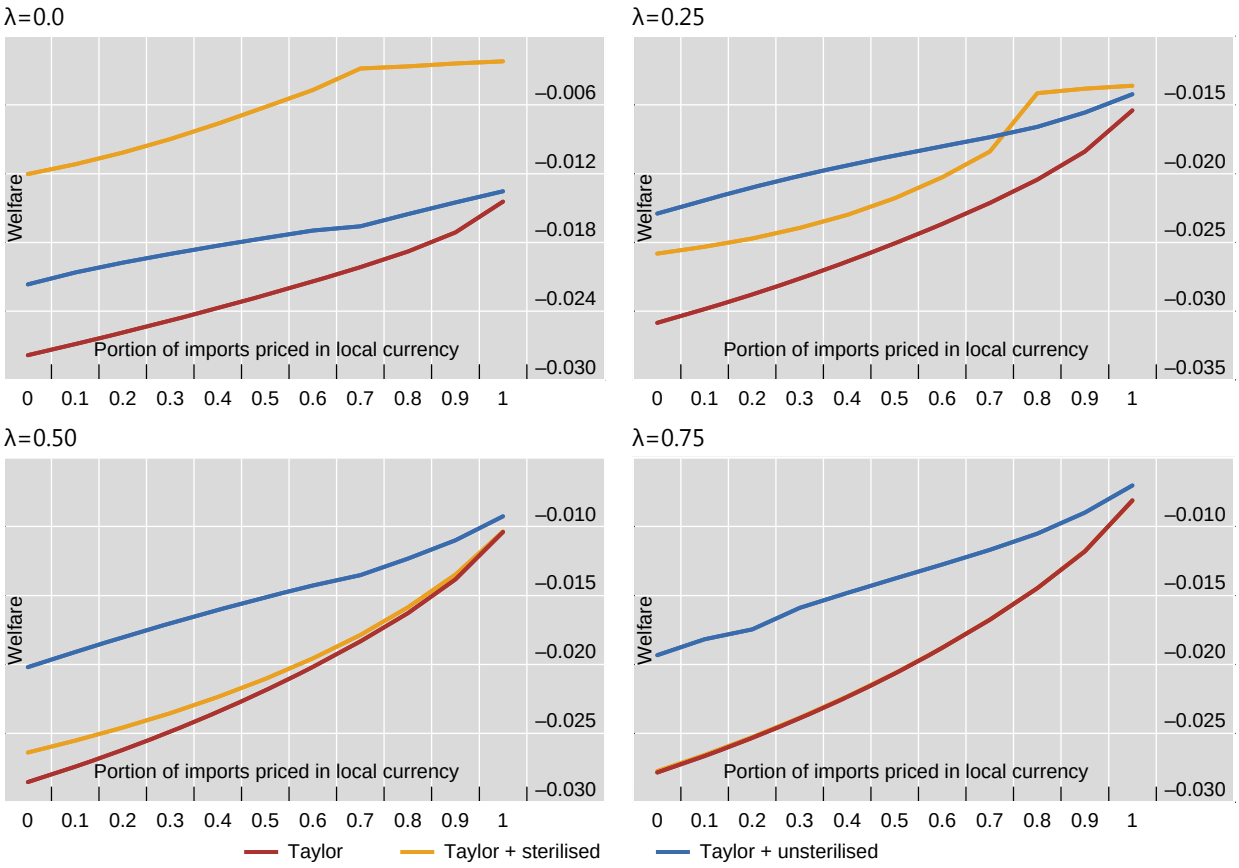
In this paper we have examined how monetary policy should respond to nominal exchange rate changes. We have shown how the optimal response to exchange rates depends on the degree of financial internationalisation, goods market integration and exchange rate pass-through. Sterilised intervention can be a potent tool that offers policymakers an additional degree of freedom in maximising global welfare. The potential welfare benefits from sterilised intervention are largest when exchange rate pass-through is high and when international goods markets are poorly integrated.

However, as the international policy trilemma implies, there are limitations to the use of sterilised intervention. As financial internationalisation increases, achieving a given degree of exchange rate stability requires ever increasing changes in foreign exchange reserves. Taking into account that volatile reserves are likely to

be costly, increased financial internationalisation reduces the role for sterilised intervention. And in the case of fully integrated international financial markets, sterilised intervention has no influence on exchange rates at all.

Where sterilised intervention is no longer a desirable policy tool, unsterilised intervention may have a role to play. However, the potential welfare gains from the optimal use of unsterilised intervention in our model are relatively small. With unsterilised intervention, a single policy instrument (interest rates) is being used to respond to an additional variable (exchange rates), compromising its response to inflation for most plausible parameters. In contrast, unsterilised intervention represents an additional policy tool that does not impinge on the optimal response of interest rates to other variables.

Welfare effects of productivity shocks with costly reserves volatility — Graph 13



Source: Authors' calculations.

Most central banks in Asia have actively used sterilised foreign exchange intervention as a policy tool to smooth exchange rate movements over time. In our model, the use of sterilised intervention represents good policy from a welfare point of view when goods markets and financial markets are not well integrated internationally and exchange rate pass-through is high. But these characteristics are changing in the region. By most metrics, the degree of exchange rate pass-through has fallen. The combination of developing domestic financial markets, and declining barriers to international capital flows, has seen increased financial internationalisation. And goods markets have become more integrated as consumer preferences across countries have moved closer together.

The effect of these changes is to reduce the benefits of stabilising exchange rates with sterilised foreign exchange intervention in our model. And, given the limited effectiveness of unsterilised intervention, our model results imply that the role of exchange rate movements in the optimal setting of monetary policy is decreasing across the region.

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Comments on Michael Devereux and James Yetman's paper

Ippei Fujiwara[1]

Introduction

How should central banks respond to exchange rates? This is one of the oldest questions in open economy macroeconomics, but still applies today. Although there are many cases of exchange rate controls in reality, traditional prescriptions tend to be against exchange rate stability. The seminal research by Friedman (1953) recommends exchange rate flexibility. Aoki (2001) theoretically proves this claim in a micro-founded monetary DSGE model. There is no welfare cost from fluctuations in inflation rates in flexible price sectors. On the other hand, those in sticky price sectors lead to price dispersions and therefore create welfare costs. Welfare costs from unstabilized inflation rates become larger when prices become stickier. Hence, central banks should aim to stabilize inflation rates in sticky price sectors. Since exchange rates are thought to be flexible, there is no need to stabilize exchange rates.

Devereux and Yetman (2014a) tackle this problem using a standard open economy DSGE model with imperfect pass-through as analyzed in Devereux and Engel (2003). With imperfect pass-through, the terms of trade improve with monetary expansion. In an extreme case of no exchange rate pass-through on impact, when evaluated by the domestic currency unit, exchange rate depreciation does not change import prices, but increases export prices. As a result, the terms of trade improve. Thus, expansionary monetary policy has beggar-thy-neighbour effects. With home bias in preferences, the role of which will be explained later, the central bank in each country has an incentive to manipulate exchange rates in favour of its own country.

Based on such a model, Devereux and Yetman (2014a) discuss whether exchange rate control can be still an effective tool even with changing economic as well as financial conditions in Asian economies. This is the main aim of the paper, which makes it very exciting and intellectually stimulating. In particular, Devereux and Yetman (2014a) show three dynamic characteristics in Asian economies and financial markets. They are: (1) the degree of exchange rate pass-through on imported goods has fallen; (2) financial markets are now more integrated globally; and (3) goods markets have become more integrated. Based on these observations, Devereux and Yetman (2014a) conclude that "the role of exchange rate movements in the optimal setting of monetary policy is decreasing in Asia."

This paper aims to give answers to the most important question in open economy monetary economics, with a very rigorous choice-theoretic model which is based on empirical facts. In addition, albeit technical, the idea of expressing the international financial markets as the convex combination of complete markets and

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autarky is truly an ingenious one. Thus, I am sure that the paper will be a seminal study for discussing the pros and cons of exchange rate control.

Below, let me first discuss the relationship between monetary policy and exchange rate control. Secondly, I will discuss how three characteristics in Asian economies and financial markets are expressed in the model. Thirdly, I will try to give some intuition for the main result. Finally, I will comment on several issues, mainly about theoretical interpretation of empirical facts in Asian economies and financial markets.

Monetary policy and exchange rate control

According to standard macroeconomic theory, monetary policy is considered as the policy to control nominal (real when prices are sticky) aggregate spending through changes in nominal variables, such as money supply and nominal interest rates

$$\mu = PC,$$

where μ denotes the monetary policy stance. PC is nominal aggregate demand, that is, aggregate consumption C multiplied by aggregate price P. You may think of μ as money supply M. Then,

$$\mu = M = \frac{1}{V}PC.$$

Money supply together with constant velocity V can represent μ that constrains aggregate demand. μ can be also considered short-term nominal interest rates as consistent with current practice in many central banks. The intertemporal optimality condition, namely the consumption Euler equation

$$u'\left(C_t\right) = \beta \mathbb{E}_t \frac{1+i_t}{1+\pi_{t+1}} u'\left(C_{t+1}\right),$$

can be transformed into

$$\mu = 1 + i_t = \frac{1}{\beta} \frac{\mathbb{E}_t P_{t+1} C_{t+1}}{P_t C_t},$$

when preference is log-utility. Thus, short-term nominal interest rates control the growth rate of aggregate spending or the level of aggregate spending given expectations. In particular, when prices are sticky, changes in nominal variables will have real consequences.

In a country where most consumption goods are imported, nominal exchange rates can control aggregate spending. Let me consider an extreme situation, where all those produced are exported and all consumed are imported. Then, the resource constraint in this economy is given by

$$P_M C = P_X Q,$$

where P_M, P_X and Q denote import price, export price and output, respectively.

This can be re-written as

$$C = ToTQ = \frac{P_X}{P_M} Q_t = \frac{P_X}{SP_M^*} Q_t$$

.

ToT_t denotes the terms of trade. Also, I assume the law of one price or perfect pass-through for imported goods:

$$P_M = SP_M^*$$

where S is nominal exchange rates and P_M^* is import price in the foreign currency unit. Given output, changes in nominal exchange rates can control real aggregate spending when prices are sticky. Therefore, in an open economy exchange rate control can be a good option for central banks to control aggregate spending.

Central banks need to control aggregate spending to eliminate distortions. Suppose a positive technology shock hits the economy. This will reduce the marginal cost. When all prices are flexible, prices decrease and therefore demand and output increase. On the other hand, when prices are sticky, prices do not change and output is also sticky. As a result, labour demand decreases. In the latter case, due to the distortion stemming from price stickiness, the output is suboptimally low and the price and the markup are suboptimally high. Hence, an increase in aggregate demand through accommodative monetary policy can lead to higher welfare.

Welfare becomes higher by eliminating unnecessary fluctuations in consumption, namely by consumption smoothing. In the open economy considered in Devereux and Yetman (2014a), there are two distortions to prevent consumption smoothing. They are: (a) markup fluctuations across time and states; and (b) incomplete international financial markets.

Regarding the former, there are also two types of distortions. One is staggered price setting, which creates price dispersions. The implication is that the central bank should achieve price stability in order to eliminate the fluctuations in marginal costs. The other is imperfect pass-through, which creates international price dispersions. Devereux and Engel (2003) show the possible gains from exchange rate stability. By fixing exchange rates, we can avoid international price dispersion arising from this second distortion. Both distortions result in markup fluctuations. Households buy too much of the cheaper goods when the markup is low. Therefore, it is better to stabilize the markup or marginal costs as the inverse of the markup. This prescription of markup stabilization is based on the classic idea from Lerner (1934) that "If the social degree of monopoly is the same for all final products there is no monopolistic alteration from the optimum at all."

Regarding welfare costs from financial market incompleteness, let me explain this using a simple example. Suppose two agents receive income exogenously of 100 on average. The sum of their income is 200, but it can be distributed as 80–120 or 190–10. The optimal contract is to commit to receive 100. Anything more or less than 100 is transferred. This is the allocation under the complete market. If the market is incomplete, neither country can smooth consumption since income is subject to idiosyncratic fluctuations. This will create unnecessary fluctuations in consumption and therefore result in welfare costs.

Monetary policy as aggregate spending control should be utilized in order to reduce welfare costs stemming from these two distortions.

Model and empirical facts

As stated in the introduction, Devereux and Yetman (2014a) show three developments in Asian economies and financial markets: (1) the degree of exchange rate pass-through on imported goods has fallen; (2) financial markets are now more integrated globally; and (3) goods markets have become more integrated.

(1) is expressed by $\delta \to 0$ in

$$P_{F,t} = \left(1-\delta\right) S_t P^*_{F,t} + \delta \arg\max_{P_{F,t}} \mathbb{E}_t \sum_{t=0}^{\infty} m^*_{t,t+1} \omega^t \pi \left(\frac{P_{F,t}}{S_t} C_{F,t} - MC^*_t C_{F,t} \right),$$

where $\pi\left(\cdot\right)$ is the periodic profit function. ω is the Calvo parameter. With probability $1-\omega$, firms can change export prices. $P_{F,t}$, $P^*_{F,t}$, $m^*_{t,t+1}$, $C_{F,t}$, and MC^*_t denote the price of imported goods in the domestic currency unit, the price of imported goods in the foreign currency unit, the stochastic discount factor in the foreign country, demand for imported goods and marginal costs in the foreign currency unit, respectively. When $\delta = 0$, this equation implies perfect pass-through or producer currency pricing. On the other hand, when $\delta = 0$, each firm aims to set prices directly in the foreign currency unit while taking possible future exchange rate fluctuations into account. Under this local currency pricing, exchange rate fluctuations will not be fully reflected in import prices.

(2) is expressed by $\lambda \to 1$

$$\left[\frac{P_t u'\left(C_t\right)}{S_t P^*_t u'\left(C^*_t\right)} \right]^{\lambda} \left(\frac{\bar{P}_t Y_t - \Delta\left(FR_t\right)}{P_t C_t} \right)^{1-\lambda} = 1 \quad . \tag{1}$$

where $\bar{P}_t$ is the average price under financial autarky but only financial transactions through foreign reserves FR_t are allowed. This is an ingenious idea also used in the accompanying paper, Devereux and Yetman (2014b). Usually, so far, open economy macroeconomists tend to discuss the cases with complete and incomplete markets separately. By having this convex combination between complete and incomplete financial markets, we can express the realistic open economy between these two polar cases. When $\lambda = 1$, the above equation collapses to

$$u'\left(C_t\right) = \frac{S_t P^*_t}{P_t} u'\left(C^*_t\right) \quad . \tag{2}$$

This is the complete market condition. In particular, when purchasing power parity,

$$P_t = S_t P^*_t \ ,$$

holds, this condition implies that consumption must be equated between the two countries. On the other hand, when $\lambda = 0$,

$$\bar{P}_t Y_t - P_t C_t = \Delta FR_t \ .$$

Since private holdings of foreign assets are prohibited, net exports, namely production minus spending, must be equal to the difference of foreign reserves.

(3) is expressed by $\upsilon \to 1$ in

$$C_t = \left(\frac{C_{H,t}}{\upsilon/2}\right)^{\frac{\upsilon}{2}} \left(\frac{C_{F,t}}{1-\upsilon/2}\right)^{1-\frac{\upsilon}{2}}.$$

Devereux and Yetman (2014a) assume two countries with equal size. So, υ implies that there is no home bias.

Intuition of main results

The main conclusion in Devereux and Yetman (2014a) is that because (1) the degree of exchange rate pass-through on imported goods has fallen, (2) financial markets are now more integrated globally, and (3) goods markets have become more integrated, "the role of exchange rate movements in the optimal setting of monetary policy is decreasing in Asia". Let me try to explain the intuition as to why (1) to (3) will lessen the effectiveness of exchange rate controls.

Regarding (1), in an extreme case when $\delta = 1$, there is almost no exchange rate pass-through on imported goods.

$$C = \frac{P_X}{P_M} Q \neq \frac{P_x}{SP_M^*} Q.$$

So, nominal exchange rates cannot control real aggregate spending anymore.

Regarding (2), when $\lambda \neq 1$, central banks have an incentive to achieve higher welfare by controlling foreign reserves in equation (1) so that the allocations become closer to equation (2). Yet, when $\lambda = 1$, namely under full financial market integration or complete financial markets, without any action, the optimal allocations in equation (2) are already achieved. So, there is no need to use foreign exchange rate intervention (foreign reserves) to achieve better allocations.

Regarding (3), as shown by Devereux and Engel (2003), if there is no home bias $(\upsilon = 1)$ and prices are flexible, $C_t = C_t^*$. This is the allocation which both central banks in two countries aim to achieve under sticky price equilibrium. CPI (inflation) stabilization in both countries can achieve nominal as well as exchange rate stabilization. As equation (2) implies, this results in the optimal allocation $C_t = C_t^*$. On the other hand, when there is home bias $(\upsilon \neq 1)$, Duarte and Obstfeld (2008) show that such a prescription of fixing the nominal exchange rate through CPI stabilization is no longer optimal. Central banks have incentives to manipulate nominal as well as real exchange rates to attain optimal allocations under home bias.

Comments

This paper discusses the most important question in open economy monetary economics using a rigorous choice-theoretic model reflecting empirical facts observed in Asian economies and financial markets. Thus, I am sure that this model will be a benchmark for discussing the effectiveness of exchange rate control.

Below, I would like to make comments from four different angles: (1) the (new) role of foreign reserves; (2) empirical facts and model setting; (3) depreciation bias; and (4) incomplete markets.

Regarding foreign reserves, in the model, foreign reserves are used to mimic the allocations under a complete financial market. A question that comes to my mind is whether this is what is observed in Asian central banks in reality. Sterilized intervention is usually recognized as a tool to induce the signalling effect. So I would like to know how changes in foreign reserves alter nominal exchange rates in this model. Second, the model may miss an important role of foreign reserves. For example, Obstfeld, Shambaugh and Taylor (2010) show that a country with a higher level of foreign reserves experienced less currency depreciation. They point out a new role of foreign reserves as an insurance device. If this is true, a policy using foreign reserves should not be considered as monetary policy in controlling aggregate spending.

Regarding the second point, some empirical facts stated in this paper seem to be inconsistent with the model settings. In the paper, goods market integration in terms of increasing openness observed in the data is considered to imply less home bias. I am not quite sure about this relationship. Ability to trade or reduced trade barriers may have nothing to do with home bias. There should be the case where home bias remains even without frictions in trade. Also, financial market integration in terms of increasing cross-border financial transactions is considered to imply a situation closer to complete international financial markets. I am not quite sure whether this is true. If true, it seems that the global imbalance, which increases cross-border transactions, has contributed to equalizing consumption growth rates across different countries. Data will not support this view.

Regarding the third point, I wonder whether Asian central banks have really aimed to achieve exchange rate stability. Rather, they seem to have depreciation bias. Increases in foreign reserves hint at the existence of depreciation bias in addition to the need for insurance. In this context, Asian countries may have been interested in output rather than consumption maximization. This may reflect the existence of increasing returns to scale (or infant industry protection) or the need to speed up the technology catching-up with "learning by doing", as considered in Day and Fujiwara (2013).

Regarding the final point, what types of incomplete markets can equation (1) replicate?[2] For example, which λ can replicate the allocations in incomplete markets only with one period bond? I would like to know whether equation (1) can capture any form of incomplete international financial markets.

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Session 3

Has Asian emerging market monetary policy been too procyclical when responding to swings in commodity prices?

Andrew Filardo and Marco Lombardi[1]

Commodity price fluctuations in recent years have led to wide swings in inflationary pressures across Asian emerging market economies and have revived the discussion on how monetary policy should best react. We argue that the conventional wisdom for emerging market economies of treating commodity price fluctuations as external supply shocks is misguided in the current policy environment. We first present new empirical evidence that global demand shocks have driven commodity prices and inflationary pressures in Asian economies. We then show that the incorrect diagnosis of global demand shocks as external supply shocks leads to suboptimal outcomes in a simple two-country monetary policy model with endogenously determined commodity prices. Given such misdiagnosis risk, the results in this paper strengthen the case for targeting headline inflation as part of a robust monetary policy framework for Asian emerging market economies.

Keywords: Monetary policy; commodity prices; inflation; demand shocks; policy coordination

JEL classification: E52, E31, Q43, F42, F68

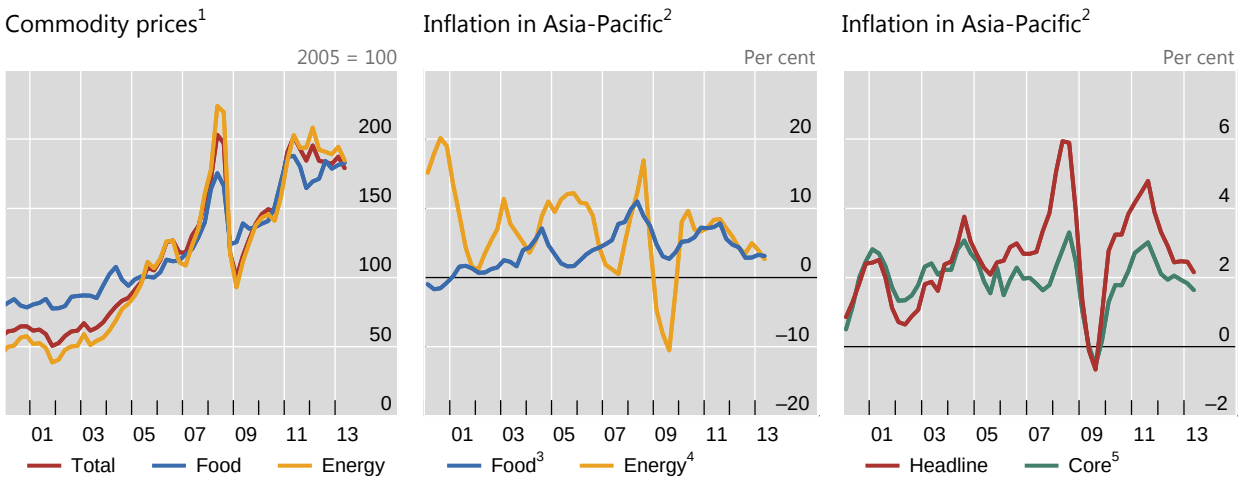
[1] The views expressed are those of the authors and do not necessarily represent those of the Bank for International Settlements. The authors would like to thank Claudio Borio and Luis Catão for insightful comments and Emese Kuruc for superb research assistance. This paper was prepared for the PBoC-BIS Research Conference on "Globalisation and Inflation Dynamics in Asia and the Pacific", 23–24 September 2013, Beijing, China.

I. Introduction

In the past 10 years, global commodity prices have experienced several pronounced swings, with some commodities reaching historically high price levels. Such heightened volatility translated into high inflationary pressures in Asian economies (Graph I.1), and clearly has presented a challenge to policymakers. To fully understand the policy trade-offs facing central banks, one needs to dig into the underlying sources of the shocks – for example, determine whether they are primarily demand or supply shocks.

The conventional wisdom about commodity price fluctuations and monetary policy is that each country should respond only to those fluctuations that lead to second-round inflationary effects. Practically, this suggests that monetary authorities should focus on core inflation and look through the initial impact of commodity price fluctuations on headline inflation. This conventional wisdom was largely built upon experiences in the 1970s and 1980s when oil supply shocks led to wide swings in energy prices. The more generalised swing in commodity prices in recent years, however, raises questions about the general relevance of this conventional wisdom in today's more globalised world.

Inflation and commodity prices — Graph I.1



[1] Quarterly averages. [2] Year-on-year changes in consumer price index. Weighted averages based on the 2005 GDP and PPP exchange rates of Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore and Thailand. Wholesale prices for India. [3] For Hong Kong SAR, Q4 2005–Q2 2013; for Indonesia, Q2 2000–Q2 2013; for Malaysia, Q1 2006–Q2 2013. [4] For Hong Kong SAR, Q4 2005–Q2 2013; for Indonesia, Q2 2000–Q2 2013; for Japan and Malaysia, Q1 2006–Q2 2013; for the Philippines, Q1 2007–Q2 2013. [5] For China and Malaysia, Q1 2006–Q2 2013; for Indonesia, Q2 2000–Q2 2013; for the Philippines, Q1 2007–Q2 2013.

Sources: IMF, *World Economic Outlook* and *International Financial Statistics*; national data.

To address these policy concerns, the paper first highlights global trends that help to explain the pronounced commodity price swings over the past decade. Section III presents statistical evidence supporting the case that global demand shocks have been a key driver of global commodity price swings and of domestic inflation dynamics in emerging market economies, especially in Asia. Section IV offers a new theoretical monetary policy model consistent with the empirical facts and supports the case that emerging market monetary policymakers should target headline inflation rather than core inflation. Section V concludes that emerging

market central banks need to take an increasingly globe-centric view of the policy challenges associated with swings in commodity prices.

II. Understanding recent commodity price swings

What can we say about the changing nature of the economic and financial environment, with respect to the factors driving commodity prices? In this section, we highlight some of the arguments which suggest that a fundamental change in the policy environment has been under way for a while. Despite some retreat during the international financial crises, the overall trend is towards greater economic and financial globalisation. The section then highlights the broad monetary policy challenges from a globe-centric, rather than a country-centric, perspective for emerging market central banks facing volatile commodity prices.

II.1 A changing economic and financial landscape

At the time of writing, global food and energy price movements have been moderate compared with those of recent years, albeit with isolated price spikes in certain segments due to idiosyncratic factors. But one can point to a number of fundamental forces indicating a more permanent change in the state of affairs. Two interrelated factors are the relative shift in economic gravity away from the advanced economies to the emerging market and developing economies, and the spread of financial globalisation, to which we now turn.

Shifting economic gravity

The relative economic decline of the advanced economies and the corresponding increase in the importance of the emerging market and developing economies have been manifest in the past decade. By the end of 2012, emerging and developing economies accounted for over 25% of global output (Graph II.1). This shift has yielded important benefits. Per capita incomes in these economies and standards of living, for example, are rising at a much faster pace than imagined a few decades ago. However, these positive developments have had side effects. One of them is the impact on commodity prices.

One way to conceptualise the policy environment is to consider commodity supply and demand curves. The global economic growth shifted global commodity demand out along an increasingly steeply sloped commodity supply curve. Two key arguments support this view (Inamura et al (2011), G20 (2011)). First, a greater share of global demand is accounted for by emerging market economies. Second, emerging and developing economies tend to be more commodity-intensive than the advanced economies. The higher commodity intensity means that for every dollar of global output produced in the emerging and developing economies, relative to the advanced economies, there is a greater demand for commodities.[2]

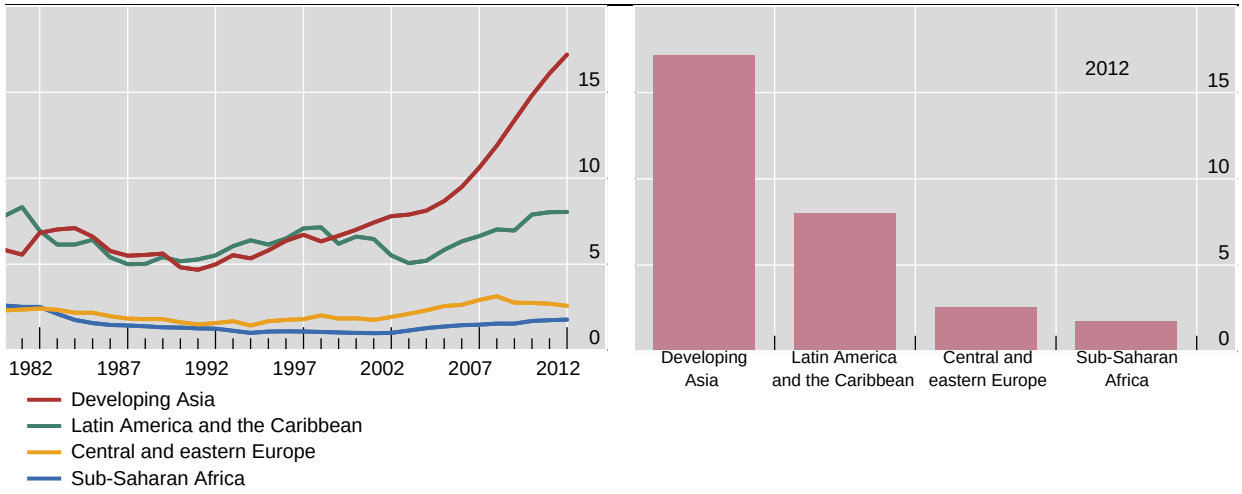
[2] It is also the case that the international financial crisis has accelerated the shift of production of commodity-intensive products and demand from the advanced economies to the emerging market and developing economies. In addition, the increased demand for commodities by the emerging and developing economies, of course, could be offset eventually by greater efforts in exploration

In terms of volatility, emerging and developing economies, however, tend to be "higher beta" economies; that is, they are much more volatile than the advanced economies during global business cycles. This sensitivity helps account for some of the volatility in commodity prices in recent years. It is useful to note that the string of financial crises affecting the advanced economies since mid-2007 has contributed to the volatility in demand for commodities. Demand for commodities has been affected especially by the waves of global risk aversion. Spikes in global risk aversion have been found to drive capital flows to emerging and developing economies, with significant impacts on financial stability conditions (see eg Forbes and Warnock (2011), Bruno and Shin (2012), Filardo (2013) and Rey (2013)).

Rising share of global output outside the advanced economies

In per cent

Graph II.1



Source: IMF, *World Economic Outlook*.

The impact of the international financial crises on commodity markets also brings up a concern about the future. It is important to note that recent commodity price booms have ended primarily because of crises. This happened in late 2008 in the wake of the Lehman collapse and again in 2011–12 as the sovereign debt crisis in Europe intensified. These episodes have left us wondering what might have happened if these adverse international spillovers had not come along and acted as powerful headwinds against the commodity booms and inflation (Graph II.2).

Financial globalisation and the financialisation of commodity markets

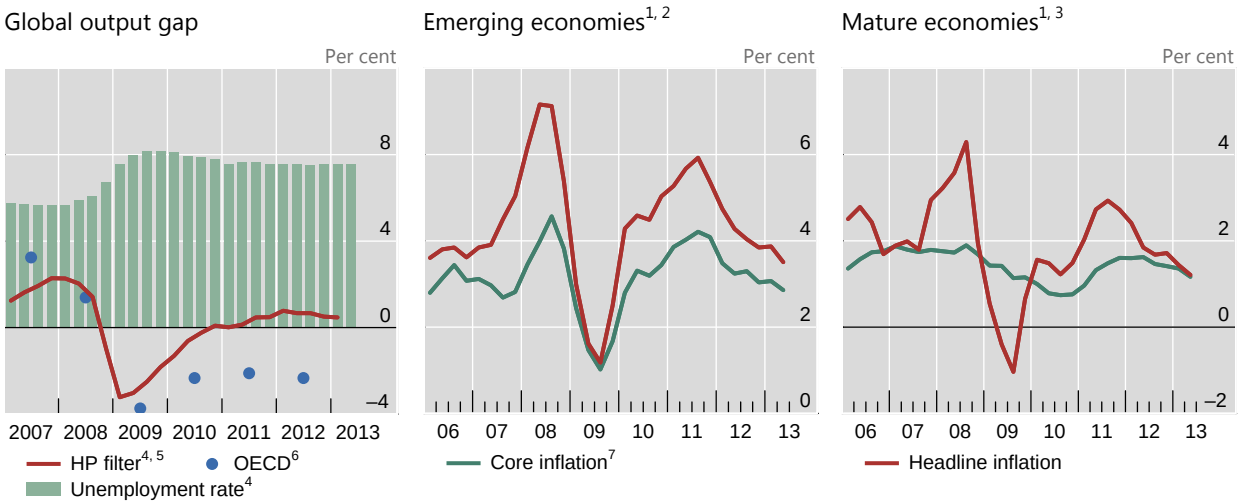
Greater financial globalisation has raised the prospects that commodity markets have become much more volatile because of increasing activity in the commodity futures market. It is true that, over the past decade, there has been a fundamental transformation in commodity trading, ie a shift from participants primarily interested in physical delivery to those interested in commodities as an asset class.

for new sources of commodities as well as the introduction of new technologies that are less commodity-intensive. The oil shale development in the United States in recent years demonstrates this potential. However, over "short" periods such as a decade, the supply inelasticity of commodities and the steady increase in global demand are likely to keep the average level of commodity prices high (Adams (2009)). This has helped and will continue to help commodity-producing Asian economies.

Along with greater financial globalisation, financialisation is thought to have boosted asset return correlations across asset classes. Indeed, commodity prices in recent years have been rather sensitive to swings in generalised risk perceptions in markets. According to Lombardi and Ravazzolo (2013), from the early 2000s correlations between commodity price returns and stock market returns went from around zero to above 0.4 by 2012. It is no wonder policymakers have become more sensitive to possible links between excessive speculation (and herding behaviour) and commodity prices.

Global output gap and inflation

Graph II.2



[1] Year-on-year changes in consumer prices, in per cent. [2] Weighted averages based on 2005 GDP and PPP exchange rates of Brazil, China, Chinese Taipei, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Korea, Malaysia, Mexico, the Philippines, Poland, Singapore, Slovakia, South Africa, Thailand and Turkey. Wholesale prices for India. [3] Weighted averages based on 2005 GDP and PPP exchange rates of Canada, Denmark, the euro area, Japan, Norway, Sweden, Switzerland, the United Kingdom and the United States. [4] Major advanced and emerging economies. [5] Based on a world aggregate; trend calculated using Hodrick-Prescott filter with standard specification. [6] Aggregation of national output gaps. [7] For 2006, excluding the Philippines.

Sources: IMF, *World Economic Outlook*; OECD, *Economic Outlook*; Datastream; national data.

But how much of the commodity price volatility is due to the financialisation of commodity markets? This is not an easy question to answer. Some evidence suggests that financialisation of commodity markets has increased the frothiness in some commodity prices, but the size and breadth of the impact have been limited (Kilian and Murphy (2012), Lombardi and Van Robays (2011)). Irwin and Sanders (2010) document that the activity of exchange-traded funds in commodity futures markets did not increase commodity price volatility. One additional piece of corroborating evidence for this view is that the volatility of commodity prices that are not actively traded on organised exchanges has been similar to the volatility of prices on organised exchanges where financial speculation is present. Hence, while some of the frothiness in commodity prices can be linked to the financialisation of commodity markets, a good share of the volatility is probably not.[3]

[3] This evidence would also suggest that this aspect of the commodity price issue has limited financial stability implications for central banks. Nonetheless, public calls for specific anti-speculation measures, such as financial transaction taxes, have been heard with increasing frequency in recent years.

Overall, these factors help to explain why we have seen greater swings in a wide range of commodity prices in recent years and the correlation in cross-sectional EM inflation dynamics, especially in Asia (Graph II.3). The swings have been wider and more frequent than in the prior years. The nature of the trends suggests that these forces will continue to influence the policy environment going forward.

II.2 Are EM monetary policy responses contributing to commodity price procyclicality?

For policymakers, it is also important to consider the possibility that existing monetary policy frameworks have contributed to the amplitude of the boom-bust commodity cycles. It is possible that the traditional country-centric view of central banking is becoming less relevant as economies around the world are becoming more globalised economically and financially. Globalisation trends call for consideration of more globe-centric policy frameworks. In this section, we first review the country-centric and globe-centric views before addressing the empirical evidence and policy implications.

Country-centric versus globe-centric perspectives

This section lays out two conceptual perspectives within which to frame the current policy debate about commodity prices. The first perspective is a country-centric one; the other a globe-centric one (Borio and Filardo (2007)). To highlight the different policy implications of the two perspectives, we sketch a simplified typology of the two views before turning to the policy implications.

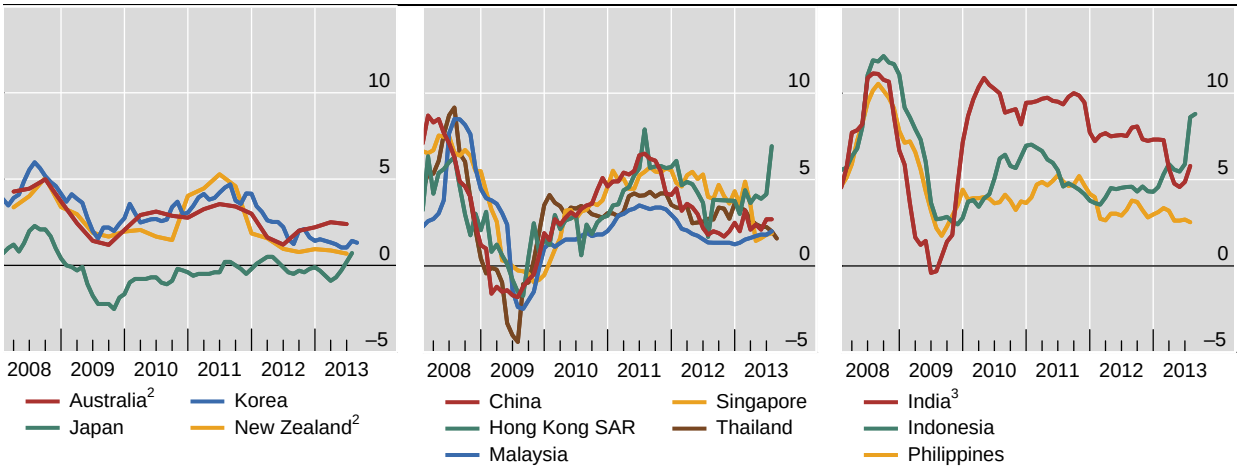
First, consider the country-centric perspective. This is the traditional approach to policymaking. The organising principle is the national economy. In the case of inflation and financial stability issues arising from commodity price developments, excess demand and supply conditions are assessed at the country level, as would be the analysis of wages, capital formation etc. External price developments would be assessed by looking at import prices, assuming there are sufficient statistics to summarise the relevant regional and global factors.[4]

In contrast, the organising principle of the globe-centric perspective takes the global economy as the starting point of the analysis. In the case of commodity prices, the globe-centric perspective makes particular sense since most commodities are highly traded goods and have their benchmark prices determined in a global marketplace. In this perspective, the critical determinants of prices would be global excess supply and demand. Moreover, wages and capital formation would be influenced not only by domestic forces but also global ones.[5]

[4] In addition, the country-centric perspective would assume limited cross-border substitutability of goods and very limited mobility of capital and labour. This is consistent with a closed-economy type of analysis found in most traditional macroeconomic textbooks.

[5] In the extreme, labour and capital would be assumed to be highly mobile across geographical boundaries, so that global, or regional, developments play a larger role than local factors in pricing the efficient allocation of goods.

Consumer price inflation[1] Graph II.3



[1] Annual percentage change. [2] Quarterly frequencies. [3] Wholesale prices.

Source: National data.

Monetary policy considerations

Relative price shifts associated with commodity prices, theory tells us, should have only transitory impacts on inflation dynamics. To get commodity prices to have longer-lasting impact on inflation dynamics, relative price shifts would have to influence the setting of monetary policy in a systematic way. This begs the question: is it possible that wide swings in global commodity prices have contributed to procyclical monetary policy in emerging market economies?

The answer to this question depends, in an important sense, on the source of the shocks driving commodity prices. If a surge in commodity prices is driven by a supply shock, the lessons learned during the experiences of the 1970s and 1980s apply: central bankers must focus on the impact of the rise in commodity prices on inflation expectations. There have been numerous examples of central banks successfully looking through the gyrations of commodity price shocks, as long as the increase in prices did not appear to feed an increase in medium-term inflation expectations – the so-called second-round effects. This is consistent with a country-centric approach.[6]

However, as noted above, soaring global commodity prices in recent years appear to have been rather the result of a sequence of global demand shocks. In other words, the higher prices have been the result of a shift in global demand along a more steeply sloped aggregate supply curve. One tell-tale sign that it is mainly demand, and not supply, driving up commodity prices is that output grew robustly, even as prices of all types of commodities rose.[7] The globe-centric approach has much to offer in this situation.

[6] One additional possibility is that low interest rates at the global level have increased commodity prices through a financial portfolio rebalancing channel, which at the country level would look like a cost-push shock (Ito and Rose 2011).

[7] Recent empirical evidence from Lee and Rhee (2013) finds some evidence in Asian economies that rising food prices tend to have a bigger impact on core inflation than energy prices. In addition,

A useful thought experiment

The following thought experiment highlights the nature of the policy trade-offs in the case of a positive global demand shock. We might imagine the existence of a hypothetical global monetary authority. This authority has the power to coordinate monetary policy actions across existing monetary jurisdictions. Asking the following question helps us to understand the implications of the globe-centric approach: how would this global monetary authority respond to commodity price booms and busts, and would this response deviate significantly from what we have seen?

In many respects, the policy prescription for the hypothetical global monetary authority is quite straightforward when the commodity price boom is driven by strong global aggregate demand. This hypothetical global monetary authority would tighten monetary policy by raising the average real policy rate sufficiently to counteract the underlying shift in aggregate demand. If calibrated correctly across jurisdictions, non-inflationary sustainable growth would be achieved and commodity price pressures would reverse. Indeed, if the global monetary authority was sufficiently credible and economic agents forward-looking, the prospect of a tightening of monetary policy might forestall the initiation of a commodity price boom in the first place.

So, how does the policy prescription for this hypothetical global monetary authority compare with the behaviour of central banks during the run-up in commodity prices in 2006–08 and in 2011? Graphs II.4 and II.5 illustrate that the actual responses stand in sharp contrast to theoretical considerations. Across EM Asia, and most jurisdictions around the globe, nominal rates were not raised sufficiently quickly, if at all, to boost real policy rates. In other words, global monetary policy became more, not less, accommodative during the commodity price booms and resulted in higher inflation.[8]

What might account for this discrepancy between theory and practice? One difficulty in operationalising this theoretical policy prescription at the national level is that a global demand shock looks in many respects like an external supply shock to national policymakers.[9] This would be particularly the case when an economy is a large net importer of commodities.

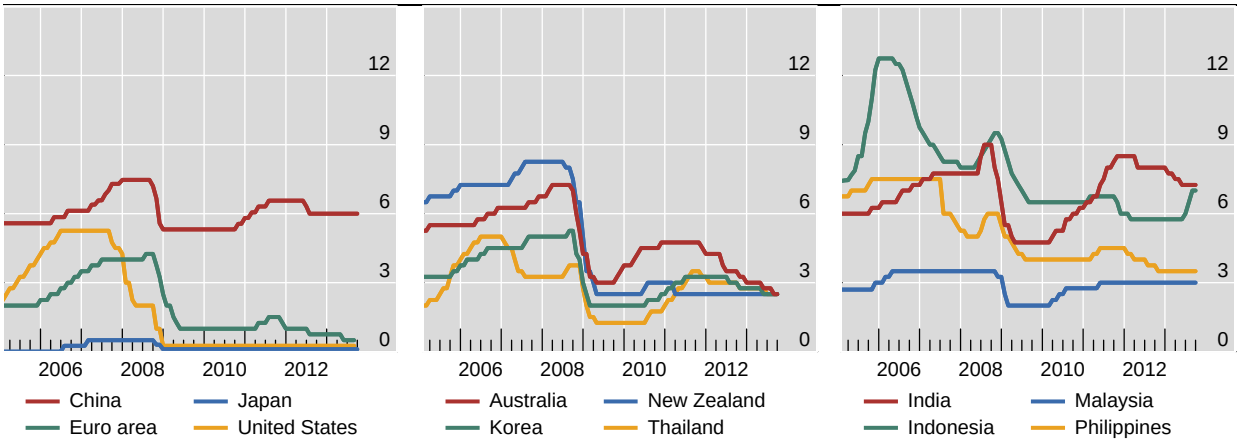
core inflation shows a tendency to move towards headline inflation rather than vice versa. This evidence provides support for the view that monetary authorities should put greater weight on headline inflation in emerging and developing economies than on core inflation in the conduct of monetary policy.

[8] Of course, if the commodity price increases represented a supply shock, this policy response would have been appropriate, based on the experience of the 1970s and 1980s.

[9] This may sound like pure semantics, but there is an important distinction in terms of communicating to the public the accurate conceptual framework being used by central banks; this may also be valuable for internal deliberations inside the central bank. Filardo (2012b) discusses this policy challenge.

Nominal policy rates[1]

Graph II.4

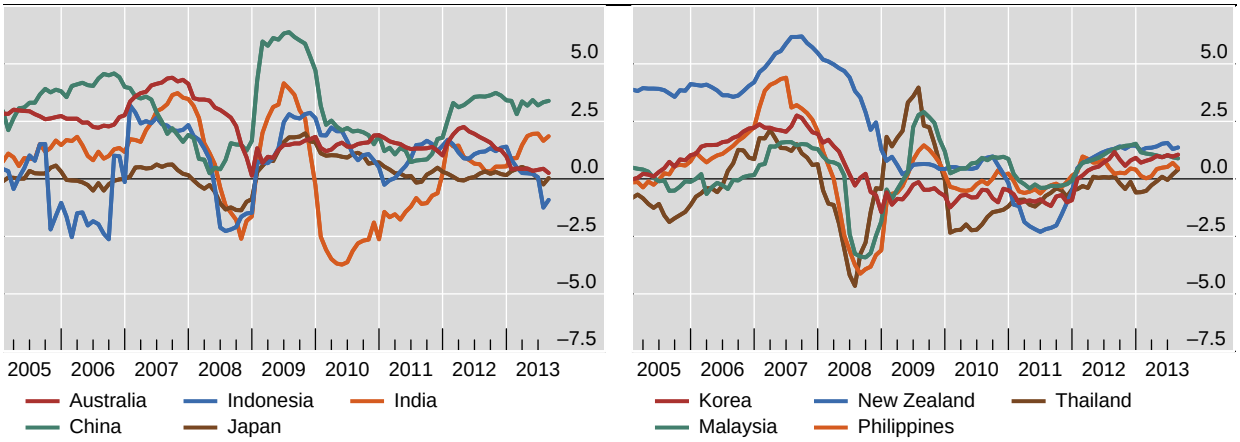


[1] In per cent. Policy target rates or their proxies. For Australia, Reserve Bank of Australia cash target rate; for China, benchmark one-year lending rate; for the euro area, ECB main refinancing rate; for India, repo rate; for Indonesia, one-month official discount rate; for Japan, target policy rate; for Korea, target for the overnight call rate; for Malaysia, overnight policy rate; for New Zealand, official cash daily rate; for the Philippines, overnight reverse repo rate; for Thailand, one-day repo rate; for the United States, target federal funds rate.

Source: National data.

Real policy rates[1]

Graph II.5



[1] In per cent. Policy target rates or their proxies minus average of year-on-year change in CPI and consensus inflation forecast for the year. Wholesale prices for India. For Australia, Reserve Bank of Australia cash target rate; for China, benchmark one-year lending rate; for the euro area, ECB main refinancing rate; for India, repo rate; for Indonesia, one-month official discount rate; for Japan, target policy rate; for Korea, target for the overnight call rate; for Malaysia, overnight policy rate; for New Zealand, official cash daily rate; for the Philippines, overnight reverse repo rate; for Thailand, one-day repo rate; for the United States, target federal funds rate.

Sources: National data; BIS calculations.

It is important to emphasise the distinction between reality and perception when thinking about commodity price shocks. When commodity prices rise and fall significantly, there is a temptation for national central banks, as well as others, to dwell on the external nature of the shock, both in terms of their internal discussions at the time of policy meetings and in terms of communication with the public. There is an underlying logic to categorising commodity price movements as external supply shocks from a country-centric point of view. In the case of a small, open economy, it might be difficult to see how the policy response alone would materially influence global demand. And, given that commodities are important inputs into production, the higher prices are contractionary from a comparative

statics point of view. However, from a general equilibrium perspective at a global level, the commodity prices are really driven by global demand shocks, not supply shocks. There is a growing consensus that this distinction is important from a policy point of view.

The misdiagnosis of the source of the shocks opens up the risk of administering the wrong medicine to the problem. If the shock is misdiagnosed as a supply shock, policymakers may find themselves heeding the monetary policy lessons of the 1970s and 1980s. The oil price experience in the 1970s and 1980s taught monetary policymakers a key lesson: it is important to take strong policy actions to prevent second-round inflation effects, but otherwise to ignore the gyrations in the price level. When this advice about first-round versus second-round effects was taken during the second oil crisis, central banks such as the Deutsche Bundesbank, the Bank of Japan and the Swiss National Bank achieved much better macroeconomic and financial outcomes.

As a result of a misdiagnosis, a monetary authority could find itself behind the curve because it has an incentive to wait until surging commodity prices push up inflation expectations. Of course, if all economies are more or less subject to the same incentives, this would lead to accommodative monetary policy at the global level and a surfeit of global liquidity which would, in turn, feed upward pressure on global commodity prices and spur more global demand expansion. In other words, global monetary policy settings would tend to be too accommodative during the upswing in commodity prices.

Traditionally, such liquidity expansion and economic overheating would conjure up images of upward inflation spirals which central banks focused on price stability would naturally combat. However, this empirical lead-lag relationship between credit growth and inflation has broken down in many economies that have achieved a high level of credibility for price stability. Recent studies of credit booms gone bad (see eg Schularick and Taylor (2012)) have taught us that credit booms often lead to credit busts and financial instability without a sharp deterioration in the short-term inflation picture. Indeed, these longer lags between excess liquidity provision by central banks and inflation have put a premium on complementing traditional monetary policy tools with macroprudential ones in order to curb the tendency for boom-bust credit and asset price cycles. This has also called for central banks to focus on policy horizons much longer than the conventional two-year one (Borio and Zhu (2008), Reinhart and Rogoff (2009)).

What is the empirical foundation of this perspective? The global trends support the case. The sheer size of emerging market economies as a share of global activity raises the possibility that correlated EM policy responses to commodity price swings are having a non-trivial feedback on global activity and hence commodity prices. If truly a reflection of global demand conditions, the policy responses may be feeding inflationary pressures. To assess the empirical relevance of this, we dig into the empirical record and explore the theoretical nature of the monetary transmission mechanism implied by misperceptions of global demands as country-centric supply shocks.

Insights from the literature on commodity prices and monetary policy

The literature on commodity prices and monetary policy has highlighted the trade-offs central banks face as a result of large swings in commodity prices. Large commodity price swings have been seen as making it more complicated for central banks to not only achieve price stability but also stabilise the real economy.

Bernanke et al (1997) argued, for example, that the US recessions of 1974 and 1982 were exacerbated by the Federal Reserve's reaction to oil price shocks.

For decades, much of the literature has supported the conventional wisdom that monetary authorities should "look through" first-round relative price effects of commodity prices but respond once second-round effects kick in. The IMF (2011) re-examined the issue in light of recent swings in commodity prices and largely affirmed the conventional wisdom of looking through commodity price shocks, ie targeting core inflation rather than headline inflation; this is consistent with theoretical findings going back to Aoki (2001). Coletti et al (2012) argue that price-level targeting worsens the trade-off between inflation and output stabilisation when compared with inflation targeting; they treat commodity price movements as cost-push shocks.

From the perspective of emerging market economies, gyrations in food prices have taken on greater prominence in the literature, leading to different arguments for putting more weight on headline versus core inflation in monetary policy frameworks. First, given the share food has in consumption baskets of emerging economies, the inflationary consequences of commodity price movements are much greater than in the advanced economies.[10] Second, rising food prices have significant social implications that policymakers confront; Catão and Chang (2010) examine the case of a small, open economy in which food has a large role in the utility function. In such a setting, they find support for targeting consumer prices rather than targeting producer prices when food price shocks are volatile. Credit constraints are also likely to affect consumers in emerging economies; Anand and Prasad (2010) argue that, with incomplete markets and financial frictions, targeting headline inflation is optimal.

The papers above generally start their analysis from the assumption that commodity price movements are largely exogenous developments from a small, open economy's perspective. Indeed, the exogenous nature of commodity price developments has been a long-standing assumption in macroeconomic models. For example, in his seminal paper, Hamilton (1983) argued that almost all post-WWII US recessions were preceded by exogenous oil supply-driven price increases. Early theoretical models featuring energy prices (see eg Kim and Loungani (1992)) were also built on the assumption that energy price shocks are exogenous to the rest of the economy. Whereas treating commodity prices as exogenous may be reasonable from a narrow small, open economy perspective, it is not tenable from a global perspective. As a consequence, what might look like an appropriate country-centric response may no longer be the best way to fully analyse the policy environment, especially if other economies are responding in a correlated fashion.

The broad-based surge in commodity prices of the 2000s spurred academic interest in the demand, rather than the supply, shock implications of commodity price developments. Since the influential paper by Kilian (2009), a growing empirical literature has supported the contention that commodity price fluctuations in the past decade have been heavily influenced by demand side developments, which are

[10] Cutler et al (2005), for example, report evidence that the pass-through of commodity prices to consumer prices in Hong Kong SAR and mainland China is higher than in mature economies. Bank of Thailand (2011) also finds that the correlations between domestic price indices and international food prices increased in the 2000s. Tang (2008) argues that monetary authorities in East Asia responded slowly to commodity price increases during the mid-2000s.

in turn associated with the growing importance of commodity-hungry emerging economies. This has spurred on interest in the state-contingent nature of the monetary policy response. Bodenstein et al (2012) employ a two-country dynamic stochastic general equilibrium model with endogenous oil production, and show that the optimal monetary policy response to an increase in the price of oil depends on the nature and the location of the shock that produced the price increase. Robust control issues associated with alternative shocks driving commodity price fluctuations have received less attention in the literature despite relevance for policymakers.

Finally, the literature has also drawn links between commodity price developments and monetary policy settings. This raises the issue of the extent to which monetary policy can itself influence commodity prices via its impact on demand. On this point, Barsky and Kilian (2002) reported evidence that high oil prices in the 1970s and early 1980s may have been caused by loose monetary policy rather than supply shocks; the link to monetary policy was also highlighted by global monetarists in the early 1980s (eg McKinnon (1982)). Anzuini et al (2013) also find evidence that monetary policy can contribute to commodity price fluctuations by generating expectations of higher demand.

III. Commodity prices and EM inflation – empirical role of global supply and demand[11]

In this section, we examine the empirical evidence supporting the notion that recent commodity price developments have been driven significantly by global demand shocks. We begin by identifying global supply and demand shocks from a small-scale global macroeconomic model using a Blanchard-Quah identification scheme.

This Blanchard-Quah model and identification strategy yield global demand and supply shocks, denoted respectively with D_t and S_t. Graph III.1 plots the estimated global demand shocks from 2000 to 2012. The crisis and its immediate aftermath stand out. Starting in late 2008, demand shocks were persistently negative until one positive shock at the end of 2009, followed by smaller negative supply shocks. Prior to 2008, the demand shocks exhibited less amplitude in swings and were less correlated, but tended to be positive in the run-up to the crisis.

Having identified the global demand and supply shocks, we can now use them to estimate the components of commodity price inflation (π_t^{cp}) attributed to demand and supply shocks, respectively[12]:

$$\pi_t^{cp} = \alpha^{cp} + \sum_{k=0}^{4}\left(\beta_k^{cp} D_{t-k} + \theta_k^{cp} S_{t-k}\right) + \sum_{k=1}^{4}\gamma_k^{cp}\pi_{t-k}^{cp} + \varepsilon_t^{cp} \qquad \text{(III.1)}$$

[11] Further details on the empirical analysis and simulation results can be found in a forthcoming *BIS Working Paper* by the authors.

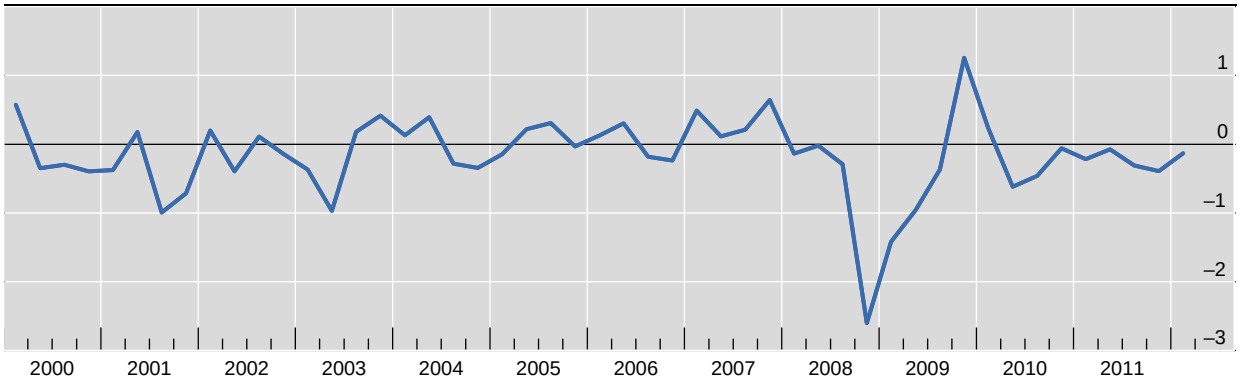
[12] The statistical issue of generated regressors applies here. While the coefficient estimators in this case are theoretically unbiased, the estimator of the variance-covariance is biased and may lead to an overstating of significance levels. Establishing the power and size of the tests is left for future research.

where $\pi_t^{cp,d} \equiv \sum_{k=0}^{4} \hat{\beta}_k^{cp} D_{t-k}$ and $\pi_t^{cp,s} \equiv \sum_{k=0}^{4} \hat{\theta}_k^{cp} S_{t-k}$.

Graph III.2 highlights the relative importance of global demand shocks in driving commodity price fluctuations. The red bars represent the demand component of commodity price inflation. They show that the demand component was typically negative in the early part of the 2000s, indicating that demand was acting as a headwind at the time. This component then turned around in the mid-2000s and was mainly positive. The most dramatic contributions for the demand component came at the depth of the international financial crisis when it was highly negative and persistent.[13]

Estimated global demand shocks

Graph III.1

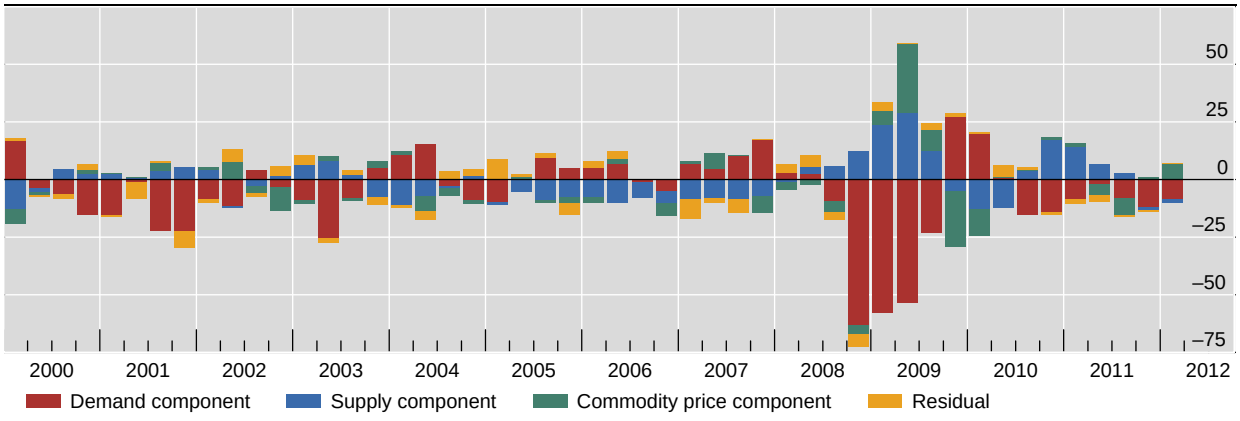


Estimated model described in equations (III.1) to (III.3).

Sources: IMF, *International Financial Statistics*; BIS calculations.

Demand, supply and commodity price components[1]

Graph III.2



[1] The components are estimated from the following regression: $\pi_t^{cp} = \alpha^{cp} + \sum_{k=0}^{4}(\beta_k^{cp} D_{t-k} + \theta_k^{cp} S_{t-k}) + \sum_{k=1}^{n4} \gamma_k^{cp} \pi_{t-k}^{cp} + \varepsilon_t^{cp}$ and defining $\pi_t^{cp,d} = \sum_{k=0}^{4} \beta_k^{cp} D_{t-k}$, $\pi_t^{cp,s} = \sum_{k=0}^{4} \theta_k^{cp} S_{t-k}$, and $\pi_t^{cp,cp} = \sum_{k=1}^{n4} \gamma_k^{cp} \pi_{t-k}^{cp}$.

Sources: IMF, *International Financial Statistics*; Datastream; BIS calculations.

[13] See BIS (2010) for more detail on the international financial crisis impact on Asia-Pacific economies.

We now turn to the pass-through of commodity price inflation to domestic headline inflation (π_t^h) and assess the relative contributions coming from the demand and supply components of commodity price inflation. The following equation is estimated for various economies:

$$\pi_t^h = \alpha + \sum_{k=0}^{4}\left(\beta_k^h \pi_{t-k}^{cp,d} + \theta_k^h \pi_{t-k}^{cp,s}\right) + \sum_{k=1}^{4}\gamma_k \pi_{t-k}^h + \varepsilon_t^h \qquad \text{(III.2)}$$

Graph III.3 succinctly summarises the findings from equation (III.2). The sum of the coefficients on the demand shocks is presented in the left-hand panel and on the supply shocks in the right-hand panel. What immediately becomes apparent is that the coefficients on the demand shocks are generally positive and exceed those on the supply shocks. The sum of the coefficients is generally statistically significant, as indicated by the red bars.

In addition, the sum of the coefficients appears to be larger and more statistically significant than the average result for the emerging markets as a whole (designated by EME) or for Latin American economies (designated by LAT). The individual Asian emerging market economies exhibit a fair amount of diversity, but headline inflation is much more sensitive to global demand side commodity price inflation than the global supply side commodity price inflation.

In a similar way, we now estimate the influence of the components of commodity price inflation due to global demand and supply shocks on core inflation (π_t^c), economy by economy:

$$\pi_t^c = \alpha + \sum_{k=0}^{4}\left(\beta_k^c \pi_{t-k}^{cp,d} + \theta_k^c \pi_{t-k}^{cp,s}\right) + \sum_{k=1}^{4}\gamma_k \pi_{t-k}^c + \varepsilon_t^c \qquad \text{(III.3)}$$

The regression uses autoregressive lags as well as four lags of the demand- and supply-driven components. Statistical tests are used to assess the adequacy of the fit.

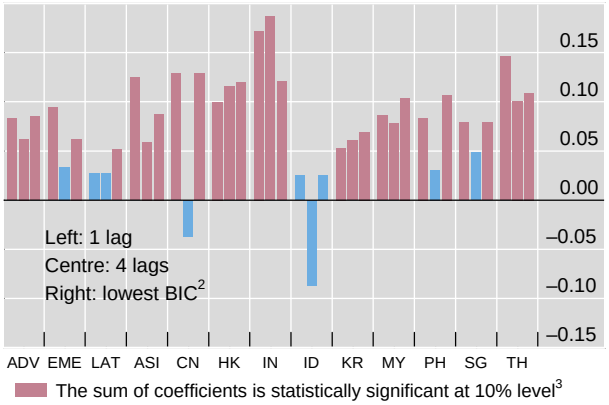
As might be expected, the influence of commodity price inflation on core inflation is generally smaller than in the case of headline inflation. Graph III.4 is designed in an analogous way to that of Graph III.3. A similar pattern emerges: the global demand component of commodity price inflation appears to be more often statistically significant and with a somewhat larger sum of coefficients than the global supply component of commodity price inflation.

Overall, this section has documented the important role that global demand shocks play in determining EM domestic inflation dynamics. We have found that global demand shocks are correlated with swings in commodity prices and the global demand-driven component of commodity price inflation is an important factor driving emerging market economy inflation dynamics.

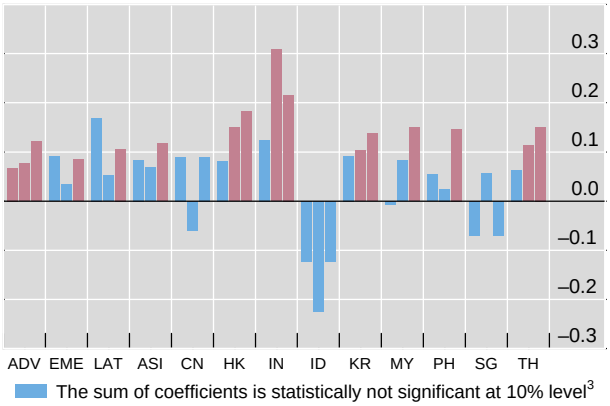
Pass-through of global commodity price inflation to domestic headline inflation[1]

Graph III.3

Sum of the coefficients of the demand component



Sum of the coefficients of the supply component



ADV = Australia, Canada, euro area, Japan, New Zealand, United Kingdom and United States; ASI = China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand; EME = Asia, Latin America, Czech Republic, Hungary, Poland, Russia, South Africa and Turkey; LAT = Brazil, Chile, Colombia and Peru. CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; KR = Korea; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand.

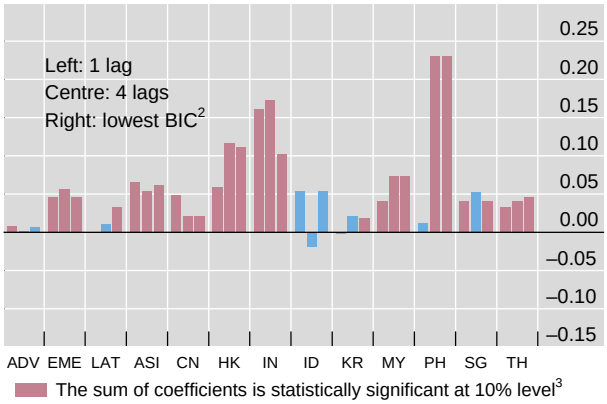
[1] Regression estimation of equation: $\pi_t^h = \alpha + \sum_{k=0}^{n}(\beta_k^h \pi_{t-k}^{cp,d} + \theta_k^h \pi_{t-k}^{cp,s}) + \sum_{k=1}^{n} \gamma_k \pi_{t-k}^h + \varepsilon_t^h$. Q1 2000–Q1 2012. Wholesale prices for India. [2] 1–4 lags. [3] According to the Wald test.

Sources: IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

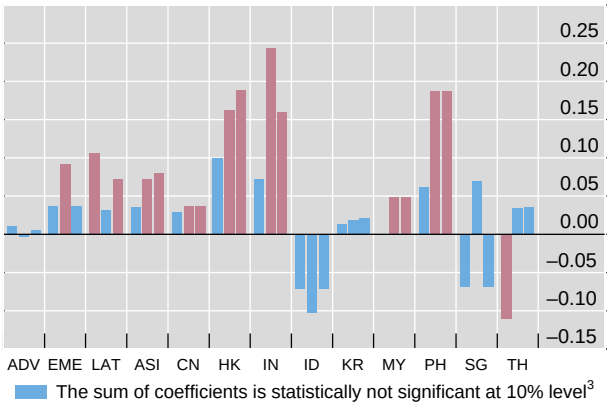
Pass-through of global commodity price inflation to domestic core inflation[1]

Graph III.4

Sum of the coefficients of the demand component



Sum of the coefficients of the supply component



ADV = Australia, Canada, euro area, Japan, New Zealand, United Kingdom and United States; ASI = China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand, where data are available; EME = Asia, Latin America, Czech Republic, Hungary, Poland, South Africa and Turkey, where data are available; LAT = Brazil, Chile, Colombia and Peru, where data are available. CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; KR = Korea; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand.

[1] Regression estimation of equation: $\pi_t^c = \alpha + \sum_{k=0}^{n}(\beta_k^c \pi_{t-k}^{cp,d} + \theta_k^c \pi_{t-k}^{cp,s}) + \sum_{k=1}^{n} \gamma_k \pi_{t-k}^c + \varepsilon_t^c$. Q1 2000–Q1 2012; for China and Malaysia, Q1 2006–Q1 2012; for Indonesia, Q3 2000–Q1 2012; for the Philippines, Q1 2007–Q1 2012. Wholesale prices for India. [2] 1–4 lags. [3] According to the Wald test.

Sources: IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

IV. Global commodity price swings and domestic inflation dynamics: a misperceptions modelling perspective

This section explores the question: do we need to rethink EM monetary policy frameworks when global demand shocks drive global commodity price swings and in turn EM domestic inflation dynamics? And, what are the implications for EM central bank monetary policy frameworks going forward in a more globalised world?

To address these questions, we explore a simple two-country monetary policy model in which commodity prices evolve endogenously and also play an important role influencing inflation dynamics. This is solved for the optimal monetary policy response given the array of possible shocks. The novel use of this model is to simulate the consequences of a central bank observing an increase in commodity prices due to buoyant global demand, but treating this as a commodity supply shock. This model demonstrates how misperceptions can lead a monetary authority to unwittingly induce procyclical monetary policy.

In terms of monetary policy framework implications, such misperceptions argue for EM central banks putting more weight on headline inflation rather than core inflation in monetary policy frameworks oriented towards price stability. This model also supports the case for greater regional and global cooperation as the global economy becomes increasingly integrated economically and financially.

IV.1 Simple monetary policy model

For each economy $i \in \{EM, ROW\}$, the following equations describe the macroeconomic setting.

Macroeconomic block – output and inflation

The macro block comprises four equations describing the dynamics of output, core inflation, headline inflation and global commodity price inflation. The output equation takes forward-looking specification and the coefficients may differ across economies:

$$\textit{IS curve: } y_{i,t} = -\beta_i r_{i,t} + \theta_i y_{i,t-1} + (1-\theta_i) E y_{i,t+1} - \kappa_i \pi_t^{cp} + \varepsilon_{i,t}^{y} \qquad \text{(IV.1)}$$

Output (y) is determined by the real interest rate (r), past and expected output, global commodity price inflation (π^{cp}) and an error term (ε). Global commodity price inflation adversely affects output in a manner consistent with a supply shock.

Inflation dynamics take on a dynamic Phillips curve specification in which the difference between headline and core inflation is highlighted.

$$\textit{Core inflation: } \pi_{i,t}^{c} = \tilde{\pi}_{i,t-1}^{c*} + \zeta_i E\pi_{i,t+1}^{c} + \gamma_i y_{i,t-1} + \alpha_i(\pi_{i,t-1}^{c} - \pi_{i,t-1}^{h}) + \varepsilon_{i,t}^{\pi^c} \qquad \text{(IV.2)}$$

$$= (1-\mu_i)\pi_{i,t-1}^{c} + \zeta_i E\pi_{i,t+1}^{c} + \gamma_i y_{i,t-1} + \alpha_i(\pi_{i,t-1}^{c} - \pi_{i,t-1}^{h}) + \varepsilon_{i,t}^{\pi^h};$$

$$\textit{where } \tilde{\pi}_{i,t-1}^{c*} = \mu_i \pi_i^{*} + (1-\mu_i)\pi_{i,t-1}^{c} \textit{ and } \pi_i^{*} = 0$$

In this equation, core inflation is a function of backward- and forward-looking inflation as well as the output gap, the gap between core inflation and headline inflation and an error term. The backward-looking component of core inflation is adjusted to take into account the strength of the anchoring of long-run inflation. In this case, the long-run inflation target is zero and μ calibrates the strength of this anchor.

Headline inflation: $\pi^h_{i,t} = \pi^c_{i,t} + \tau\pi^h_{i,t-1} + \iota_i\pi^{cp}_t + \varepsilon^{\pi^h}_{i,t}$ (IV.3)

Global commodity price inflation is by definition taken as a common variable that influences both economies. It is assumed to be driven by global demand and idiosyncratic supply shocks:

Global commodity price inflation:

$$\pi^{cp}_t = \phi\pi^{cp}_{t-1} + \omega_{EM}\, y_{EM,t} + \omega_{ROW}\, y_{ROW,t} + \varepsilon^{\pi^{cp}}_t \quad \text{(IV.4)}$$

This specification allows the coefficients on country-specific output to differ. A larger weight on EM reflects the greater commodity intensity of emerging market economies per unit of output. In other words, a given unit of output in EM has a larger demand impact on commodities than a similarly sized increase for the rest of the world (ROW). Implicitly, the contemporaneous output terms capture the impact of the central banks' reaction function.

For completeness, the error terms $(\varepsilon^{y}_{i,t}, \varepsilon^{\pi^c}_{i,t}, \varepsilon^{\pi^h}_{i,t}, \varepsilon^{\pi^{cp}}_t)$ are assumed to be i.i.d. normally distributed random variables with constant variances.

Monetary policy block

Monetary policy is assumed to follow a Taylor-type rule assuming policy rate inertia:

$$r_t = R_t - \pi^h_t = \lambda\pi^c_t + \delta y_t + \eta r_{t-1} \quad \text{(IV.5)}$$

In each economy, the monetary authority sets the interest rate so as to minimise the losses associated with the variance of output, inflation and the volatility of interest rate changes. In particular, the central bank's decision problem is a conventional one. The loss function for each central bank is $L_i = \text{var}(\pi_i) + \nu_y \text{ var}(y_i) + \nu_r \text{ var}(r_i - r_{i,-1})$, where the preference parameters are assumed (without loss of generality) to be the same. The decision for each central bank is:

$$\underset{\{\lambda_i,\delta_i,\eta_i\}}{Min}\; L_i = \text{var}(\pi_i) + \nu_y \text{ var}(y_i) + \nu_r \text{ var}(r_i - r_{i,-1}) \quad \text{(IV.6)}$$

subject to equations (IV.1) to (IV.5). The resulting dynamic two-country model is the baseline model for the simulations.[14]

IV.2 Results

In this section, we first present the baseline results from the model under the assumption of complete information. We then compare the impulse response from

[14] The model is solved using Dynare by iterating over equation (IV.6) for each economy. The calibrated parameters in the baseline model are listed in Table A1 in the Annex.

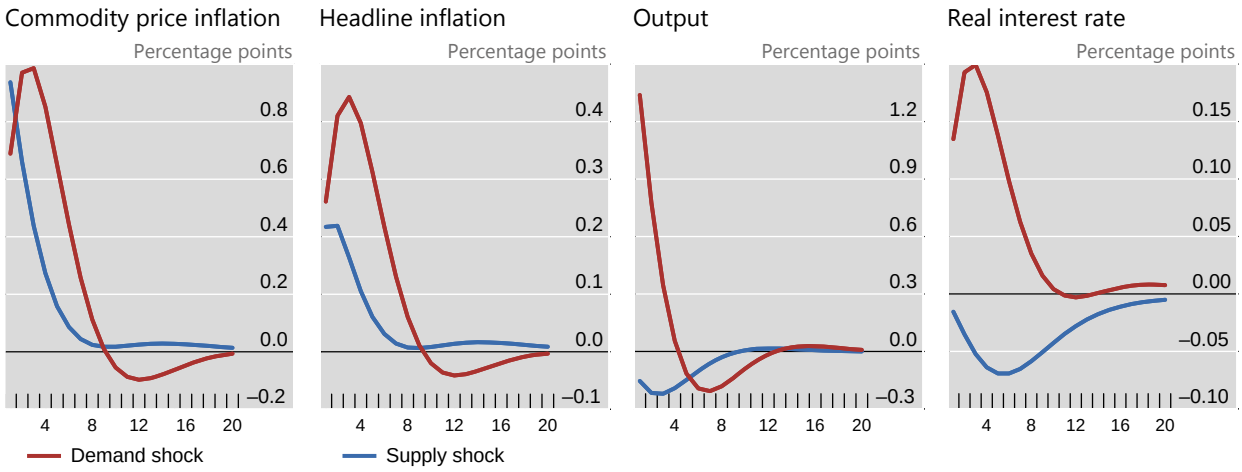
the baseline model with the impulse responses from a model in which the EM monetary authority misinterprets an increase in commodity prices as a global commodity supply shock instead of global demand shock. We highlight how this misdiagnosis leads to (ex post) procyclical monetary policies relative to the baseline.

Baseline results

In Graph IV.1, we report the response of commodity prices, headline inflation, output and the real interest rate to a global demand shock (red line) and a commodity supply shock (blue line). Starting from the left-hand panel, we report the responses of commodity prices to the two different shocks: the responses are quite similar. Also the impact of the two shocks on the dynamic responses of headline inflation are similar, although the degree of pass-through differs somewhat. The responses of output to the shocks, however, are quite different: the demand shock has an expansionary impact, whereas a commodity supply shock has a contractionary one. As a consequence, it is not surprising that the optimal monetary policy responses differ as well: in the presence of a commodity supply shock, the central bank accommodates the decline in output, whereas it tightens in the presence of a demand shock.

Response to demand and supply shocks[1]

Baseline[2] Graph IV.1



[1] Responses of selected variables to a unit shock to global demand and to commodity supply. [2] Calibrated parameters as in Table A1.

Source: Authors' calculations.

This indicates the importance of correctly identifying the source of shocks in the formulation of monetary policy. However, it should be noted that distinguishing the source of the shocks may not be straightforward – for example, by merely observing the behaviour of commodity prices or inflation. Because the responses of commodity prices (and headline inflation) to the two types of shocks are similar, the only way to pin them down in this setting is to look at output dynamics. However, data on output are noisy, subject to significant revision and only available after a delay. All these considerations highlight the risk of ex post policy mistakes due to the misdiagnosis of the source of shocks.

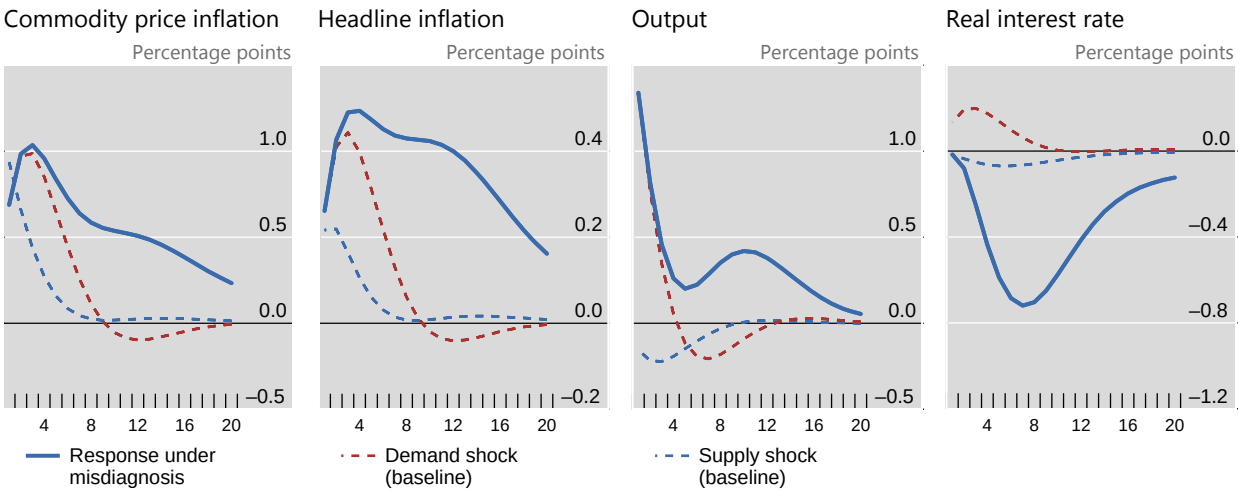
Accounting for misdiagnosis risk – misdiagnosing a global demand shock as an external supply shock

Armed with these simulation results, we now turn our attention to the implications of central bank misperceptions. The scenario we have in mind is one in which the monetary authority mistakenly interprets a change in commodity price inflation due to a global demand shock as a commodity supply shock. In the baseline, it is assumed the monetary authority correctly diagnoses the source of the shocks. In the misdiagnosis case, we assume the monetary authority does not realise its mistake throughout the simulation.[15]

Results of this counterfactual simulation are found in Graph IV.2. In the right-hand panel, the blue line represents the response under misdiagnosis. Initially, the blue line coincides with the optimal response to a commodity supply shock. This policy mistake is procyclical, stimulating more output and inflation than otherwise. In the second period and afterwards, the policy rate response reflects both the implied inherent persistence of a policy response to the initial commodity supply shock as seen in the baseline case and also the consequences of the policy error. This explains why the blue line deviates from the dashed blue line (ie from the baseline) across the simulation horizon.

Response to a policy misdiagnosis[1]

Policy rule with core inflation — Graph IV. 2



[1] Cumulated response to a sequence of policy mistakes. The dashed lines show responses of selected variables to a unit shock to global demand and to commodity supply, baseline scenario.

Source: authors' calculations.

The consequences of the misdiagnosis of the shock on headline inflation and output are reported, respectively, in the second and third panels. The additional stimulus due to the misdiagnosis does indeed stimulate the economy, and results in much higher and persistent inflation. The procyclical monetary policy also feeds

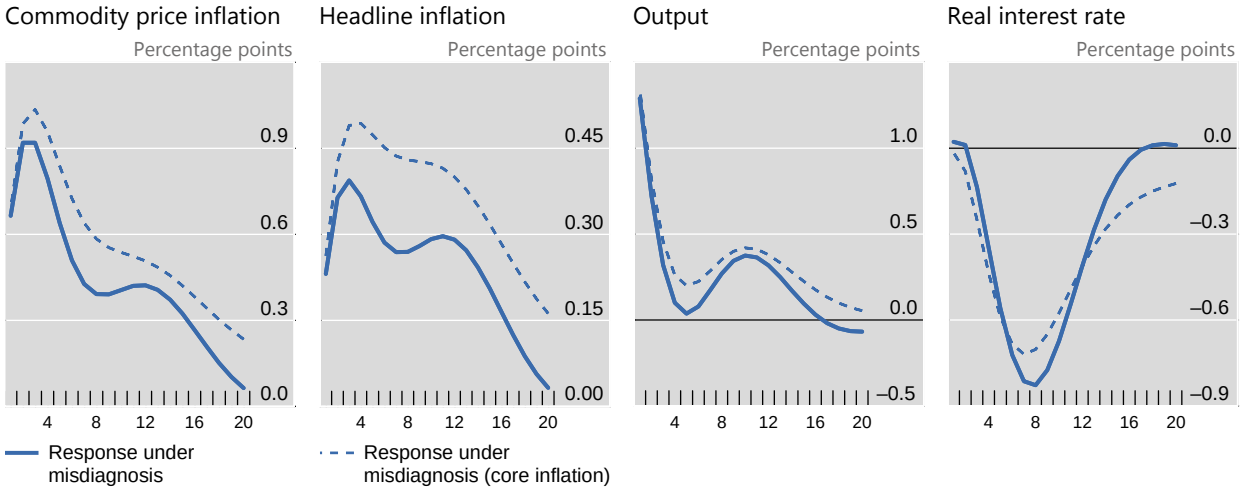
[15] In this model, we assume that the monetary authorities follow the implied policy response assuming a supply shock. In future research, we will explore this problem in an environment where the monetary authorities take account of possible misperceptions and optimally learn from the way the economy evolves.

back and fuels commodity price inflation (left-hand panel), thereby elongating the swing in commodity prices.

Finally, it should be noted that, in the presence of misdiagnosis risks of the type described above, targeting headline inflation (versus core inflation) generates more favourable monetary policy trade-offs. Graph IV.3 illustrates this by comparing the impulse responses under a headline inflation reaction function for the central bank and under a core inflation one. Both inflation and output return to the steady state more quickly under the headline rule.

Response to a policy misdiagnosis[1]

Policy rule with headline inflation — Graph IV.3



[1] Cumulated response to a sequence of policy mistakes.

Source: authors' calculations.

V. Policy implications and conclusions

This paper offers new evidence on the role of global demand and supply factors in driving global commodity prices and, in turn, the influence of these factors on domestic inflation dynamics in Asian emerging market economies. We have found that global demand shocks play an important role in domestic inflation dynamics in emerging markets and therefore have implications for the design of monetary policy frameworks in emerging market economies such as those in Asia. We have explored the policy trade-offs within the framework of a stylised monetary policy model, investigating the implied welfare losses from misdiagnosing the source of commodity price fluctuations, and building the case for putting greater weight on headline versus core inflation in economies subject to misdiagnosis risk.

The results in this paper turn the conventional wisdom about how to respond to commodity price developments on its head. The conventional wisdom that came out of the experiences of the 1970s and 1980s suggested that central banks should "look through" commodity price increases. This prescription in our model leads to poor macroeconomic outturns when there is uncertainty over the source of the shocks hitting the economies.

In this respect, our experiment has also underscored the importance for central banks of identifying the source of commodity price fluctuations in pursuit of price stability. Some have suggested that small, open economies cannot influence global economic conditions and therefore should treat global commodity price increases as an external supply shock. This country-centric perspective, however, ignores the global dimension and potential feedbacks of the problem. If all emerging market economies respond in the same way to global commodity prices as external supply shocks, the aggregate response will matter.

All this points to the conclusion that even small, open emerging market economies cannot afford to adopt a country-centric perspective in an increasingly globalised world. The collective actions have implications that spill over geographical borders and include feedbacks from the others which, when taken together, lead to suboptimal outcomes.[16] In this respect, efforts in Asia to promote regional cooperation and information-sharing are positive trends.

Beyond explicit monetary policy coordination, central banks can adopt various practices to mitigate the risk of monetary policy procyclicality with respect to commodity price swings. As highlighted in the policy simulations, greater focus on headline inflation targeting versus core inflation targeting would produce better outturns when there is misdiagnosis risk associated with commodity price movements. Of course, this is a second best outcome. The first best is based on an accurate assessment of both the nature of the shocks and the cross-border spillovers of policy actions.

Finally, to the extent that global forces are playing a more dominant role today and will continue to do so in the future, central banks have a role in ensuring that the public fully understands the changing nature of the monetary policy environment. This could be a communication challenge vis-à-vis commodity prices. It would require tearing down the conventional wisdom built up over the decades that "looking through" commodity price movements is the appropriate policy approach.

[16] See Taylor (2013) for a discussion of other types of coordination failures in the presence of global policy spillovers. See Filardo (2012a) for issues associated with global spillovers arising from monetary policy tail risks associated with asset price swings.

Annex

Calibrated parameters

Table A1

Equation	Parameter	EM	ROW
IS	β	0.10	0.10
	θ	0.50	0.50
	κ	0.05	0.02
PC	μ	0.55	0.55
	ζ	0.50	0.50
	γ	0.02	0.04
	α	–0.01	–0.01
Headline inflation	τ	0.34	0.12
	ι	0.25	0.05
Taylor rule	λ	0.01	0.03
	δ	0.10	0.09
	φ	0.85	0.90
Commodity prices	ϖ	0.35	0.15
	ϕ	0.80	
Loss function	ν_y	3.00	3.00
	ν_r	5.00	5.00

Source: Author's calculations.

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Comments on Andrew Filardo and Marco Lombardi's paper

Luis A V Catão[1]

This is a thought-provoking paper on a timely topic. The past decade has witnessed large swings in world commodity prices as global economic growth waxed and waned. While commodity prices have been better behaved over the past two years as global growth limped along, this state of affairs may not endure. As the global recovery strengthens, we may soon have to revisit the vexing issue of how national monetary policies should respond to imported commodity inflation – particularly, if food prices should again become the villain of the piece.

A long-standing dictum is that monetary policy should respond to commodity price fluctuations only if second-round inflationary effects should emerge. Reiterated time and time again in policy circles, this advice is often taken to imply that national monetary policy should focus on "core" consumer price index (CPI) inflation – even though the overwhelming majority of inflation targeting central banks have a clear mandate to target headline CPI inflation (see de Gregorio, 2012).

Filardo and Lombardi dispute this received wisdom. Their main contention is that inflationary and growth risks are non-trivial when commodity price pressures build up and when they stem from global demand shocks. In support of this contention, four pieces of evidence are presented. The first is a qualitative discussion of ongoing structural changes in global commodity markets, which suggests that the elasticity of commodity prices to global growth has risen significantly over the past decade. This is because of the higher weight of "commodity-hungry" emerging markets in global aggregates, and also because emerging markets are "high-beta" economies; the financialisation of commodity markets, prompting more immediate price reactions to demand-supply imbalances in global commodity markets, helps fuel underlying volatility.

The second and third pieces of evidence provided are regression-based. Filardo and Lombardi use the Blanchard and Quah decomposition in a VAR on global output and CPI inflation to show that demand shocks have been the main driver of global output and price developments since 2007, and that global commodity prices were far more responsive to global demand shocks in 2007–09 than to supply shocks.

They then estimate pass-through coefficients from global commodity prices to headline CPI inflation in several emerging markets, distinguishing the supply from the demand component of global commodity prices. The finding is that the pass-through associated with the global demand component typically far outweighs that of the global commodity supply component. They also find that pass-throughs are generally higher in emerging Asia than elsewhere, particularly Latin America, and

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The views expressed here are the author's alone and should not be attributed to the JVI, the IMF, their management or board of directors.

that core inflation tends to converge back to headline inflation, but not the converse.

The authors wrap up their case for less lenient policy responses to imported commodity inflation with a simulated two-country world economy model with new Keynesian features. A key aim of this exercise is to gauge the effects on output and inflation of a response by central banks to global commodity prices as if these were driven by a commodity supply shock, when they stem in fact from a global demand shock. The model consists of three main behavioural equations and closes with a Taylor rule featuring interest rate smoothing. In the IS equation, commodity price inflation enters separately and affects output negatively; the dynamic Phillips curve features a distinction between headline and core inflation; and there is a behavioural equation linking global commodity prices to outputs in the two countries – the "emerging" and the "advanced" one – with coefficients proportional to the respective weights in global output. If the emerging economy central bank correctly observes the commodity shock, it should lower its policy rate under a supply shock and raise it under a global demand shock. In this case, ***core*** CPI targeting delivers higher welfare (measured in terms of output and core inflation variability). But if a central bank fails to observe the correct source of the commodity price shock, welfare losses are smaller if the central bank targets ***headline*** inflation. As an interesting spin-off from this exercise, the authors compute the welfare gaps between the two rules as the probability of misdiagnosis changes. If that probability is 50%, headline inflation targeting reduces welfare losses by about 12%.

I have four main comments. First, it is hard to disagree with the authors' diagnostic that far-reaching structural changes in global commodity markets and the higher emerging market share in global demand should entail a higher elasticity of commodity prices to global output than that observed historically.

In that light, however, my second comment pertains to the assumption, underlying their use of the Blanchard-Quah decomposition, that demand shocks are temporary. If main changes in global commodity demand patterns are structural, as the authors themselves argue, then what we typically think as a demand shock may not be so temporary. Indeed, the rising weight of fast-growing commodity-hungry emerging markets in global output is likely to continue. Looking at Graph III.2, it seems that the authors' result of a temporary demand shock driving global commodity prices is dominated by a one-off episode – the 2008–09 financial crisis. There may well be a more persistent demand component that is filtered out with the use of this decomposition scheme. The greater persistence of such a shock has potentially far-reaching policy implications – one being that fiscal policy may have a greater role to play in helping monetary policy to cope with highly persistent shocks to relative commodity prices. Relatedly, the authors note that they performed the Blanchard-Quah decomposition with data going back to the 1970s. Yet, only post-2000 estimates are plotted. As a model check, it would be instructive to know if their VAR characterises the global relative price shocks of the 1970s and 1980s. Likewise, it would be instructive to see how robust their results are to dropping the 2007–09 boom and bust from their sample. My other suggestion would be to include global commodity prices in the VAR (as well as other known determinants of world commodity prices, such as the US short-term interest rate); one could then gauge the sensitivity of commodity prices to global supply and demand shocks more directly and more thoroughly. That would be technically more involved but may well result in somewhat distinct estimates: allowing for feedback effects of commodity supply shocks on overall global output demand and supply may change the VAR coefficients quite a bit.

My third comment focuses on the cross-country heterogeneity of pass-throughs from global commodity prices to domestic CPI inflation. One reason why pass-throughs in emerging Asia are higher seems to be related to a lesser degree of exchange rate flexibility than in other countries/regions (notably Latin America). Whether the global commodity shock stems mostly from demand versus supply arguably should not matter as much, as differences in exchange rate regimes are starker. Structural differences in production structures could also be played out more in the analysis, as they should heavily influence pass-throughs. For instance, some countries (eg China) are major net commodity *importers*; others (eg Indonesia) are major net commodity *exporters*; and others have a more balanced commodity trade. These should entail non-trivial cross-country differences in terms of trade, output, and inflation responses to any given global commodity shock. Likewise, there are wide cross-country differences in financial openness – no matter which of the existing indices one uses (eg Chinn-Ito's, Quinn's, Schindler's, or the Lane-Milesi-Ferretti data). These differences should also have a non-trivial effect on pass-throughs.

This takes me to my fourth and last comment: it seems unlikely that one-rule-fits-all is good policy advice. In Catão and Chang (2013a and 2013b), we show that the welfare superiority of distinct inflation targeting rules (such as headline CPI targeting versus producer price index targeting, versus exchange rate pegs) depends non-trivially on production structure and trade elasticities, as well as on the degree of international financial integration. This also implies that, even if all countries choose to target headline CPI, those structural differences may call for variants around the broad targeting rule. These variants can take the form of:

- wider or narrower tolerance bands around the central inflation target;
- differences in targeting horizons;
- different weights on the output gap in the Taylor rule; or
- distinct reliance on foreign exchange market intervention.

This broad point, however, does not imply that the authors' criticism of country-centric approaches to monetary policy is not well taken. Indeed, externality problems generated by a Nash-type approach to national monetary policies have been well acknowledged in the recent literature on open economy macroeconomics (see Corsetti et al, 2010, for a review). Further, and beyond strict macro considerations, leaving global CPI un-anchored on the face of large shocks to food prices, for instance, may have major effects on income distribution that are neither economically optimal nor politically palatable.

In short, this is a stimulating paper leaving us with much food for thought. I find myself in broad agreement with its appraisal of global commodity market developments; and while thinking that the econometric analysis of global supply and demand shocks could be more thorough, the findings on the cross-country diversity of pass-throughs and dynamics of headline CPI convergence to core CPI inflation are very interesting. Building more structure into the canonical new Keynesian setup so as to zoom in on the roles of country-specific production structures, trade elasticities, and forms of financial imperfections on optimal policy rules, under both Nash and cooperative solutions, should have high priority in this research agenda.

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Inflation and China's monetary policy reaction function: 2002–2013

Eric Girardin, Sandrine Lunven and Guonan Ma[1]

Abstract

Our paper attempts to enhance the understanding of China's monetary policy rule, which may help explain the country's remarkable inflation performance over the past decade, in spite of the absence of explicit inflation targeting. In particular, we aim to shed light on the role of inflation in the conduct of monetary policy by the People's Bank of China (PBC) in the New Millennium, when both the underlying economy and its monetary policy framework were transformed. We develop a new monetary policy index (MPI) in China by combining quantity, price and administrative instruments and estimate a hybrid (backward- and forward-looking), dynamic, discrete-choice model for the period 2002–13.

Three main results arise from the paper. First, the Chinese monetary policy changes under PBC Governor Zhou from 2002 onwards have been relatively hawkish and smoothed. Second, the PBC appears to have built up a monetary policy framework similar to implicit flexible inflation targeting, with a hybrid reaction function, seemingly taking into account the forward-looking aspect of inflation. Third, the PBC's behaviour post-2002 resembles that of the post-1979 anti-inflation policy of the G3 central banks, albeit with a high output weight typical of emerging economies.

Keywords: monetary policy in China, People's Bank of China, Taylor rule, inflation targeting

JEL classification: E52, E58, O11, O52

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1. Introduction

With China's rising role in the global economy and markets, economists have become more interested in understanding the complexity of its financial system development and the way its central bank conducts monetary policy. China's economic performance has been impressive over the past decade, with high GDP growth (around 10% per annum) and low CPI inflation (around 2% on average). An interesting question concerns the role of inflation in China's monetary policy decisions helping to deliver good inflation performance, while policy is not officially targeting inflation. Filardo and Genberg (2009), examining the inflation performance in the Asia-Pacific region, argue that formal inflation targeting is not the only monetary policy framework capable of delivering price stability. This paper attempts to determine the relevance of the "price stability paradigm" in the case of China, defined as a strong response to price developments to achieve low and stable inflation (Creel and Hubert (2010)).

Many questions over China's monetary policy rule remain open, most importantly the issue of the appropriate left-hand-side variable. Indeed, properly measuring the monetary policy changes is crucial to a better understanding of the conduct of monetary policy in China. Conventional measures of monetary policy have many drawbacks (for an overview, see Garcia-Herrero and Girardin (2013)). To address these drawbacks, we build on the work of He and Pauwels (2008) and Xiong (2012) and construct a new aggregate measure of China's monetary policy by combining the multiple price, quantity and administrative instruments deployed by the PBC. However, our measure goes one step further by calibrating the changes in these instruments in a way that allows for an interpretation of this new measure in terms of a "27 basis point equivalent" change in the policy rate.

To capture the characteristics of the monetary policy rule in China, we proceed to estimate a dynamic, hybrid discrete-choice model. We use the Bayesian method proposed by Dueker (1999) and Monokroussos (2010), combining *data augmentation* and *single-move Gibbs sampling* of the Markov Chain Monte Carlo literature. The model they use has many advantages, such as taking into account the discrete nature of the monetary policy instrument. We also examine the relative weight of the backward- and forward-looking aspects in the Chinese monetary policy rule for the period 2002–13.

Our paper contributes to the literature with the following three main findings. First, our new monetary policy index (MPI) shows that, under the Zhou Governorship of 2002–13, monetary policy features relatively hawkish changes and a style of small but frequent steps. Second, the chapter provides empirical evidence that the PBC has engaged in a regime that looks a lot like informal flexible inflation targeting, with a weight on inflation similar to levels seen in other major economies (with a long-term coefficient higher than unity). Moreover, China's central bank has been using a hybrid reaction function, both backward-looking and taking into account forward-looking aspects of inflation, with an overall coefficient of inflation higher than the 1.5 level originally suggested by Taylor (1993) as describing the monetary policy rule of the US Federal Reserve. Third, the paper presents empirical evidence that the rule followed by the PBC over the period 2002–13, under the Governorship of Zhou Xiaochuan, shares similarities with the post-1979 anti-inflationary policy of G3 central banks. While the weight on output is much higher in the PBC's monetary policy rule than in those of the G3 central banks, it is on a par with those of most other emerging economies.

The rest of the paper is organised as follows. Section 2 presents the literature, while Section 3 describes the construction of a new measure of the monetary policy changes in China. Section 4 discusses the estimation method and data, and Section 5 presents the estimation outcomes. The final section concludes.

2. Case studies on China's monetary policy rule

Our paper builds in part on the existing literature of empirical research on the conduct of monetary policy in China, which can be divided into two main categories. The first category of works tries to transpose a specification standard for major OECD countries to the case of China. This strand of research typically models the interbank interest rate in line with the methodology of Clarida et al (2000). Xie and Luo (2002) is probably the first paper formally applying the Taylor rule to the case of China in the 1990s. The paper takes a standard Taylor rule to compute the implied policy rate and compares it to the actual interest rate. They conclude that the two broadly track each other in most cases but policy responses sometimes lagged behind the business cycle.

Focusing on movements of the Taylor rule over time, Zheng et al (2012) use a regime-switching forward-looking specification estimated with the two-step maximum likelihood procedure of Kim et al (2006). They conclude that the magnitude of the response to inflation was larger in 1998–2002 than during previous periods. Chen and Huo (2009) consider a forward-looking Markov-switching, and a time-varying parameter, model to estimate the changing coefficients of the monetary policy reaction function in China. They assume that the PBC adjusts the M2 growth rate in response to inflation and the output gap and find two structural changes in the Chinese monetary policy rule, the first one around 1998 and the second around 2002–03. Moreover, they conclude that a pure forward-looking monetary policy rule cannot fully explain the Chinese situation and that the PBC is partly backward-looking. Indeed, they show that the responses to the lagged inflation variables are statistically significant after 2002.

However, one drawback of the analyses in this category is their questionable measures of the monetary policy in China. Zheng et al (2012) choose China's interbank offered rate (CHIBOR) as the policy rate, along with Xie and Luo (2002). As Garcia-Herrero and Girardin (2013) argue, the liquidity in the CHIBOR market may not be deep enough, at least in the 1990s. He and Pauwels (2008) argue that short-term interbank interest rates are not a good measure of policy due to market segmentation. Besides, M2 is not controlled by the authorities and may not be a good monetary policy proxy.

Therefore, the second category of works aims at better measuring monetary policy, using an approach pioneered by Gerlach (2004) to construct an implicit index of the ECB's monetary policy changes from the observed changes in the policy instruments. It takes the form of a discrete variable with three classes: "hawkish", "neutral" and "dovish". Then ordered-probit techniques are used to estimate the reaction function. He and Pauwels (2008) compute a measure of the PBC's policy changes by studying changes in various PBC policy instruments over the period 1992–2007. Their monetary policy rule estimation reveals that deviations of CPI inflation from an implicit target and deviations of broad money growth from the announced targets figure significantly as determinants of the PBC's policy changes, but not the output gap. They conclude that these findings are consistent with a

characterisation of the monetary policy framework in China as one of "implicit inflation targeting".

Xiong (2012) follows the qualitative-variable methodology of He and Pauwels (2008) and tests a forward-looking specification by examining the PBC's statements in its quarterly *Monetary Policy Executive Report*. He concludes that monetary policy reacts to actual output growth. But, when deviations from trend levels are considered, the PBC responds more to inflation. In the forward-looking model, he finds that inflation plays a key role in determining the PBC's policy moves. Finally, Shu and Ng (2010) use a narrative approach by compiling indices of the PBC's policy stance on the basis of meeting notes and the policy statements. They test various objective variables and find that growth and inflation are key monetary policy determinants and that the PBC appears to follow a rule of thumb, using historical averages as target rather than official targets.

3. Measuring monetary policy in China

A proper measurement of monetary policy changes is crucial in China's case. The PBC's conduct of monetary policy differs significantly from that of central banks in most of the major OECD economies. These central banks typically implement monetary policy using a short-term interbank interest rate as the main operating target, such as the Fed funds rate for the United States and EONIA for the euro area. Instead, the PBC deploys multiple policy tools to implement its monetary policy.

There are three main categories of policy instruments employed by the PBC: (i) price-based instruments, such as interest rates on bank deposits and lending, as well as on required and excess reserves, or PBC refinancing;[2] (ii) quantity-based instruments, such as the reserve requirement ratio (RRR) and open market operations (OMOs); and (iii) administrative window guidance, which the PBC also uses to influence bank lending, and which is not directly observable. These instruments may in turn influence interbank market interest rates, which can also be affected by other market demand and supply factors in the broader financial system.

To make the task of measuring monetary policy more challenging, the mix of these instruments has evolved over time. The RRR was first introduced in 1998 but not often adjusted until the mid-2000s. The PBC started conducting OMOs on a regular basis in 1998 and selling its own bills on a meaningful scale in 2002. From late 2007, the PBC increasingly used the RRR to drain liquidity (Ma et al (2011)), mainly because its use to withdraw liquidity on a more permanent basis is more cost-effective from the PBC's point of view.

Simply put, there is no single policy tool, interest rate or otherwise, that can properly summarise the monetary policy of the PBC. This points to the need for a composite measure that can reflect the changing mix of policy instruments used by the PBC. We take on this challenge by constructing a new measure of the monthly MPI in four main steps.

[2] From July 2013, all bank lending rates are no longer directly regulated by the government.

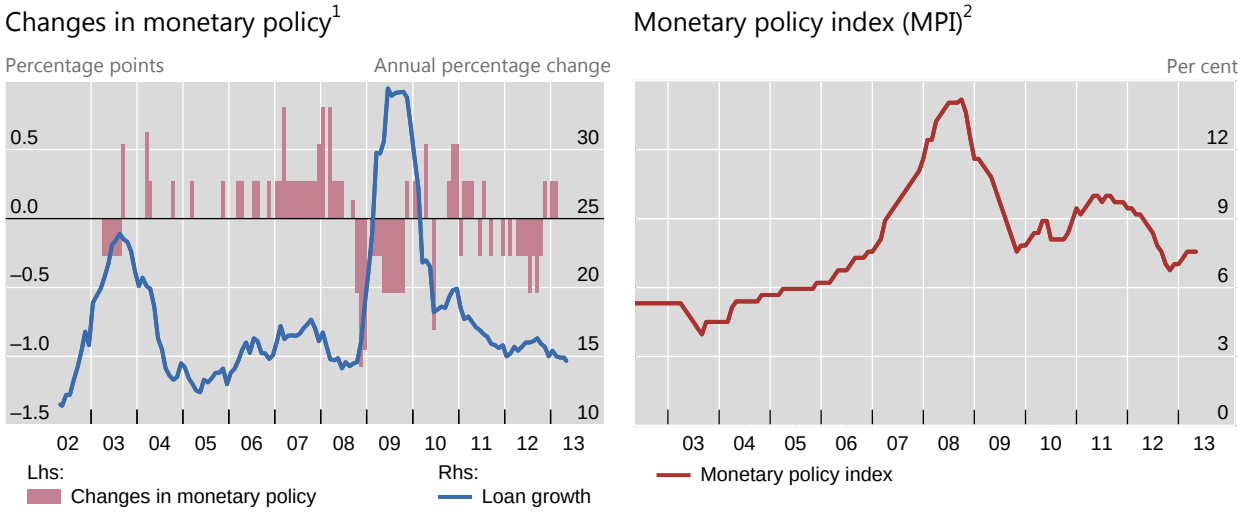
The first step is to compute a monthly "27 basis point equivalent" change in the policy rate for each instrument. This 27 bp change corresponds to the usual move on all regulated bank deposit and lending rates and interest rates paid by the PBC. Next, the RRR usually moves by 50 bp, which we assume to be equivalent to a 27 bp change in the policy rate. Finally, we convert a given net monthly liquidity change from OMOs into an equivalent 27 bp rate change in the following way. A net monthly liquidity withdrawal or injection from OMOs is viewed as a tightening or easing move. He and Pauwels (2008) and Xiong (2012) take the threshold of CNY 200 billion as equivalent to a 50 bp change in the RRR. We assume this threshold to be equivalent to a 27 bp change, while CNY 350 billion is equivalent to a 54 bp change and CNY 500 billion to a 81 bp change.

The second step is to combine these monthly 27 bp equivalent changes of various instruments. We adopt the following simple aggregation rules: (i) If different policy instruments move in opposite directions in a given month, we sum their monthly "27 bp equivalent" variations. (ii) If all policy instruments move in the same direction in that month, we keep only the instrument change that gives rise to the maximum monthly "27 bp equivalent" change. In this case, we do not take into account multiple variations of different instruments. The intuition is that the PBC typically changed both deposit and loan rates in the same direction by 27 bp, which should not be regarded as a policy move of 54 bp. Also, a mix of rate and quantity tool changes in the same direction should be viewed as a change in the quantity tool to ensure the money market rates move in line with the prevailing deposit and lending rates. Therefore, our measure of changes in monetary policy enables us to interpret coefficients in a similar way to the Taylor rule, as it captures the magnitude of instrument changes, an addition to the pure qualitative-variable approaches used in Gerlach (2004) for the ECB, and He and Pauwels (2008) and Xiong (2012) for the PBC.

The third step is to take into account possible informal credit quotas and window guidance, which are not directly observable, and to adjust for effects of the Chinese New Year. First, following Xiong (2012), we approximate the administrative window guidance in terms of unusual loan-growth acceleration. We define a "minus 27 bp equivalent" change if year-on-year loan growth accelerates above 20% and a "minus 54 bp equivalent" change if loan growth accelerates above 30%. It is particularly important to take this into account since directing a record growth in bank credit was the means found by the Chinese authorities to sidestep the (lack of effectiveness of the) transmission mechanism which handicapped quantitative easing in the G3. Second, we adjust for Chinese New Year effects, as liquidity is typically injected before the Chinese New Year and withdrawn soon afterwards.

The resultant measure shows an interesting historical pattern of monetary policy changes (Graph 1, left-hand panel). The policy moves during 2002–13 are mostly hawkish. The start of the Zhou Xiaochuan Governorship in December 2002 represents a combination of a liberalisation process, culminating in China's WTO accession (in late 2001), and a period of strong growth and some emerging price pressure. The restrictive policy changes intensified during the subsequent 2006–08 episode of food price inflation and rapid foreign currency reserve accumulation. Second, this also seems to display a distinct monetary policy style, characterised by relatively small but frequent policy steps (with six policy moves a year), ie a smoothing and not abrupt policy style. Indeed, more than two thirds (52 out of 74) of the policy changes during 2002–May 2013 are 27 bp equivalent or less.

Monetary policy stance in China Graph 1



[1] 27 basis point equivalent change in policy rate. [2] The starting point of the MPI in January 2002 is taken as the one-year lending rate in that month.

Sources: CEIC; authors' computation.

Before the estimation of the policy reaction function, we transform our measure of the changes in monetary policy into a monetary policy index (MPI) by cumulating the monthly variations from January 2002 onwards (Graph 1, right-hand panel). This procedure enables us to interpret the coefficients of the explanatory variables in line with the Taylor rule conventions.

4. Methodology and data

This section describes the data issues and discusses the methodology which allows us to deal with both the discrete nature of MPI changes and to interpret our findings along the Taylor-rule specification in the case of China.

4.1 Estimation of the Taylor rule

Our empirical analysis is based on the methodology of Monokroussos (2010), which is itself an extension of the approach suggested by Dueker (1999). This approach emphasises the discrete nature of monetary policy changes, which, as pointed out by Dueker (1999), poses special challenges to empirical analysis. They propose a model belonging to the multinomial ordered probit family because the size of possible monetary policy actions is limited (such as, in our case, multiples of 27 basis points) and such actions are ranked (monetary policy is considered more hawkish when the index changes by 54 than by 27 bp). As in probit models in general, one models a continuous latent variable, the PBC's desired level for the MPI, which determines the behaviour of the observed discrete variable. However, their methodology also allows the use of the standard specification of the Taylor rule by capturing the "interest rate smoothing" aspect and accounting for both backward- and forward-looking inflation. This equation is described as follows:

$$MPI_t^* = \beta_{0,t} + \beta_{1,t} MPI_{t-1}^* + \beta_{2,t}\pi_{t-1} + \beta_{3,t} y_{t-1} + \beta_{4,t} E_{t-1}\pi_{t+3} + \varepsilon_t \quad (1)$$
$$\varepsilon_t \sim N(0, \sigma_t^2)$$

where MPI_t^* is the desired level of the MPI_t discussed in Section 3, π_{t-1} is lagged inflation, $E_{t-1}\pi_{t+3}$ is the expectation of future inflation one quarter ahead and y_{t-1} is lagged output.[3] ε_t is a normally distributed, mean-zero error term. We interpret β_1 as an indicator of the degree of smoothing of interest rate changes. $\beta_{1,t}$ close to zero (unity) suggests little (lots of) smoothing of policy rates. Moreover, Woodford (2001) and Sack and Wieland (2000) argue that the observed smoothing of the interest rate may indeed be optimal, even if the central bank is not explicitly concerned with interest rate volatility. Thus, equation (1) corresponds to a hybrid (backward- and forward-looking) specification.

It is worth noting that we introduce raw data on inflation and output growth rather than the usual output gap and deviations from the inflation target. The first reason is that, in China, such official targets are not announced as true objectives to be attained, as observed in G3 economies, but are rather published as guidance. As a result, economic growth (inflation) was generally higher (lower) than the targets over the past 20 years, which implies that official targets cannot be considered as good measures of potential or steady-state values.

While this methodology differs from the standard model in the literature (such as Clarida et al (2000)), it employs a similar specification by including (both backward- and forward-looking) inflation and output as explanatory variables. Moreover, estimated coefficients are interpretable as in a standard Taylor rule.

4.2 Data

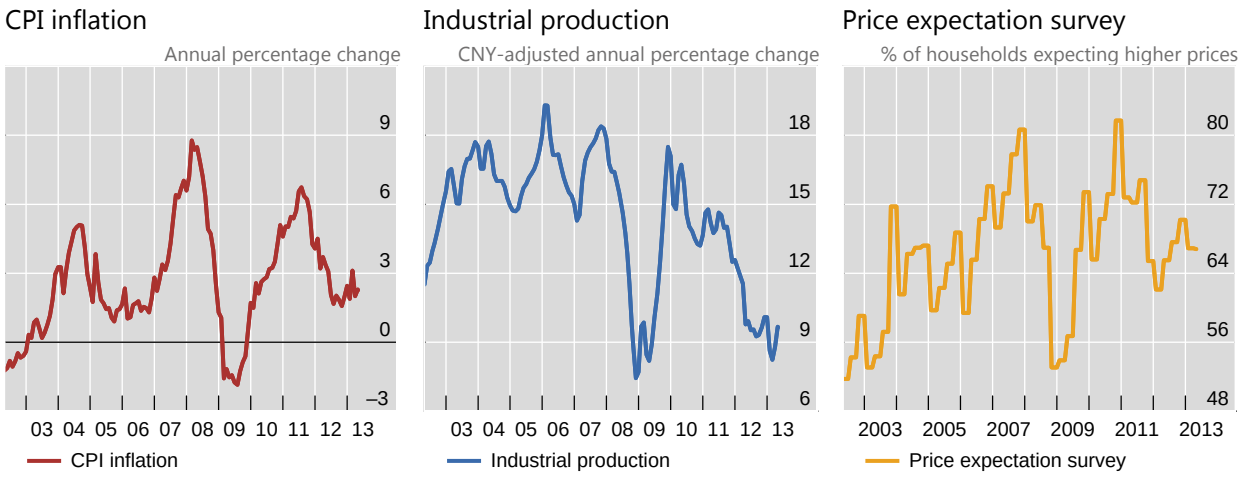
The data series used span the period from January 2002 to May 2013. For the economic activity variable, we use the level of industrial output in constant renminbi from China's National Bureau of Statistics.

Graph 2 highlights China's performance during the period 2002–May 2013, combining high output growth and low CPI inflation. This period witnesses an attractive inflation-growth trade-off, with interesting inflation and output dynamics. Indeed, CPI inflation was low on average but mostly on the rise, while output growth expanded strongly for most of the period.

Finally, we use the expectation of future price index from the PBC quarterly depositors' survey as our proxy of inflation expectations (the right-hand panel of Graph 2). We normalise the indicator, constraining it to lie within the same range as inflation. The PBC survey series, published quarterly (end of quarter), refers to expectations with respect to the next quarter. As we assume that this represents expectations for the whole quarter, we will need to take its lagged value in the estimation with monthly data and apply the same value for each month during the quarter.

[3] We have also tried to evaluate the effect of external factors (such as the Fed funds rate, effective exchange rate and foreign exchange reserves). However, results are not presented as their coefficients were insignificant.

Inflation, industrial production and inflation expectations in China Graph 2



CNY = Chinese New Year.

Sources: People's Bank of China; CEIC; NBS; authors' computation.

5. Empirical results

We estimate a hybrid monetary policy rule which integrates both backward- and forward-looking aspects, as in Equation 1. Table 1 summarises the long-term coefficients of the PBC's hybrid reaction function over the 2002–May 2013 period.

During 2002–13 under the Zhou Governorship, the PBC appears to have granted a substantial overall weight to inflation in the reaction function, at a level above unity, corresponding to international benchmarks. Such a result is consistent with the so-called Taylor principle. With such an anti-inflationary policy, the monetary policy of the PBC looks a lot like that of an informal inflation targeter. However, this targeting involves a high weight on output, larger than unity.

Long-term coefficients of the hybrid reaction function for China Table 1

PBC monetary policy	Inflation (1)	Expected inflation (2)	Total inflation (1) + (2)	Output
2002(1)–2013(5)	1.05	1.05	**2.1**	**1.15**

Note: short-term intercept (–0.6), and the coefficient for lagged MPI (0.97).

Source: Authors' computation.

In addition, the weight on expected inflation is substantial. Accordingly, a central bank implicitly targeting inflation understands that inflation expectations have to be considered in the conduct of monetary policy, notably to evaluate its own credibility and to ensure that inflation expectations are well anchored. In addition, with the gradual price liberalisation and labour market reforms, inflation expectations may play a role because they directly influence wage negotiations and

price setting in China, which in turn drive current inflation. These may help explain the PBC's use in the New Millennium of a hybrid reaction function that takes into account both expected and past inflation. A forward-looking component in the PBC's reaction function shows that the monetary authorities take into account the need to anchor inflation expectations (showing the vigilance advised by Zhang and Clovis (2010)), after a period when inflation may have become less persistent and less responsive to shocks (Filardo and Genberg (2009)).

It is instructive to compare the Chinese experience with that of other major central banks across different periods. Table 2 summarises the comparable results for G3 central banks. They include the estimates by Monokroussos (2010) for the Fed during the post-Volcker period, and by Clarida et al (1998) for the Fed during the period after October 1982 (the start of a new operating procedure), the Bundesbank (after the founding of the EMS in March 1979) and the Bank of Japan (after April 1979, a period of significant financial market deregulation).

As Clarida et al (1998) show, all the G3 central banks started targeting inflation in an implicit way from the late 1970s onwards, after a decade of high inflation. The subsequent Great Moderation was interpreted then as a sign of "the broad success of monetary policy in these countries over this time period" (Clarida et al (1998), page 1033).

Despite major differences in the economic context between the post-1970s and 2000s, a comparison of the Chinese and G3 reaction functions shows some interesting similarity.

Long-term coefficients in G3 reaction functions — Table 2

	Inflation[1]	Output[2]
US Fed reaction function		
Volcker-Greenspan period (August 1979–mid-1998)[3]	1.9	0.5
Volcker-Greenspan period (October 1982–December 1994)[4]	1.8	0.6
Other G3 reaction functions		
Bundesbank (April 1979–December 1993)[4]	1.3	0.25
Bank of Japan (April 1979–December 1994)[4]	2.0	0.1

[1] Expected inflation as independent variable. [2] Output gap as independent variable. [3] MCMC estimation by Monokroussos (2010). [4] GMM estimation by Clarida et al (1998).

Sources: Clarida et al (1998); Monokroussos (2010).

Indeed, the estimated responses to inflation by the G3 central banks[4] during the post-1979 period and by the PBC during the post-2002 period are strikingly close. Indeed, for both China and the G3, the long-term inflation coefficients are close to 2.0, meaning that such central banks' policies are anti-inflationary. These comparative findings strengthen the argument that the PBC may have adopted since the early 2000s a "state of the art" monetary policy rule, with the long-term inflation coefficient close to international benchmark values typical of major central banks. While the estimated weight on output in the PBC's policy rule is still high

[4] Interestingly, the estimation results for the post-1997 reaction function of the Bank of England similarly grant a large long-run coefficient for inflation (1.8, as reported by Adam et al (2005)).

relative to those for the G3, it is largely in line with the estimates for the emerging economies in general (Hofmann and Bogdanova (2012)) and India in particular (Singh (2010); Patra and Kapur (2012)). It can reflect both a high preference for output (with the usual caution that we cannot back out the implied weights in the preference function of the monetary authorities) and the structure of the economic transmission mechanism (see Hayo and Hofmann (2006)).

6. Conclusion

This paper aims at enhancing our understanding of China's evolving monetary policy during 2002–13. More specifically, we attempt to learn more about the PBC's monetary policy, the role of inflation (and output) in its reaction function and its policy style.

To meet the challenge that no single policy instrument represents a good proxy of China's monetary policy, we have built on previous work to develop a new composite measure to better gauge the changes in monetary policy by combining many price, quantity and administrative tools. Our constructed monetary policy index (MPI) seems to capture the important changes in China's monetary policy well and enjoys the advantage of being interpretable in line with the conventional Taylor rule based on a target interest rate.

To deal with the multiple challenges of smoothing behaviour, both backward- and forward-looking aspects, and discrete choices in the Chinese monetary policy rule, we have used a Bayesian method proposed by Dueker (1999) and refined by Monokroussos (2010) to estimate a dynamic hybrid discrete-choice model.

Our results convey a number of key messages. First, our new measure of China's monetary policy changes suggests that during the period 2002–13 the Chinese monetary policy featured hawkish changes and a smoothing style of frequent but small steps. This may reflect a combination of strong growth, increased price pressures and the new policy orientation of the PBC under the Zhou Governorship from December 2002.

Second, over that period, the PBC appears to place a large weight on inflation, lending support to the argument that its policy is similar to informal flexible inflation targeting. We also show that the PBC may be using a hybrid reaction function, both backward- and forward-looking. The PBC seems to have adopted a "state of the art" monetary policy rule, with coefficients of inflation and output growth similar to those of China's peers. Indeed, in the New Millennium the long-term coefficient on inflation in the PBC reaction function reaches similar levels to that of the G3 central banks prevailing in the post-1979 period. Moreover, the emerging economy character of China still matters, as the current weight on output is larger than those in the G3 countries but similar to the average for emerging economies.

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Comments on Eric Girardin, Sandrine Lunven and Guonan Ma's paper

Dong He[1]

I. What does this paper do and say?

First, this paper converts a bundle of monetary policy instruments into a single monetary policy index (MPI), and introduces the idea of "equivalent 27 basis point changes" in the policy index. It also integrates different instruments for each period of time, allows time-varying instrument components in the index, and measures policy stance in both directions and magnitudes.

The paper then uses this index to answer the following two relevant questions regarding the monetary policy rule of the People's Bank of China (PBC): which one is the PBC more responsive to, output or inflation? Is the PBC an inflation targeting central bank?

The paper finds that there is a clear change of policy style: big and infrequent policy changes before 2002, but frequent and small policy changes thereafter. It also finds that the PBC has attached a growing weight to inflation, as captured by empirical models (both backward-looking and hybrid). The paper argues that as inflation expectations tend to be increasingly important, this implies a more forward-looking style of the PBC's policy considerations.

II. Comments

I offer my comments on the paper by attempting to answer the following three questions: first, how should we define and measure China's monetary policy stance? Second, what are the implications of the changing relationship between the quantity and price of credit? And third, is the detected regime shift robust?

Measuring the PBC's monetary policy stance is a difficult task. According to Bindseil (2004), "the monetary policy stance at a certain moment in time consists of the prevailing value of the operational target and the expected changes thereof that result from the central bank's communication." However, the PBC does not publicly specify a clear operating target. While we know that PBC is in action when it moves any of its arsenal of policy instruments, its policy stance is in fact hidden behind the policy actions. In addition, whether a certain level of the operational target variable reflects a tight or loose stance cannot be determined independently of the circumstances. The MPI constructed by the authors may not be a good indicator of the PBC's policy stance because it relies solely on the observed changes in the PBC's policy instruments, and does not relate to the prevailing macroeconomic conditions.

[1] Hong Kong Monetary Authority.

One approach to gauging the PBC's policy stance is to treat instrument changes as "signals" of movements in the unobservable policy stance. Adopting this approach, He and Pauwels (2008) estimate a discrete choice model, which measures the PBC's policy stance as a latent variable that has realisations in the form of observed changes in the PBC's policy instruments. The authors run a discrete choice regression that relates these realisations of policy stance to major trends of macroeconomic and financial developments, which are represented by common factors extracted from a large number of variables. The fitted or predicted values of the dependent variable are taken as an indicator of the PBC's desired monetary policy stance. They found that, despite the more frequent policy actions taken by the PBC during 2007, the estimated implicit stance in late 2007 was actually looser than was observed in 2006. Thus, relative to the prevailing macroeconomic conditions, the strength of policy tightening during 2007 was probably weaker than commonly thought.

Any characterisation of the PBC's monetary policy stance also needs to take into consideration China's evolving monetary policy strategy. The broad context of the strategy is China's transition from a planned economy to a mixed economy, and then to a market economy. In this context, the PBC's monetary policy strategy has been shifting from a focus on the quantity of credit to the price of credit, and the transition is yet to be completed. The key question is then: how do we translate quantities into prices in measuring the PBC's policy stance? What is the "interest rate equivalence" of certain credit targets? The authors treat a rise of the RRR of 50 basis points as equivalent to a 27 basis point rise in the benchmark interest rate. This may be problematic because the strength of these two policy actions can be quite different.

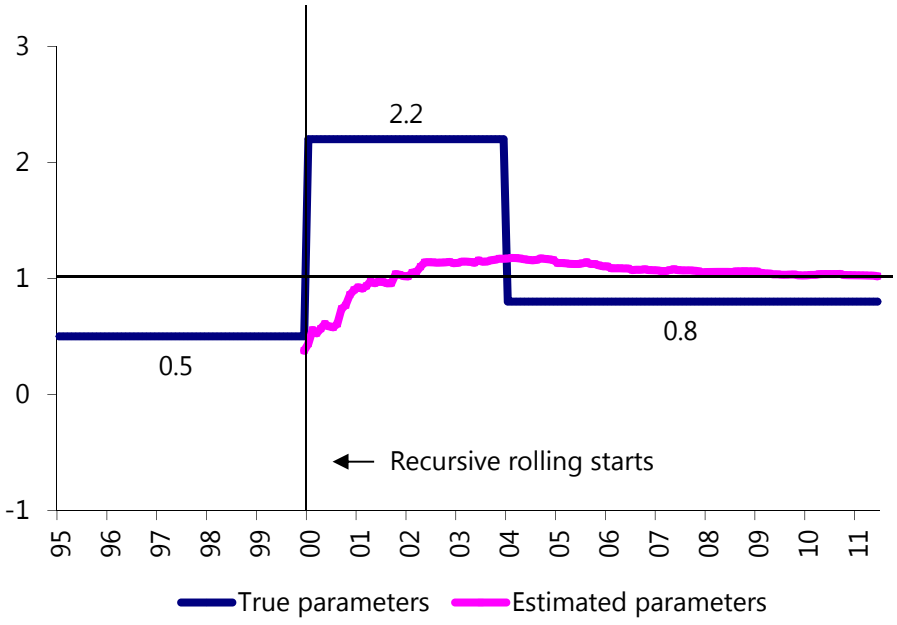
We need a benchmark in order to measure the strength of different policy instruments. He and Wang (2012) gauge the strength of policy instruments by examining their impact on the money and bond market rates, in the context of China's "dual-track" interest rate system. According to their findings, a 27 basis point change in the benchmark interest rate would be 1.3–1.5 times as powerful as a 50 basis point change in the RRR. However, this relationship might not have been the same back in the 1990s. In the 1990s, the interest rate elasticity of credit was very low, so small movements in the quantity of credit would imply very large interest rate changes. In the 2000s, the diversification of channels of financial intermediation and the emergence of "dual-track" interest rates imply that, in the banking sector, the interest rate elasticity of credit was probably still low; but in money and capital markets, the interest rate elasticity of credit was much higher. In fact, He and Wang (2013) find that the "loan rate is affected not only by the regulated benchmark deposit rate, but also by market-determined interest rates. On the other hand, loan size does not appear to be sensitive to either the regulated rate or the market rate; instead, it seems to be affected by an implicit quota imposed on aggregate bank lending as a policy instrument of window guidance."

The evolving relationship between the price and quantity of credit in China could imply that the authors may have underestimated the strength of PBC policy stance in the earlier period of their sample: PBC might well have been very hawkish against inflation in 1990s, as it reined in credit supply when credit demand was very strong. But we cannot measure the strength of such policy actions because interest rates were controlled and we could not observe credit demand.

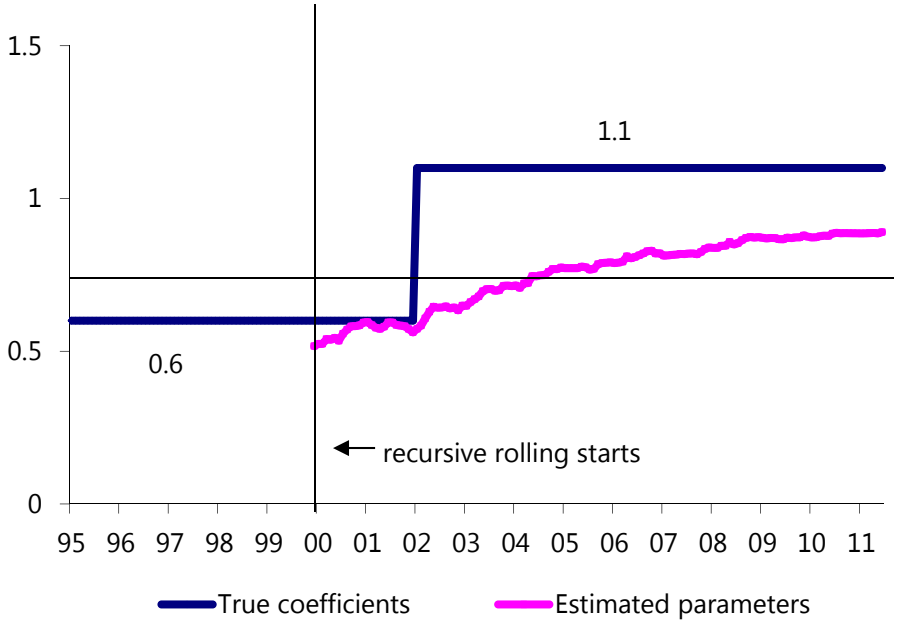
The authors detected a regime shift in the PBC's policy style – the Bank has become more hawkish toward inflation since 2003. Is this detected regime shift

robust? Or could it be just an artefact from the method of recursive regression? Graph 1 shows that estimated coefficients from a recursive regression can be easily affected by the early part of the sample. On the other hand, if the true coefficients of CPI were 0.6 before 2002 and 1.1 after 2002, then simulations show that the estimated coefficients from a recursive regression would increase over time (Graph 2). Since the authors believe that the sample period was characterised by two regimes, perhaps the model can be estimated for the two periods separately and the estimated coefficients can be tested to see whether they are significantly different.

Graph 1



Graph 2



III. Conclusions

This is an interesting paper addressing a very important question, and it contributes to a small but growing literature on the monetary policy framework of China, the world's second largest economy. Understanding China's monetary policy framework is difficult because it has a mixed financial system, characterised by a juxtaposition of quantity- and price-based policy instruments and the co-existence of regulated and market-determined interest rates. For future work, the authors may wish to strengthen their measurement of the policy stance, particularly in the earlier sample period. The authors may also wish to check whether the detected regime shift is robust to their estimation techniques.

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Closing remarks

Stephen G Cecchetti

This conference marks the completion of the two-year research programme on Globalisation and Inflation Dynamics in Asia and the Pacific conducted under the auspices of the BIS Asian Consultative Council.

This conference and the research programme more broadly sought to address three issues related to the overall theme of globalisation and inflation dynamics:

(i) Trade globalisation and inflation

(ii) Financial globalisation and inflation

(iii) Globalisation and monetary policy

We have covered quite a bit of ground during these one and a half days of presentations and discussions, so it will be impossible for me to do justice to all the insightful points that have been raised. Instead, I will try to summarise the progress we have made in increasing our understanding of these three topics, and share with you my views about what still remains to be done.

Let me start with trade globalisation and inflation. Many of us think of globalisation of trade as having lowered inflation through increased import competition from emerging markets. While the effects look like aggregate price changes, and may indeed be such in the short run, theory suggests that trade globalisation should mainly affect relative prices. And even if headline inflation rates do fall as a result of more intense import competition, the question arises: how long can such disinflationary pressures continue? Let me give you a tangible example. T-shirt factories are moving from China to Vietnam to Bangladesh. As they do, the prices of T-shirts fall. But the impact on the price of T-shirts will eventually run its course. And when it does, downward pressure on prices will abate.

A quite different type of impact on prices will arise from globalised supply chains, where different stages of manufacturing occur in different countries. Today, a typical factory producing electronic equipment in this region assembles products using parts imported from all over the world.

The research programme covered two areas relevant to the relationship of trade globalisation and inflation: supply chains and economic slack. On the first, Raphael Auer and Aaron Mehrotra conclude that cross-border cost spillovers in this region's manufacturing chains have an important impact on domestic producer prices. Moreover, the intensity of these spillovers is increasing in line with the growing use of imported intermediate inputs in various industries. One could conjecture, then, that supply chain globalisation leads to increased price flexibility. This, in turn, means lower inflation persistence and increased short-run inflation volatility. More generally, the evolution of supply chains is an important example of real factors affecting inflation dynamics, as mentioned by former Governor Shirakawa in his keynote address.

Turning to economic slack, the relationship of deviations of output from potential or natural output is a classic example of the link between real and nominal variables. But understanding that relationship requires that we have both a theoretical foundation for constructing a measure of potential output and the data

we need to carry out the analysis. Neither of these requirements is straightforward. Since we have competing, and largely insufficient, theories, it is difficult to know what to compute. Different models suggest different concepts, and their empirical counterparts vary accordingly.

When looking at the data, we must accept that data revisions are often quite large.[1] And, unfortunately, the initial estimates are the least reliable around business cycle turning points. That is, the data are at their worst when we need them the most. So, measuring economic slack is a formidable task; indeed, the challenge is made even the greater by globalisation, including the phenomenon that production is becoming global. How should we think about economic slack at the national level when trade is globalised?

In his paper presented at the conference, James Morley provides a measure of economic slack in a domestic context. His forecast-based model-averaged output gaps appear to be robust, which is important. However, as he goes on to show, the link between slack and inflation does not appear to be linear in many economies. This adds yet another layer of complexity to the use of output gaps in policymaking. Indeed, as Morley shows, slack is often a misleading indicator of future inflation.

Turning to the next topic, financial globalisation and inflation pose an important set of challenges for monetary policy. Given that increases in cross-border financial flows tend to boost policy spillovers, it is not surprising that this issue was the subject of much discussion during the last day and a half.

An intuitive way to think about financial globalisation is that the marginal unit of credit is cross-border. And this is probably what drives people to worry so much about the impact of external factors on financial conditions. Financial conditions become much more difficult to measure and to influence domestically in a world where credit is readily available from abroad.

It is interesting to ask how far financial globalisation can go. International asset positions currently stand at roughly 150% of GDP globally. This is much larger – about three times as large as a share of GDP – than was the case in the 1990s. My rule of thumb is that wealth is four times GDP. Then, perfect risk-sharing with all asset holdings in the form of equity would imply international asset positions of three times GDP. We're probably not going to get that far any time soon, but it gives you some idea how far we could move from where we are today.

On this topic, the work by Michael Devereux and James Yetman examines the impact of international risk-sharing on a monetary policy framework where interest rates are set to respond to domestic inflation, while at the same time sterilised FX intervention is used to stabilise the exchange rate. The authors find that increased risk-sharing is raising the cost of such a strategy. As a consequence, the policy responses that have been used to reduce exchange rate volatility and managing exchange rates more generally may have to change.

The third topic I will touch on is globalisation and monetary policy. Globalisation affects inflation dynamics, and therefore monetary policy, directly through commodity prices, inflation expectations and policymakers' responses.

As Andy Filardo and Marco Lombardi point out in their paper, commodity prices are increasingly driven by global factors. The authors emphasise the

[1] See eg Orphanides and van Norden (2002).

importance of global demand factors in particular, and the need to tailor policy responses to be consistent with the sources of the underlying shocks. This is especially relevant where food represents a significant fraction of consumer price indices, as it does in many emerging market economies. Policymakers who ignore a large and a highly persistent part of their inflation index do so at their peril.[2]

To be sure, the impact of globalisation on actual inflation dynamics depends on how stable inflation expectations are. Improved inflation performance in the region could be taken to suggest that inflation expectations have become more stable over time. An overriding theme in the study by Pierre Siklos is that average forecasts of inflation provide limited information to policymakers relative to the full distribution of the underlying forecasts. I think it may be increasingly relevant to construct portfolios of expectations rather than focusing on individual forecasts, given the loss functions of some of the forecasters. In particular, the way a forecaster becomes famous is by being right when nobody else is. And because this creates an incentive to be different, panels of forecasts may display artificial dispersion. But increased dispersion also provides relevant information for policymakers to the extent that it signals a drifting of expectations away from the central bank's target. One result that I think merits further study is that inflation targeting economies seem to be less influenced by inflation expectation spillovers than economies that manage their exchange rates.

Let me now turn to the issue of how central banks have responded to globalisation. The paper by Eric Girardin, Guonan Ma and Sandrine Lunven looks at the case of China. Given its rapid real and financial development, China provides an excellent case study for the effects of ongoing real and financial globalisation. Girardin, Ma and Lunven show how policy has evolved in the Chinese context; how policy has become more forward-looking; how the weight on inflation in the People's Bank's objective function has increased; and how the policy response seems to have become more gradual, resembling that of many other economies. The latter finding is probably not greatly surprising, considering the increasing diversity and size of the Chinese economy.

I often think of a research conference like this as a progress report on our thinking – nothing is the final word. So this leads to me to ask: where do we go from here?

On trade globalisation, has globalisation changed the relationship between real and nominal variables? Does it make sense to think about things such as economic slack at the national level? Or, do we need to focus on regional or global measures? And, more generally, how should we best include global considerations in our models?

On financial globalisation, there is no doubt that increased international risk-sharing has led to large policy spillovers. We need to understand better how large and costly those spillovers are, and how they can be identified in real time. Financial globalisation clearly has diversification, and therefore insurance, benefits. But are those greater than the costs of spillovers? This is related to the issue of whether central banks can control domestic financial conditions even when exchange rates are flexible. Put in another way, is the policy trilemma still out there? Or are we

[2] See eg Anand and Prasad (2012), who evaluate different inflation targeting rules in the presence of financial frictions.

losing degrees of freedom, with interest rates increasingly determined by global factors? This issue has been in increasing focus recently.[3]

Finally, are the benefits of policy coordination really first-order? There is an intuition arising from the envelope theorem that if you are close to optimal policy domestically, benefits from coordination are limited – even first-order problems will lead to second-order losses in terms of welfare. But sometimes, when you listen to policymakers, it appears that they do not fully buy into this story. Why is that? What are the externalities that render the welfare gains from changing the global policy framework so large? Or, alternatively, is it the case that we think of domestic policies as being far from optimal, so that coordination will lead to better outcomes?

To conclude, the presentations and discussions over the last day and a half have clearly increased our understanding about the complex relationships between globalisation and inflation dynamics. It is useful to investigate issues specific to the region and to learn from those. But ultimately, we need to think how these lessons can be applied globally. And I think we have already made quite a bit of progress on that front.

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[3] See eg Rey (2013).

Background paper

How anchored are inflation expectations in Asia? Evidence from surveys of professional forecasters

Aaron Mehrotra and James Yetman[1]

Introduction

Well anchored inflation expectations – where anchoring refers both to the level and variability of anticipated future inflation – are important for the monetary transmission mechanism. If inflation expectations are not well anchored, forward-looking price and wage-setting behaviour is likely to foment macroeconomic volatility. In standard New Keynesian models, for example, inflation depends in part on expected inflation. In such a framework, well anchored inflation expectations can significantly contribute to stabilising actual inflation.

Inflation performance has improved considerably in emerging Asia since the regional crisis in the late 1990s. This probably reflects changes in macroeconomic policies, at least in part. Some economies in the region have adopted inflation targeting frameworks, but the improvement in inflation performance has not been limited to the inflation targeters (Filardo and Genberg (2010)). However, keeping inflation stable in the region is not without its challenges. Volatile global commodity prices have made themselves felt in the fluctuations of headline inflation rates. Meanwhile, central bank balance sheets in emerging Asia have ballooned as a result of reserve accumulation. And unconventional monetary policies in the advanced economies may have contributed to strong capital flows into the region. If not well managed, such factors could affect the anchoring of inflation expectations, and complicate the central bank's job of maintaining price stability.

This paper investigates how solidly inflation expectations are anchored in Asia, using inflation forecasts by professional forecasters from Consensus Economics. We examine inflation expectations using three different methods. First, we assess the behaviour of longer-term (both five-year-ahead and two-year-ahead) forecasts in the different economies over time. Second, we assess the uncertainty related to inflation expectations by computing an indicator of forecast disagreement. Third, we use a novel method to model the behaviour of forecasts over different horizons, capturing the tendency for inflation forecasts to converge towards actual inflation as the forecast horizon becomes shorter. This analytically simple method is based on an exponential decay function, and provides a convenient way to parameterise the degree to which inflation expectations are anchored. Overall, we find that inflation expectations generally appear to be well anchored in the region. We close with some policy implications.

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Empirical evidence

Our measures of inflation expectations are for inflation based on the consumer price index (CPI) and come from Consensus Economics. We use the *median* inflation forecasts across a panel of professional forecasters, except when the uncertainty surrounding these forecasts is of interest. Each month, the forecasters are asked to provide their forecasts of the average level of inflation for both the current calendar year and the following calendar year. Thus, these are fixed-event forecasts. The data give us a panel of inflation expectations for any given year across 24 monthly horizons, for months h = 1 to h = 24.[2]

We include 10 Asian economies in the sample. Four of them are inflation targeters (Indonesia, Korea, the Philippines and Thailand). The other six (China, Hong Kong SAR, India, Japan, Malaysia, Singapore) follow other monetary policy frameworks, generally with a declared focus on price stability, even if the framework is not officially described as inflation targeting.

(i) Long-term forecasts and actual inflation

Forecasts of inflation are available at monthly horizons out to a maximum of 24 months. In Graph 1, we show the development of actual inflation and the 24-month-ahead forecasts for the same year on the x-axis, for our sample of Asian economies. As an example, the forecast shown for 1999 is the forecast made in January 1998 for average inflation in 1999. Longer-term forecasts are also available but for a shorter time period, and at semiannual rather than monthly frequency. The graph also displays the five-year-ahead forecasts for the time period 2005–12, based on forecasts made in 2000–07 (April of each year).

Graph 1 shows that long-run inflation expectations have fallen over time in most Asian economies. In many cases, the decline occurred early in the sample, during the Asian crisis of the late 1990s. We also see that longer-term inflation forecasts are less volatile than actual inflation. One explanation for this is that inflation expectations are well anchored. Notably, there was little volatility in these median inflation forecasts during the international financial crisis. However, uncertainty over future inflation did increase at the time, as we will show. In many economies, lower frequency movements in forecasts do seem to track actual inflation, albeit with some delay.

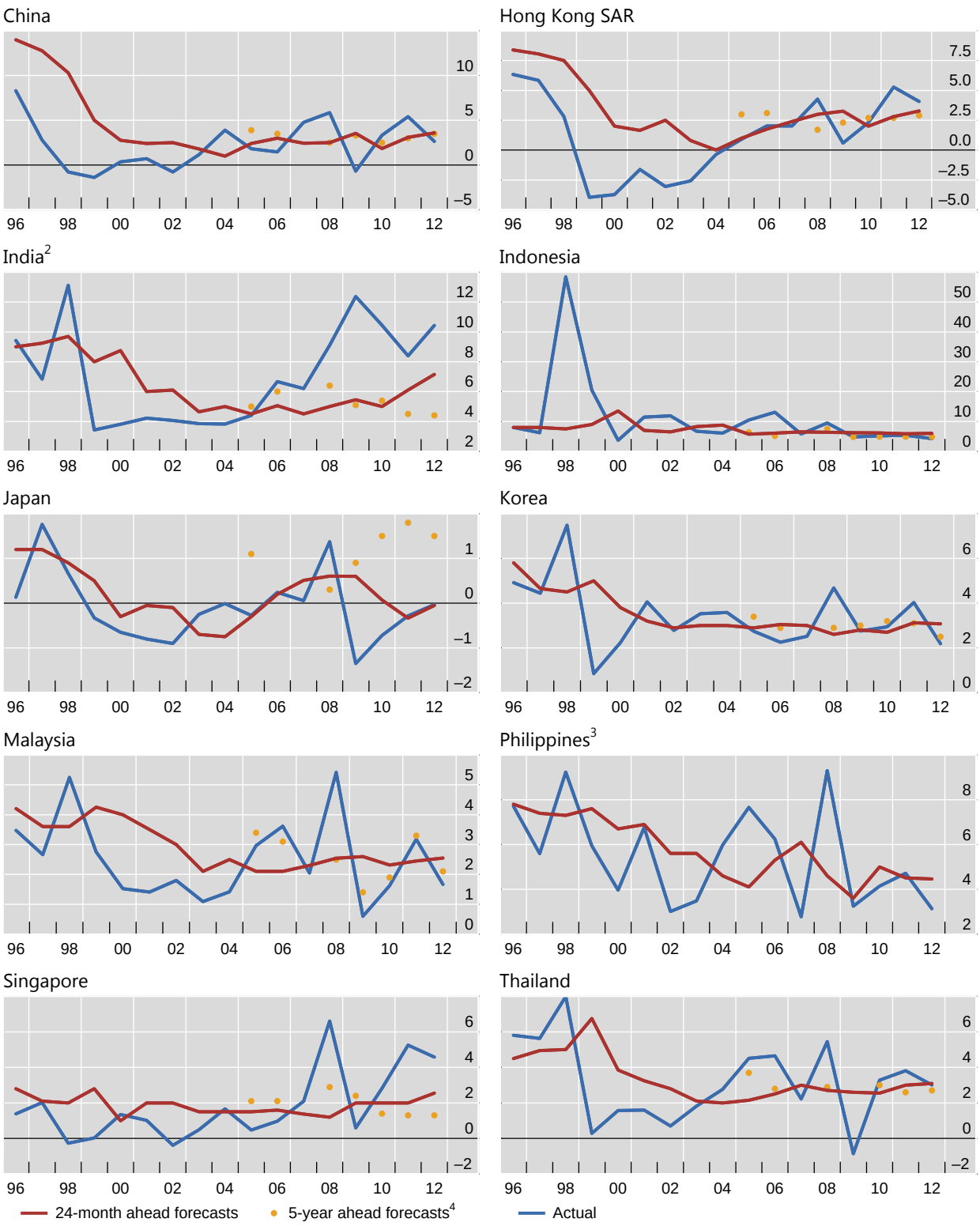
There are also some country-specific differences in the behaviour of long-term forecasts. In Japan and Singapore, inflation expectations had already fallen to low levels by the mid-1990s. In India, long-term inflation expectations have followed a U-shape over time, falling to relatively low levels in the mid-2000s but climbing again since then. A similar phenomenon can be observed for Hong Kong SAR. But overall, long-run inflation expectations have been mostly either trending down over time or have remained at relatively low levels.

[2] When examining long-term forecasts in the next section, we also use data on inflation expectations five years ahead.

CPI inflation[1]

% change over previous calendar year

Graph 1



[1] Horizontal axis represents the year being forecast. [2] Fiscal year beginning April 1. [3] Survey of five-year-ahead forecasts is not available for the period shown. [4] Forecasts published in April of each year.

Source: Consensus Economics©.

(ii) Uncertainty about future inflation

While point forecasts of inflation are important for economic decision-making, uncertainty about future inflation is also relevant. From a policymaking perspective, an increase in the uncertainty of inflation expectations could signal an erosion of monetary policy credibility, for example. Less certain inflation forecasts could also reflect elevated tail risks as perceived by the forecasters, providing useful information to policymakers.

In order to illustrate the uncertainty about inflation forecasts, we use a measure of forecast disagreement based on the (modified) squared deviation measure, as in Siklos (2013). Forecast disagreement at time t, over a forecast horizon of h, is defined as:

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

Here F denotes the inflation forecast, i identifies the forecaster, N is the number of forecasts and $\bar{F}$ is the median forecasted value across forecasters at time t. A higher value for forecast disagreement is taken as indicating greater uncertainty about future inflation, which could affect private sector consumption and investment decisions.[3] We illustrate developments in forecast uncertainty for the years 2000, 2005, 2010 and 2012, at both 12- and 24-month horizons (Table 1).

Forecast disagreement

Table 1

	12-month-ahead forecasts				24-month-ahead forecasts			
	2000	2005	2010	2012	2000	2005	2010	2012
China	0.48	0.87	0.46	0.12	0.73	1.14	1.08	0.45
Hong Kong SAR	1.59	0.23	0.71	0.42	2.21	0.33	2.52	0.53
India	1.66	0.31	2.46	0.32	1.57	0.46	0.94	1.17
Indonesia	3.45	0.50	0.48	0.40	25.50	1.73	1.25	0.40
Japan	0.05	0.06	0.12	0.05	0.25	0.11	0.15	0.20
Korea	0.15	0.08	0.13	0.08	2.76	0.27	1.26	0.17
Malaysia	0.13	0.19	0.29	0.14	3.29	0.28	0.60	0.21
Philippines	--	--	1.01	0.11	--	--	--	0.68
Singapore	0.20	0.06	0.71	0.11	0.44	0.17	0.85	0.12
Thailand	0.33	0.28	0.50	0.17	1.54	0.13	2.13	0.31

Sources: Consensus Economic©; authors' calculations.

Table 1 indicates that forecast disagreement increased during the international financial crisis in all other economies except China and Indonesia. This is visible from the 12-month-ahead forecasts for 2010, made in January 2009. For the 24-month-ahead forecasts for the same year, made in early 2008, the heightened level of forecast disagreement reflects not only growing uncertainty about potential spillovers from the growing turbulence in some of the major advanced economies,

[3] An alternative approach would be to use forecasts of the probability distribution of future inflation, as in Zarnowitz and Lambros (1987). However, probabilistic inflation forecasts are not available for many of the economies in our panel.

but also the effects of a commodity price boom on the region. However, this episode stands in contrast to the overall trend of declining forecast disagreement in the region over time.

(iii) Modelling the behaviour of inflation expectations

In this section, we present a novel method for modelling the behaviour of inflation expectations, drawing on current research at the BIS Asian Office (Mehrotra and Yetman (2014)). The framework fully utilises the multiple-horizon dimension of the data. In contrast, previous research has typically resorted to different approximations to convert fixed-event forecasts to horizon-based forecasts (see eg Dovern and Fritsche (2008); Dovern et al (2012); Siklos (2013)).[4]

The basic assumption behind the adopted functional form is that, if inflation expectations are well anchored at a particular level, inflation forecasts made sufficiently far in advance should be equal to that level. Indeed, in an environment where inflation expectations are well anchored, there should exist some horizon beyond which long-run expectations are fixed and do not systematically respond to new data about economic conditions.[5] As time passes, and the forecast horizon shortens, inflation expectations will eventually start to deviate from the anchored level towards the level of actual inflation. Forecasters gradually learn more about the realisation of shocks to inflation for a given period, for example. A slow adjustment could arise due to information about the economic conditions being disseminated only slowly through the economy. This could result from costs of acquiring and processing new information, as in Devereux and Yetman (2003) and Mankiw and Reis (2002).

The inflation expectations process for each economy is modelled as follows. The forecast of inflation for year t made at horizon h, denoted $f(t, t-h)$, is assumed to follow:

$$f(t, t-h) = \alpha(h)\pi^* + [1-\alpha(h)]\pi(t-h) + \varepsilon(t, t-h). \quad (1)$$

In (1), h is measured in months until the end of the year that is being forecast. π^* is the level that long-run inflation expectations are anchored to, which we estimate, and $\pi(t-h)$ is the level of inflation observed at the time the forecast is made. $\varepsilon(t, t-h)$ is a residual term.[6]

$\alpha(h)$ denotes a decay function. As the horizon shortens, there is greater weight on realised outcomes and less on the long-run anchor point.[7] In particular, we

[4] Lahiri and Sheng (2008) study fixed-event forecasts, although of GDP growth rather than inflation, for the G7 economies. They consider forecaster-level data and find that forecaster disagreement is greatest at longer horizons and diminishes as the horizon shortens. They also find that forecast variation for a given forecaster is lowest at longer horizons, and increases as the horizon decreases.

[5] Long-run expectations could still change if, for example, the level of monetary policy credibility varies or the central bank announces a new level for an inflation target. We consider the latter possibility below and evaluate whether the adoption of inflation targeting brought about a change in the inflation rate at which inflation expectations are anchored in the long run.

[6] To correct for the publication lag in inflation data, we use the 12-month growth rate in monthly CPI lagged by one month as the actual inflation rate. This also helps to address any potential endogeneity issues between expected and actual inflation. See the Annex for information about the variance-covariance structure of the model and other details about the econometric methodology.

[7] The use of decay functions in forecasting applications is not entirely new. Gregory and Yetman (2004) use a polynomial decay function and Blue Chip survey data to model the behaviour of

assume that $\alpha(\infty) = 1$ and $\alpha(0) = 0$. The decay process is modelled as the exponential of a polynomial function:

$$\alpha(h) = 1 - \exp\big(g(-\gamma, h)\big). \quad (2)$$

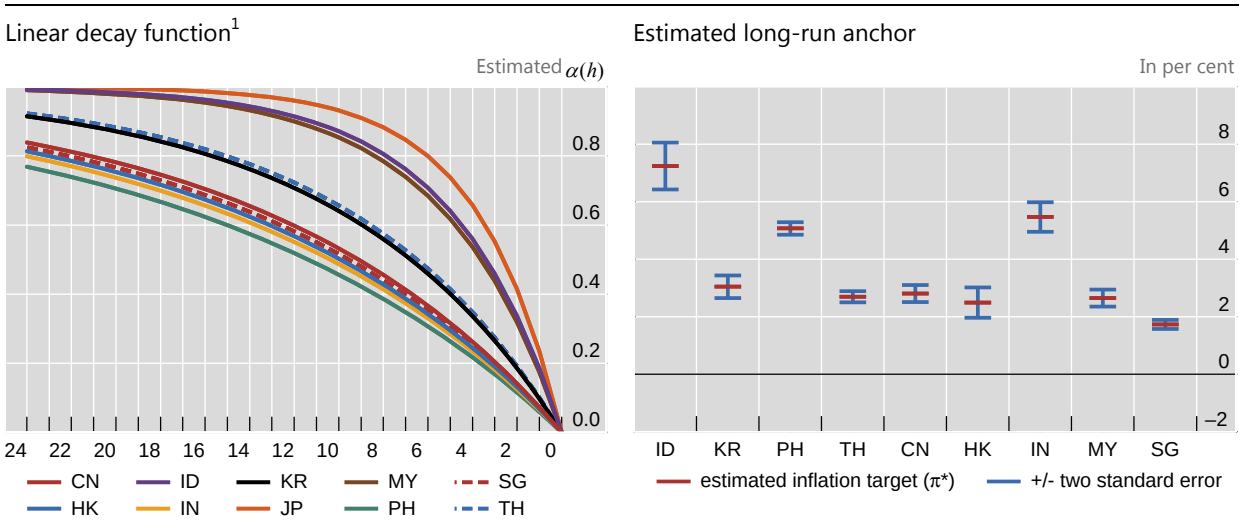
With a linear function, $g(.)$ takes the form:

$$g(-\gamma, h) = -\gamma_1(i)h. \quad (3)$$

The estimated decay functions are shown in Graph 2 (left-hand panel), for the sample period 2000–12.[8] The graph shows that, at our longest forecast horizon of h = 24 months, inflation expectations are mostly driven by the long-run anchor. At that horizon, the weight on the long-run anchor is estimated to be between 75% and 100% and the weight on actual inflation correspondingly between 0% and 25%. Expected inflation is relatively rigid in most economies and starts to move closer to actual inflation only gradually. Finally, when the horizon becomes very short, inflation expectations are driven almost entirely by actual inflation.

Decay function and estimated long-run anchor

Graph 2



[1] Horizontal axis represents forecast horizon *h*, which is the number of months before the end of the calendar year being forecast.

Source: Authors' calculations.

However, there are some differences in the estimated decay function across economies. One group of economies, comprising Japan, Indonesia and Malaysia (the three top lines in Graph 2), stand out in the sense that inflation expectations are more driven by the long-run target, relative to actual inflation, compared to other economies in the sample. As shown later, the estimated γ coefficient in these economies is correspondingly higher. Note that this does not imply anything about the *level* at which inflation expectations are anchored. It is possible that long-run inflation expectations are anchored at a high level regardless of the horizon at which expectations are affected by actual inflation.

professional forecasters, in particular the phenomenon that the forecasts converge towards a consensus, as the forecast horizon shortens.

[8] Results are broadly similar if we consider a quadratic or cubic polynomial in (3) instead.

Our method yields two straightforward measures for the anchoring of expectations: the level of the estimated long-run anchor π^* and the tightness of this anchor – the latter given by the estimated standard error of π^*. Graph 2 (right-hand panel) shows these two measures in our sample of Asian economies.

For the inflation targeting economies, the graph suggests that the estimate of the long-run anchor falls relatively close to the announced inflation targets of the central banks. As an example, for 2012 the inflation target for Indonesia was specified as 4.5±1%; for Korea 3.0±1%; for Philippines 4.0±1%; and for Thailand at 0.5–3.0%.[9] This could be interpreted as indicating that the announced inflation targets in these economies have been credible, at least when considering inflation expectations by professional forecasters.

But inflation is anchored at relatively low levels for all the economies our sample. Indeed, on average, the estimated long-run anchor is lower in the non-inflation targeting economies than the inflation targeters. This result also holds when Japan is excluded from the sample (where the recurrent bouts of deflation are reflected in the low value of the estimated π^*). The low estimate for the long-run anchor in the case of the non-inflation targeters is consistent with the broad success economies in the region have had in bringing down inflation.

Regarding the tightness of anchoring, the standard errors around the estimates for the long-run anchor are very similar on average for the inflation and non-inflation targeters. At the same time, there are differences between economies with similar estimates for the long-run anchor. Consider, for instance, Hong Kong SAR and Malaysia, where inflation expectations are anchored at very similar levels but the degree of anchoring differs in terms of the tightness of the long-run anchor. Such differences could be relevant if a central bank wants to change the level of private agents' inflation expectations, as is arguably the case currently in Japan.

Changes in the anchoring of inflation expectations over time could also be relevant. We evaluate whether the level at which inflation expectations are anchored changed with the introduction of inflation targeting frameworks. Due to the limited sample size, we compare estimates obtained from the full sample against those obtained using only the inflation targeting period. As a comparison, for the non-inflation targeters, we compare estimates obtained from the full sample against those obtained over the period beginning in 2000. The results are shown in Table 2 below.

Table 2 suggests that the adoption of inflation targeting was associated with a drop in the level at which inflation expectations are anchored in all inflation targeting economies. The average π^* for the inflation targeters fell from 4.739 to 4.210, although the fall is not always statistically significant at the 95% level. The standard error of the estimates of the π^* coefficient for all four economies declined as inflation targeting was adopted, suggesting that inflation expectations became more tightly anchored. The magnitude of the fall in the standard error is especially large in the cases of Indonesia and Thailand.

[9] The inflation target in the case of Thailand is set in terms of core inflation, whereas we use CPI inflation rates. In the case of Indonesia, the announced inflation targets have generally fluctuated more than elsewhere and have also trended down over time. This may partly explain why the estimated long-run anchor is higher for Indonesia than the announced target range for 2012.

For the non-inflation targeters, there was similarly a fall in the estimated π^* between the 1990s and the 2000s (from 3.450 to 2.507) in all economies. Their drop is even higher on average than for the inflation targeting economies.[10] Inflation expectations also became better anchored over time in the non-inflation targeting economies, in the sense that the standard error of the estimate for π^* fell, by an average magnitude of 0.074. So while inflation targeting was associated with a decline in inflation expectations, inflation expectations in the non-inflation targeters have also fallen and become more tightly anchored over time. These results are in line with those of Filardo and Genberg (2010) who suggested that the improved inflation performance is not limited to the explicit inflation targeters in the region.

Non-inflation targeters

Table 2

	CN		HK		IN	
	Coeff	std error	Coeff	std error	Coeff	std error
Full sample	4.570	0.370	4.421	0.428	6.318	0.244
2000–	2.808	0.148	2.490	0.263	5.469	0.255
	JP		MY		SG	
	Coeff	std error	Coeff	std error	Coeff	std error
Full sample	0.456	0.138	2.952	0.148	1.982	0.116
2000–	–0.111	0.108	2.651	0.148	1.733	0.079

Inflation targeters

	ID		PH		TH		KR	
	Coeff	std error	Coeff	std error	Coeff	std error	Coeff	std error
Full sample	6.493	0.234	5.723	0.229	3.186	0.209	3.553	0.239
Since IT	6.033	0.040	4.786	0.174	2.695	0.109	3.325	0.168

Estimated π^*, full sample and subsamples

Conclusion and policy implications

In this paper, we have shown that the level of long-run inflation expectations has generally fallen in Asian economies during the past decade. At the same time, uncertainty about future inflation has declined, as there is now less disagreement among professional forecasters about the level of future inflation rates. Using a novel methodology to model the behaviour of inflation expectations, we also find that long-run forecasts appear to be anchored at levels that are close to the explicit inflation targets in the region, suggesting that the announced targets have been viewed as credible. However, the degree of anchoring of inflation expectations appears to be similar for both the inflation and non-inflation targeting economies.

[10] An obvious caveat when comparing the change in the estimated π^* between the inflation targeters and the other economies is that the respective samples are small and economy characteristics vary considerably across the two samples.

These findings suggest that the ballooning central bank balance sheets have, at least so far, not led to unanchored inflation expectations in the region. Caruana (2011) mentions inflation as one of the broad policy risks that large balance sheets could pose for central banks, and suggests that their track record of delivering low inflation has granted central banks some leeway. Similarly, we note that inflation expectations in Asia have been well behaved so far, even in the context of unconventional monetary policies in the advanced economies that may at times have encouraged volatile capital inflows into Asia, partly driven by a "search for yield". But, given the robust credit growth and strong property price increases in many Asian economies, policymakers need to remain vigilant about dynamics that could occur beyond the conventional policy horizon.

While our results generally point to a reasonable degree of anchoring of inflation expectations in the sample of Asian economies, it must be borne in mind that our data on inflation expectations only cover professional forecasters. It is plausible that these forecasters pay more attention to the central bank's announcements regarding policy objectives. Surveys of consumers and firms would offer additional information, but such indicators are not generally comparable across economies.

Annex

The variance is modelled using a flexible functional form:

$$V\big(\varepsilon(i,h,t)\big) = \delta_0^i + \delta_1^i h. \quad \text{(A.1)}$$

The formulation in (A.1) allows the variance to shrink as the forecasting horizon h declines and there is less uncertainty about the inflation outturn.

Forecasts made at different horizons for the same inflation outcome are likely to be highly correlated, especially if the horizons are close together. We explicitly model this, assuming that the correlation between residuals for forecasts of the same inflation rate, but made at two different horizons h and k, is given by:

$$Corr\big(\varepsilon(t,t-h),\varepsilon(t,t-k)\big) = \phi_0^i - \phi_1^i|h-k|. \quad \text{(A.2)}$$

The assumed gradual adjustment of inflation expectations is in line with the observation that the empirical autocorrelation of inflation that only decays slowly (see Fuhrer and Moore (1995)). In practical terms, this implies that the off-diagonal elements of the variance-co-variance matrix take the form:

$$Cov\big(\varepsilon(t,t-h),\varepsilon(t,t-k)\big) = \left[\sqrt{V\big(\varepsilon(t,t-h)\big)V(\varepsilon(t,t-k))}\right][\phi_0^i - \phi_1^i|h-k|]. \quad \text{(A.3)}$$

For details on the estimation procedure, see Mehrotra and Yetman (2014).

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