Measuring economic slack in Asia and the Pacific

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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.

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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

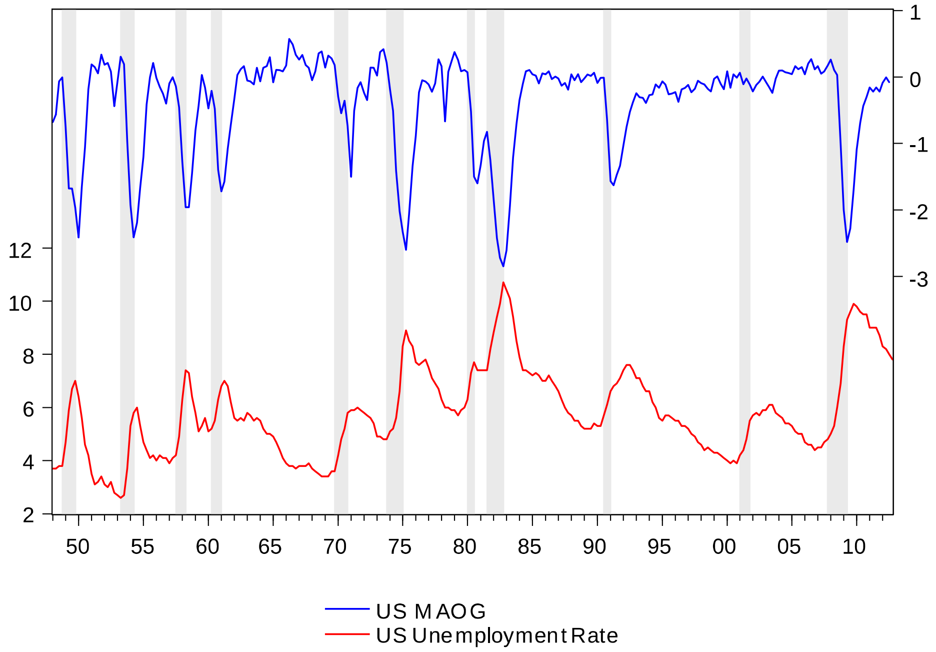
	Sample period	Correlation
United States	1960Q1–2011Q3	0.51
Australia	1959Q4–2011Q3	0.42
New Zealand	1977Q3–2012Q3	0.09
Japan	1971Q1–2011Q3	0.28
Hong Kong SAR	1973Q2–2011Q4	0.09
Korea	1970Q2–2011Q4	0.43
Singapore	1975Q2–2011Q4	–0.07
China	1992Q2–2011Q4	–0.41
India	1989Q4–2011Q3	0.14
Indonesia	2000Q3–2011Q4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

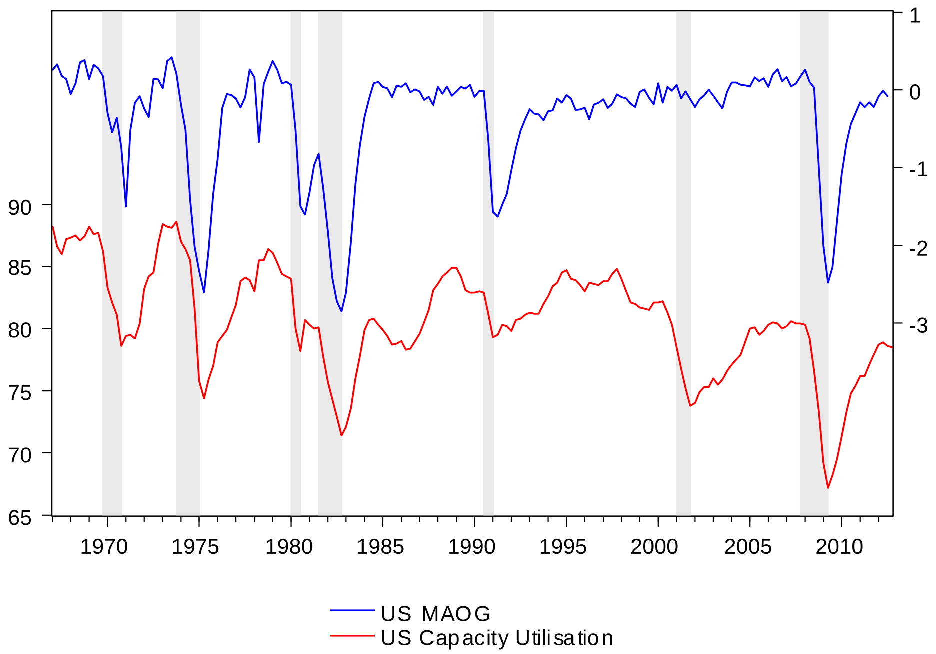
Granger causality tests for MAOGs — Table 6

	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

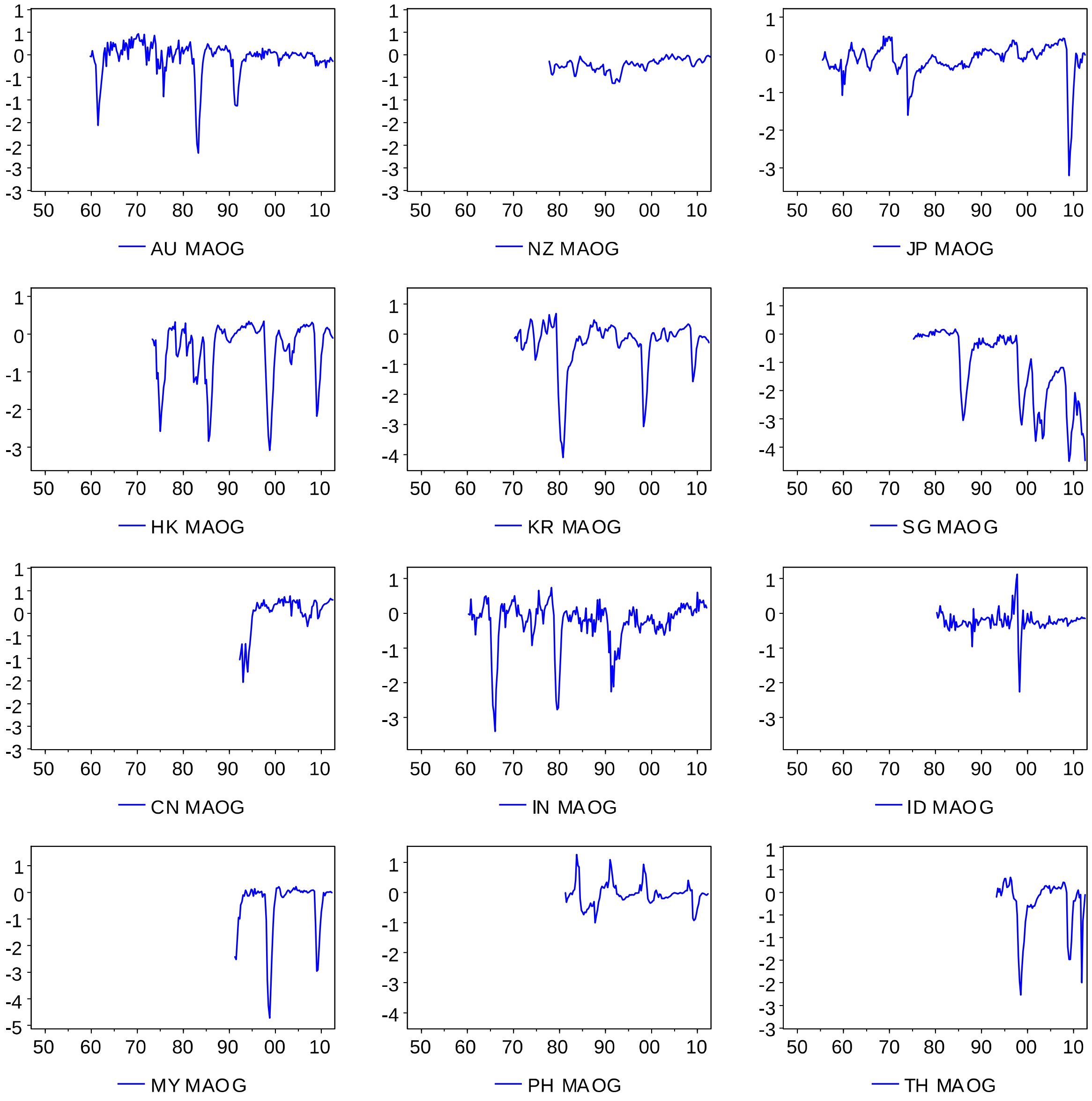




Notes: In the top panel, the model-averaged output gap for US real GDP for 1948Q1–2012Q3 is in blue (right axis) and the unemployment rate for the corresponding sample period is in red (left axis). In the bottom panel, the model-averaged output gap for US real GDP for 1967Q1–2012Q3 is in blue (right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

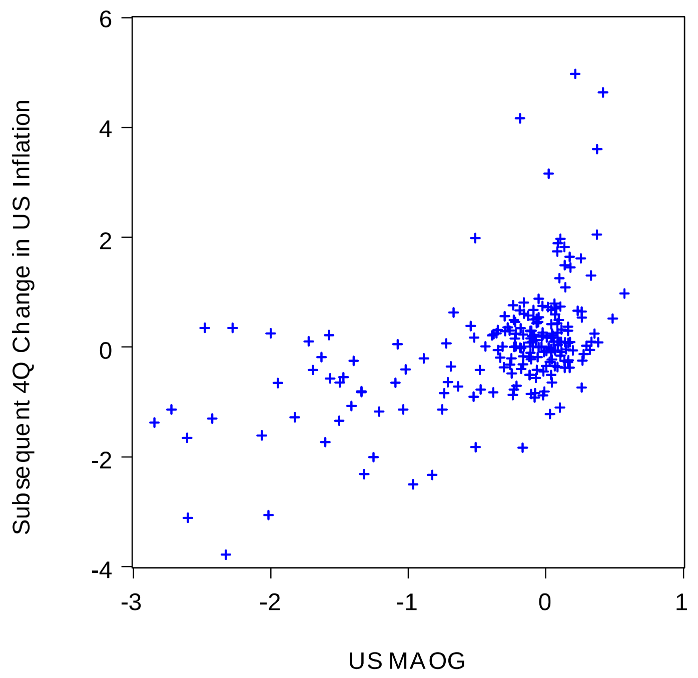
Figure 2



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

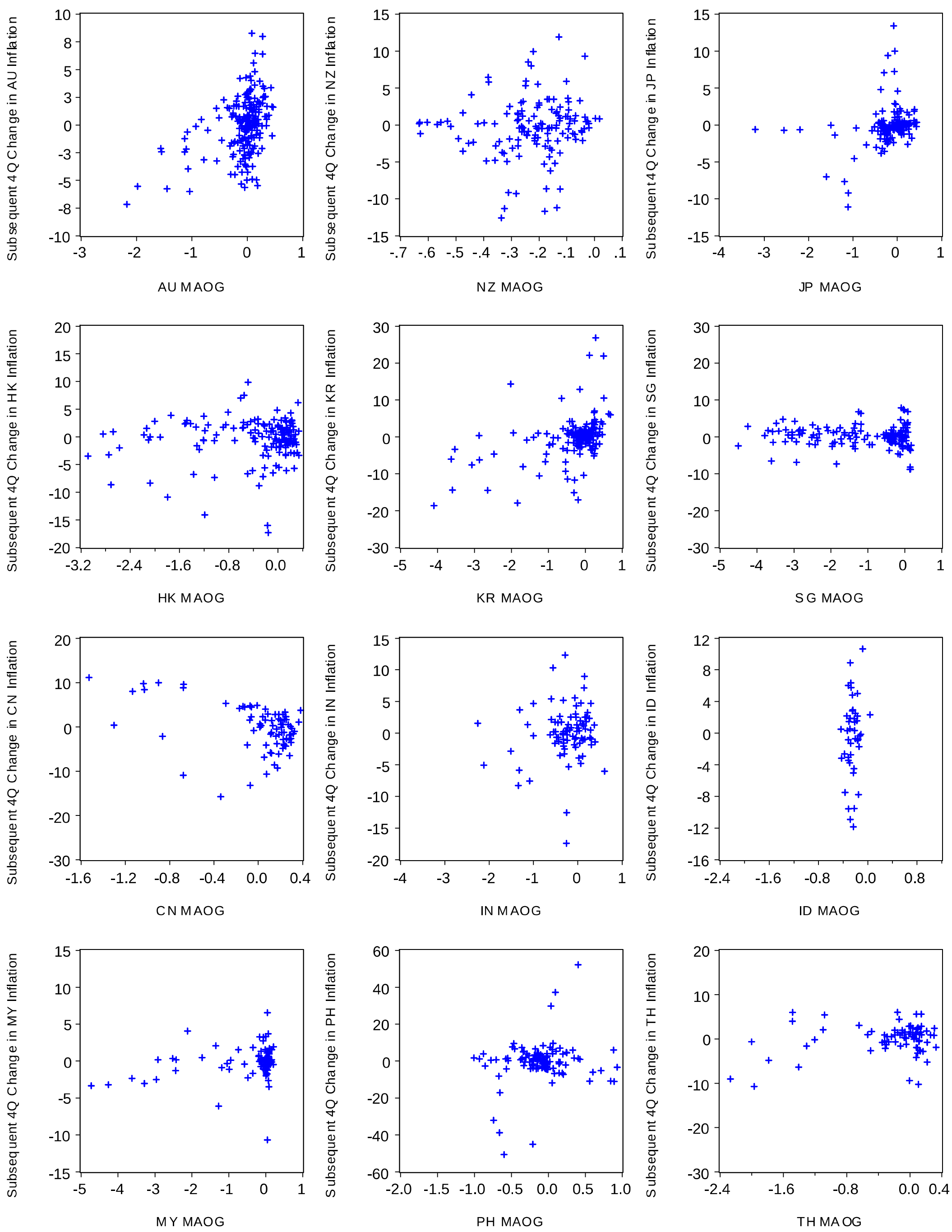
Figure 3



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.

References

Aguiar, M and G Gopinath (2007): "Emerging market business cycles: the cycle is the trend", *Journal of Political Economy*, 115, pp 69–102.

Bai, J and P Perron (1998): "Estimating and testing linear models with multiple structural changes", *Econometrica*, 66, pp 47–78.

——— (2003): "Computation and analysis of multiple structural change models", *Journal of Applied Econometrics*, 18, pp 1–22.

Barlevy, G (2005): "The cost of business cycles and the benefits of stabilization", *Economic Perspectives, Federal Reserve Bank of Chicago*, Issue Q1, pp 32–49.

Beveridge, S and C Nelson (1981): "A new approach to decomposition of economic time series into permanent and transitory components with particular attention to measurement of the business cycle", *Journal of Monetary Economics*, 7, pp 151–74.

Canova, F (1998): "Detrending and business cycle facts", *Journal of Monetary Economics*, 41, pp 475–512.

Cohen, D (2000): "A quantitative defense of stabilization policy", *Federal Reserve Board Finance and Economics Discussion Series Paper*, no 2000-34.

Del Negro, M and C Otrok (2008): "Dynamic factor models with time-varying parameters: measuring changes in international business cycles", *Staff Report*, no 326, Federal Reserve Bank of New York.

Geweke, J and G Amisano (2011): "Optimal prediction pools", *Journal of Econometrics*, 164, pp 130–41.

Harvey, A and A Jaeger (1993): "Detrending, stylized facts and the business cycle", *Journal of Applied Econometrics*, 8, pp 231–47.

IMF (2013): World Economic Outlook "Hopes, realities, risks", Chapter 3, International Monetary Fund.

Kiley, M (2013): "Output Gaps", *Journal of Macroeconomics*, 37, pp 1–18.

Kim, C, J Morley, and J Piger (2005): "Nonlinearity and the permanent effects of recessions", *Journal of Applied Econometrics*, 20, pp 291–309.

Kim, C and C Nelson (1999): "Friedman's plucking model of business fluctuations: tests and estimates of permanent and transitory components", *Journal of Money, Credit and Banking*, 31, pp 317–34.

Kuttner, K (1994): "Estimating potential output as a latent variable", *Journal of Business & Economic Statistics*, 12, pp 361–68.

Lucas, R (1976): "Economic policy evaluation: a critique", *Carnegie-Rochester Conference Series on Public Policy*, 1, pp 19–46.

Morley, J (2011): "The two interpretations of the Beveridge–Nelson Decomposition", *Macroeconomic Dynamics*, 15, pp 419–39.

——— (2014): "Measuring economic slack: a forecast-based approach with applications to economies in Asia and the Pacific", *BIS Working Paper*, forthcoming.

Morley, J, C Nelson, and E Zivot (2003): "Why are the Beveridge-Nelson and unobserved-components decompositions of GDP so different?", *Review of Economics and Statistics*, 85, pp 235–43.

Morley, J and J Piger (2008): "Trend/cycle decomposition of regime-switching processes", *Journal of Econometrics*, 146, pp 220–26.

——— (2012): "The asymmetric business cycle", *Review of Economics and Statistics*, 94, pp 208–21.

Nelson, C (2008): "The Beveridge–Nelson decomposition in retrospect and prospect", *Journal of Econometrics*, 146, pp 202–06.

Orphanides, A (2002): "Monetary-policy rules and the Great Inflation", *American Economic Review*, 92, pp 115–20.

Sinclair, T (2010): "Asymmetry in the business cycle: Friedman's plucking model with correlated innovations", *Studies in Nonlinear Dynamics and Econometrics*, 14, Issue 1, Article 3.