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Short-term Indicator Models for Quarterly GDP Growth in the BRIICS: A Small-scale Bridge Model Approach

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By Thomas Chalaux and Cyrille Schwellnus

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ABSTRACT/RÉSUMÉ

Short-term indicator models for quarterly GDP growth in the BRIICS: A small-scale bridge model approach

This paper extends the OECD Economics Department's suite of short-term indicator models for quarterly GDP growth, which currently cover only the G7 countries, to the BRIICS countries. Reflecting the relative scarcity of high-quality macroeconomic time series, the paper adopts a small-scale bridge model approach. The results suggest that in terms of short-term forecast accuracy for the first and second quarter following the most recent GDP release these models outperform simple autoregressive or constant growth benchmarks. The small-scale indicator models would have allowed the identification of the growth slowdown during the global crisis of 2008-09 and the subsequent rebound several months ahead of official GDP releases. Overall, forecast accuracy appears to be similar to that of the existing indicator model suite for the G7 countries, especially once the higher GDP growth volatility in most BRIICS is accounted for.

JEL classification codes: C53, E37
Keywords: Forecasting, growth, short-term indicators, bridge models

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Modèles d'indicateurs de la croissance du PIB à court terme dans les BRIICS : une approche avec des modèles d'étalonnage à petite échelle

Ce papier étend aux BRIICS les modèles de prévision de croissance à court terme du Département des Affaires économiques de l'OCDE qui n'englobent pour l'instant que les pays du G7. Considérant le manque de séries macroéconomiques de qualité, ce papier adopte une approche avec des modèles d'étalonnage à petite échelle. Les résultats suggèrent que les prévisions de ces modèles pour les deux trimestres suivant la publication la plus récente du PIB sont plus précises que celles des modèles autorégressifs ou qu'une hypothèse de croissance constante. Ces modèles à petite échelle auraient permis l'identification du ralentissement puis du rebond de la croissance durant la crise globale de 2008-2009 et ce plusieurs mois avant les publications officielles du PIB. Dans l'ensemble, la précision des prévisions semble être similaire à celle des modèles existants pour les pays du G7, particulièrement lorsque la forte volatilité du PIB que connaît la plupart des BRIICS est prise en compte.

Codes JEL : C53, E37
Mots-clés : Prévision, croissance, indicateurs de court terme, modèles d'étalonnages

TABLE OF CONTENTS

Tables

Figures

SHORT-TERM INDICATOR MODELS FOR REAL GDP GROWTH IN THE BRIICS: A SMALL-SCALE BRIDGE MODEL APPROACH

by

Thomas Chalaux and Cyrille Schwellnus[1]

1. Introduction

1. In most large emerging market economies (EMEs) accurate information on GDP as an aggregate measure of economic activity – which is a crucial requirement for the macroeconomic policy making process – becomes available with a longer delay than for most advanced economies. The publication lag is particularly long for Russia (13 weeks); South Africa (11 weeks); Brazil and India (9 weeks) whereas publication lags for China (3 weeks) and Indonesia (5 weeks) are similar to those of advanced economies.[2]

2. This paper describes models that use information from timely monthly indicators to gauge the aggregate state of economic activity in real time for the BRIICS (Brazil, Russia, India, Indonesia, China and South Africa). More specifically, the paper describes how to forecast GDP for the two quarters following the most recent official GDP release using a combination of hard indicators, such as industrial production, retail sales and exports, and survey indicators, such as purchasing managers' indices or business and household confidence.

3. More volatile GDP growth in most EMEs than in advanced economies and the relative scarcity of high-quality monthly indicators make the construction of short-term indicator models for EMEs particularly challenging. The volatility of quarterly GDP growth for the above EMEs over 1996-2013 (as measured by the median of the standard deviation) was about twice that for the G7 economies. Sédillot and Pain (2003) show that forecast accuracy of the existing indicator model suite for the G7 economies declines with GDP growth volatility. Moreover, long time series of monthly indicators remain scarce for EMEs: while long time series of standard hard indicators such as industrial production or retail sales typically are available, time series of survey indicators are typically fairly short or unavailable.

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1 . The opinions expressed and arguments employed in this paper are the responsibility of the authors and do not necessarily reflect the official views of the Organisation or of the governments of its member countries. The authors thank Peter Jarrett, Vincent Koen, Annabelle Mourougane and Dave Turner for valuable comments and discussions, and Sarah Michelson and Ines Gomez Palacio for assistance in preparing the document.

2. For the United Kingdom and the United States, the first estimate of GDP becomes available 4 weeks after the end of the quarter while for European Union countries the flash estimate becomes available after 6 weeks. Canada publishes quarterly GDP and a high-quality monthly GDP indicator about 9 weeks after the end of the quarter or month, implying that estimates for the first two months become available about 5 weeks after the end of the quarter.

4. The indicator models developed in this paper are based on a small-scale bridge model approach in order to retain consistency with the existing indicator model suite for the G7 countries developed by Sédillot and Pain (2003). The trend in academic research over the past few years has been towards factor models that include large numbers of indicators, but there is little evidence that such models systematically outperform small-scale models in terms of forecasting accuracy (Boivin and Ng, 2006; Camacho and Perez-Quiros, 2010). Given the high collinearity of macroeconomic time series, including a large number of imperfectly measured indicators may increase noise rather than the signal for GDP growth. Moreover, factor models that allow the inclusion of large numbers of indicators are less tractable than simple regression-based frameworks, in the sense that indicator weights typically change substantially across forecast vintages, making it more difficult to explain revisions to successive forecasts.[3]

5. The main results of the paper are as follows:

- For all the large EMEs considered in this paper (Brazil, Russia, India, Indonesia, China and South Africa) small-scale indicator models improve GDP forecasts for the first and second quarter following the most recent official GDP release relative to autoregressive or constant-growth ("naive") benchmarks.

- Forecast accuracy appears to be similar to that of the existing indicator model suite for G7 countries, especially once the higher GDP growth volatility in most large EMEs is accounted for.

- The small-scale indicator models would have allowed the identification of the growth slowdown during the global crisis of 2008-09 and the subsequent rebound several months ahead of official GDP releases.

- Pure hard indicator models contain mainly information on the first quarter following the most recent GDP release while mixed indicator models based on business confidence surveys and the OECD Composite Leading Indicators (CLIs) appear to contain mainly information on the second quarter.

- Overall, indicator models that combine hard and survey indicators by averaging across hard and mixed models appear to be superior to pure hard or pure survey models.

- Using average forecast errors over the recent past to adjust raw indicator model forecasts is particularly relevant for EMEs, as shifts in trend growth tend to be more pervasive than in advanced economies. The adjustment for EMEs over the period 2007-13 is consistent with a significant decline in trend growth not captured by the indicators.

6. The remainder of the paper is structured as follows. Section 2 describes the methodology used to construct the small-scale indicator models in this paper and reviews relevant data issues. Section 3 describes the properties of the selected models and compares them to alternative models.

3. Banbura and Modugno (2010) partly address this issue by developing a method that links forecast revisions to indicator releases in the special case of a dynamic factor model estimated by quasi-maximum likelihood.

2. Methodology and data

Methodology

7. Methodologies extracting information from high-frequency indicators to forecast quarterly GDP face three main methodological challenges: high collinearity across macroeconomic time series; mixed frequencies; and staggered data releases. In bridge models the collinearity issue is addressed by either selecting a small number of indicators based on predictive power or by combining models that include different sets of indicators. The mixed-frequency issue is addressed by a bridge equation that links quarterly GDP to higher-frequency indicators aggregated to the quarterly frequency. Staggered data releases are addressed by auxiliary models that forecast the indicators at the higher frequency.

8. An alternative to bridge models are factor models which are particularly suited to data-rich environments, as large numbers of collinear indicators can be reduced to a small number of factors. The seminal contribution of Sargent and Sims (1977), for instance, shows that two dynamic factors can explain a large fraction of the variance in US quarterly output, employment and prices. This insight has been used for the construction of coincident indicators of economic activity (Stock and Watson, 1991; Mariano and Murasawa, 2003) and for short-term forecasting of GDP (Giannone, Reichlin and Small, 2008; Camacho and Perez-Quiros, 2010).[4] Factor models deal with mixed-frequency series and staggered data releases by treating the low-frequency series as high-frequency series with missing values, which are in turn inferred by using Kalman filter estimation techniques.

9. A further approach to short-term forecasting of GDP based on high-frequency indicators is the mixed-data sampling model developed by Ghysels *et al.* (2004). In contrast to the bridge equation approach, mixed-data sampling allows the modelling of time series of different frequency without prior aggregation of the high-frequency series.[5] Staggered data releases are dealt with by re-aligning indicator series in such a way that a balanced dataset is obtained, *e.g.* if one indicator becomes available one month before all others all other indicators are shifted forward by one month. The distributed lag structure of the model is used to obtain direct forecasts of GDP several quarters ahead without resorting to an auxiliary model. Mixed-data sampling can address the high collinearity of macroeconomic time series by either combining forecasts from different indicator models or by combining mixed-data sampling with factor analysis.[6]

10. This paper develops short-term indicator models to forecast GDP based on the bridge model approach. The main reason for preferring the bridge model approach to alternative modelling approaches is to ensure consistency with the OECD's existing indicator model suite for G7 countries (Sédillot and Pain, 2003; Mourougane, 2006; Laurent and Kozluk, 2012). The existing indicator model suite has generally captured real-time economic developments fairly accurately, including during the global crisis of 2008-09 (Pain *et al.*, 2013). Bridge models also have the advantage of being highly tractable, in the sense that indicator weights only change marginally from one model run to the next so that forecast revisions can easily be linked to indicator releases.[7] Comparative studies of bridge models, factor models and mixed-data

4. See Banbura et al. (2011, 2013) for overviews.

5. A parsimonious lag polynomial of the high-frequency indicators is included in the quarterly GDP equation.

6 . Schorfheide and Song (2013) develop a mixed-frequency VAR that allows the direct modelling of time series of different frequencies by Kalman filter estimation rather than by resorting to lag polynomials.

7. For instance, higher monthly industrial production growth than forecast by the auxiliary model is typically associated with a positive GDP revision, as the estimated coefficient on industrial production in the quarterly bridge equation is positive. The decomposition of GDP forecast revisions into contributions from indicator forecast revisions requires parameter stability of the quarterly bridge equation: this condition is

sampling typically find little differences in terms of forecast accuracy between the different approaches (Foroni and Marcellino, 2013).[8]

11. The bridge models considered in this paper take the following generic form:

$$\Delta \ln y_q = c + \sum_{l=1}^{L} \emptyset_l \Delta \ln y_{q-l} + \sum_{i=1}^{I} \sum_{j=0}^{J} \beta_{ij} x_{iq-j} + \varepsilon_q \quad (1)$$
$$x_m = k + \sum_{p=1}^{P} A_p \, x_{t-m} + \mu_m \, , \quad (2)$$

where equation (1) is the quarterly bridge equation and (2) is the auxiliary monthly model to forecast the indicators. The parameters of the quarterly bridge equation (c, $\emptyset_l, \beta_{ij}$) are obtained by regressing quarterly GDP growth ($\Delta \ln y$) on a constant, lagged values of GDP growth, and contemporaneous and lagged values of monthly indicators aggregated to the quarterly frequency (x_{iq-j}). The auxiliary monthly model fits a vector auto-regression (VAR) to the indicators, where x_m is a vector of monthly indicators and A_p is a conformable matrix of coefficients. To reduce the risk of inefficient estimates due to high dimensionality of the monthly VAR and limited degrees of freedom, Bayesian methods are used to shrink the number of parameters to be estimated.[9]

12. The bridge models in this paper deal with high collinearity across indicators mainly by careful indicator selection and by forecast combination. Using a heuristic procedure, available monthly indicators are first aggregated to the quarterly frequency and ordered according to (absolute) bivariate correlation with quarterly GDP growth. Models including different combinations of the indicators most highly correlated with quarterly GDP growth are evaluated and the most accurate models along various criteria (bias, mean absolute error, root mean squared error, directional accuracy) are retained. In some cases, including indicators in the monthly VAR that are non-significant in the quarterly bridge equation increases forecast accuracy. For most EMEs, the selected model consists of a combination of a pure hard indicator model and a mixed indicator model that includes business surveys and the OECD Composite Leading Indicator.

13. Staggered indicator releases are dealt with by conditioning the forecasts of the monthly indicators in the auxiliary VAR on the last available data point for each indicator.[10] The raw quarterly GDP forecast is then obtained by averaging the monthly indicators at the quarterly frequency and substituting them into the quarterly bridge equation.

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strictly satisfied within a given quarter as the quarterly bridge equation is only re-estimated once GDP becomes available and satisfied approximately across consecutive quarters as parameter estimates typically change only marginally as one observation is added to the quarterly bridge equation.

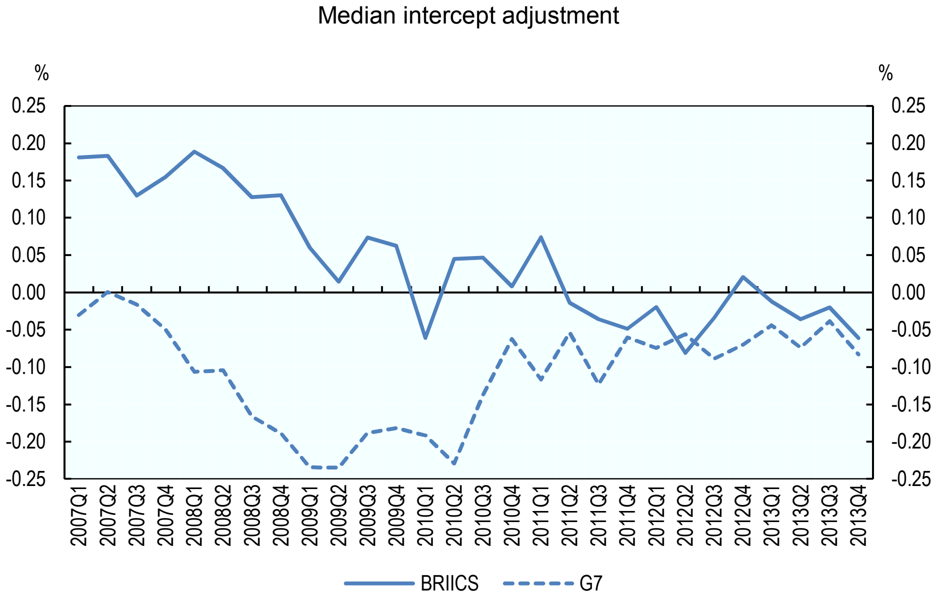
8. Banbura et al. (2013) and Matheson (2012) suggest modest gains in forecast accuracy from moving to factor models, but the empirical forecast comparisons are based on mis-specified bridge models: monthly indicators are forecast using autoregressions which does not preserve the dynamic relationships between indicators; a large number of indicators is included in the bridge model with rudimentary or no prior indicator selection; and the bridge equations are estimated for each indicator separately, with the bridge model forecast is obtained as the (weighted) average of the individual equation forecasts.

9. Sims-Zha Normal-Wishart priors on the parameters are chosen, with the overall tightness of the priors and the tightness of the prior on the first-order auto-regressive parameter set to minimise the root mean squared forecasting error of the bridge model.

10 . In practice, missing values at the end of the sample are recursively updated with one-step forecasts from the VAR estimated on the balanced monthly dataset before computing the multi-step forecasts of the monthly indicators. Matheson (2012) uses the Kalman filter to condition the forecasts on the last available data points for the monthly indicators.

14. The raw model forecast is adjusted using the estimated residuals of the quarterly bridge equation over the past 8 quarters. Empirical evidence suggests that trend growth in EMEs is more volatile than in advanced economies (Aguiar and Gopinath, 2007), which may lead to biased forecasts if trend changes are imperfectly captured by included indicators.[11] This is a particular concern, given that trend growth in most of the EMEs considered in this paper has probably declined appreciably in the wake of the global crisis of 2008-09; based on estimates in *OECD Economic Outlook No. 94* (November 2013), for instance, between 2007 and 2013 annual trend growth for China, India and Russia declined by around 2 percentage points. Following standard procedures, this paper uses a moving average of the estimated model residuals to correct the intercept of the quarterly bridge equation (Clements and Hendry, 1996; Mestre and McAdam, 2011).[12] The resulting decline in the intercept for EMEs over the period 2007-13 is consistent with a significant decline in trend growth not captured by the indicators (Figure 1).

Figure 1. The intercept adjustment suggests declining trend growth in the BRIICS



Note: The intercept adjustment is calculated as the moving average of the bridge equation residual over the past eight quarters.

Data

15. The dependent variable in the bridge equations is seasonally adjusted quarterly GDP growth at constant prices. For most EMEs considered in this paper, national statistical institutes publish sufficiently long time series of this variable (Brazil, Russia and South Africa), but the official series for China starts only in the fourth quarter of 2010. To obtain a sufficient number of observations for the estimation of the quarterly bridge equations for China, the official quarterly GDP growth series was back-cast using the

11 . E.g. similar levels of business and consumer confidence may imply different GDP growth depending on the considered time period. More generally, there may be structural shifts in the underlying model parameters.

12 . Statistical tests suggest that forecast accuracy typically is highest when using the moving average of the estimated residuals over the past 8 quarters.

official year-to-date growth series.[13] For India and Indonesia, seasonally non-adjusted quarterly GDP growth series were adjusted using the US Census' X12 seasonal adjustment procedure.[14]

16. The monthly indicators included in the models can be grouped into five broad categories: production (*e.g.* industrial production, capacity utilisation or indices of economic activity); employment and expenditure (*e.g.* employment, earnings or retail sales); financial (*e.g.* credit, stock prices or monetary aggregates); external (*e.g.* exports, imports or exchange rate); and soft indicators (*e.g.* business and consumer confidence). Hard indicators are seasonally adjusted and typically enter the models in growth rates rather than in levels to remove non-stationarity. The OECD Composite Leading Indicators (CLIs) – which were originally designed to predict business cycle turning points and which for most EMEs considered here mainly include hard indicators[15] – enter the model in growth rates: CLI levels contain information on GDP levels (relative to trend) whereas CLI growth rates possibly contain information on GDP growth rates. As survey indicators typically do not display clearly discernable seasonal patterns and are stationary, they enter the models with no prior seasonal adjustment and in levels rather than growth rates.

17. For most EMEs the indicator models are estimated on samples starting in the mid-1990s. For a number of EMEs, quarterly GDP series and monthly indicator series are available before the mid-1990s, but rapid structural change in these economies suggests that the relation between GDP and the indicators may have changed significantly over time: for instance, if the share of services in GDP increases rapidly, the association between GDP and industrial production may weaken over time. For Russia and Indonesia, the estimation sample starts at the beginning of the 2000s to remove the structural break of the 1998 financial crises and the ensuing period of high volatility.

3. Results

18. This section first gives a brief overview of the selected models and reports forecast accuracy relative to desk forecasts; relative to the existing indicator model suite for G7 countries; as well as during the global crisis of 2008-09. The focus is on root mean squared forecast error and forecast directional accuracy – the frequency of accurately predicted growth slowdowns or accelerations – over the period 2007Q1-2013Q3 in order to include the global crisis of 2008-09 in the forecast evaluation sample.

Overview of the selected models

19. The selected models for all countries except Indonesia combine forecasts from pure hard indicator models with forecasts from models mixing hard and soft indicator models, with both types of

13. Quarterly GDP levels at current prices in 1998 are used as initial levels of the series: constant and current price GDP presumably diverged only marginally over 1998 as the annual increase in the GDP deflator was near 0. Applying year-to-date growth rates to the initial levels a quarterly GDP level series is obtained, which is then (log) differenced and seasonally adjusted using X12. Note that quarterly GDP growth inferred by this method is similar to official quarterly GDP growth over the period for which both series overlap (2010Q4-2013Q3).

14 . For India, differences between GDP at factor costs and GDP at market prices can occasionally be large. To ensure consistency with the projections published in the OECD Economic Outlook, the indicator models forecast GDP at market prices.

15 . Only the CLIs for Russia and South Africa include soft indicators.

models receiving equal weights in the final forecast.[16] Indicators included in the hard indicator models typically include industrial production, retail sales or employment while the mixed indicator models typically include a purchasing managers' index and the OECD CLI, with the selected indicators jointly explaining between 35% and 80% of the variation in quarterly GDP growth (Table 1).[17] For Indonesia, reflecting low forecast accuracy of the average of hard and mixed indicator models, the selected model is based on the average of four models that each includes a single indicator in the quarterly bridge equation, with the monthly indicators forecast jointly using a Bayesian VAR.

Table 1. Included indicators to explain quarterly GDP growth

Country	Selected model	R^2 of quarterly bridge equation[1]	Component models	Included in quarterly bridge equation	Additionnally included in monthly
Brazil	Average of hard and mixed indicator models	0.79	Hard	Lag of GDP, industrial production, retail sales, employment	Capacity utilisation rate, OECD CLI
			Mixed	Markit PMI, OECD CLI	
Russia	Average of hard and mixed indicator models	0.77	Hard	Industrial production, retail sales, employment, OECD	Oil price (exogenous)
			Mixed	Markit PMI, OECD CLI	Oil price (exogenous)
India	Average of hard and mixed indicator models	0.48	Hard	Industrial production, Fertiliser production	Capital goods production, intermediate goods production, OECD CLI
			Mixed	Lag of GDP, Markit PMI, OECD CLI	
Indonesia	Average of single-indicator models	0.33	Single-indicator	Imports, exports, car sales, Markit World PMI	
China	Average of hard and mixed indicator models	0.65	Hard	Two lags of GDP, industrial production, retail sales, OECD CLI	Coke production, cement production
			Mixed	National PMI, OECD CLI	
South Africa	Average of hard and mixed indicator models	0.76	Hard	Lag of GDP, industrial production, car sales, mining production	OECD CLI
			Mixed	National PMI (employment), lag of OECD CLI	

Notes:

1. The R^2 of the quarterly bridge equation is obtained using the average of the predicted values across models. The R^2 is calculated over the full estimation sample, except for Indonesia for which it is calculated over the period 2007Q1-2013Q3 given the large decline in GDP growth volatility after the mid-2000s.

20. Forecast accuracy of the selected models is assessed by pseudo out-of-sample forecasts over the evaluation period 2007Q1 to 2013Q3. Pseudo out-of-sample forecasts for 2007Q1 and 2007Q2 are obtained by estimating the model up to 2006Q4 and using 0, 1, 2 or 3 months of indicators for 2007Q1. By recursively estimating the model over the remainder of the evaluation period a full set of pseudo out-of-sample forecasts over 2007Q1-2013Q3 can be obtained. Various measures of forecast accuracy, such as

16 . Statistical tests suggest that alternative weighting schemes based on forecast accuracy over the period 2007Q1-2013Q3 would only marginally improve performance so that the more tractable average weighting scheme is retained.

17 . For estimation purposes, PMIs for Brazil, China and India were back-cast to January 2000 using estimated coefficients from the linear regression of the PMI on the first two principal components of industrial production, retail sales and the Markit World PMI.

the root mean squared forecast error (RMSFE) or forecast directional accuracy (FDA, the share of correctly forecast changes in the direction of the quarterly GDP growth rate) are then computed by using the published quarterly GDP growth series. Reflecting the unavailability of unrevised indicator series, the pseudo out-of-sample exercise is conducted with revised data for both monthly indicators and quarterly GDP growth.[18]

21. The indicator models for the EMEs considered in this paper display similar forecast accuracy to that of the existing indicator model suite for the G7 countries, especially if allowance is made for some EMEs' higher GDP growth volatility. For the quarter following the most recent GDP release, the indicator models for China, Indonesia and South Africa achieve similar forecast accuracy as the median G7 model (Table 3). The models for Brazil and Russia are more accurate or of similar accuracy as the model with the largest forecast errors for the G7 countries despite similar or higher GDP growth volatility while the models for India and Russia are only marginally less accurate despite significantly larger GDP growth volatility.[19]

Table 2. EME indicator models' forecast accuracy is similar to that of the G7 suite of models

Quarter+1, root mean squared forecast error, 2007Q1-2013Q3

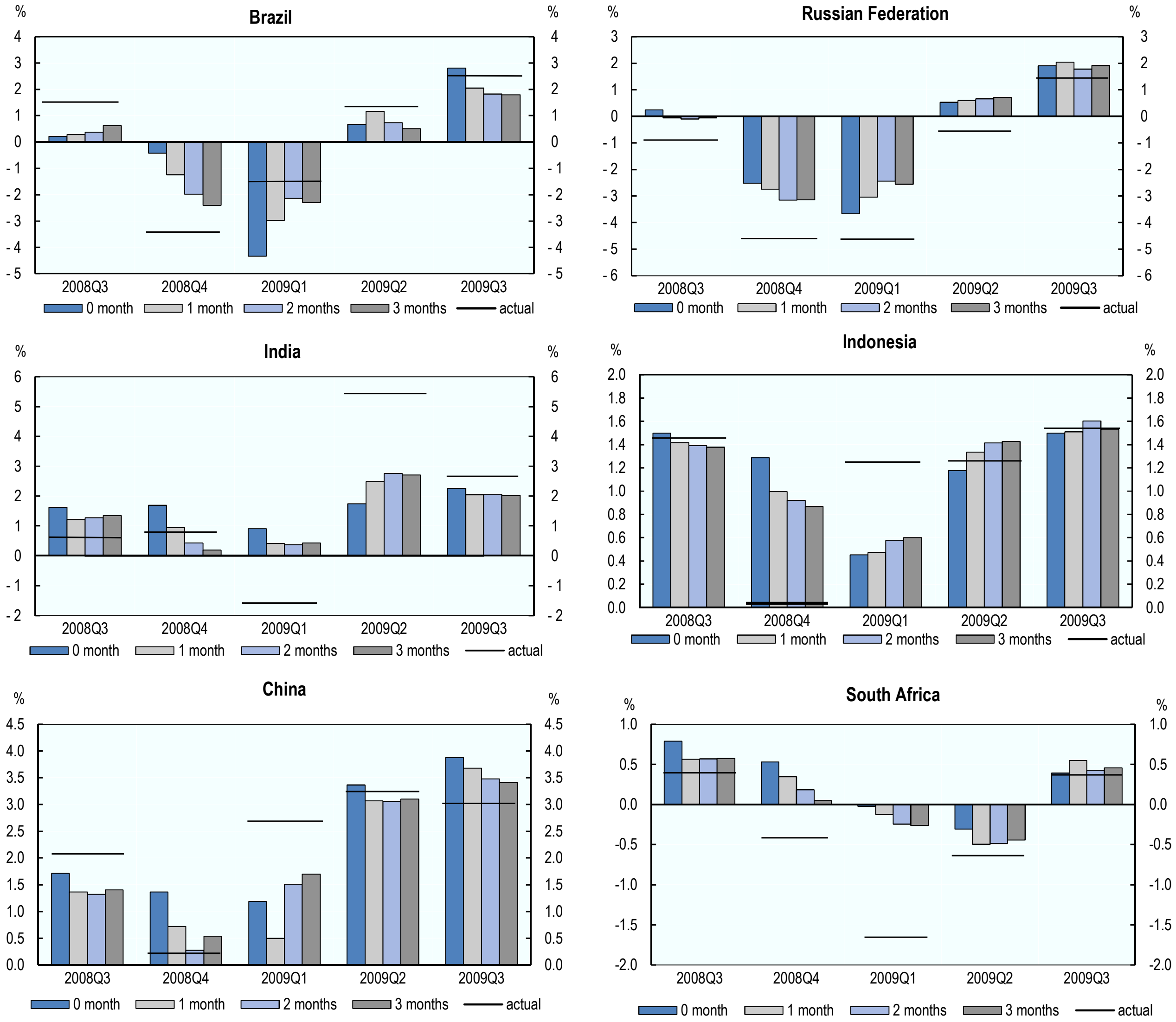
	0 month of indicators for Q+1	1 month of indicators for Q+1	2 months of indicators for Q+1	3 months of indicators for Q+1	*Standard deviation of GDP growth*
Brazil	1.07	0.83	0.72	0.65	*1.35*
Russia	1.01	0.97	0.93	0.92	*1.79*
India	1.30	1.10	1.10	1.11	*1.43*
Indonesia	0.38	0.32	0.30	0.30	*0.35*
China	0.54	0.60	0.45	0.44	*0.72*
South Africa	0.49	0.45	0.40	0.38	*0.67*
G7 max	1.29	1.09	1.03	0.90	*1.49*
G7 median	0.54	0.42	0.42	0.38	*0.88*
G7 min	0.43	0.30	0.19	0.17	*0.63*

22. For most large EMEs considered in this paper, the small-scale indicator models would have allowed an early identification of the downturn during the global crisis of 2008-09 and the subsequent rebound (Figure 2). For Brazil, Russia and China the indicator models forecast the downturn and the subsequent rebound fairly accurately several months ahead of the official GDP release. For South Africa the model underestimated the downturn while it accurately forecast the rebound. Only for India and Indonesia did the model give little indication of the slowdown and the subsequent rebound.

18 . Other reasons for which real time forecasting performance may differ from the figures reported below are (i) that the pattern of missing data at the end of the sample is not exactly replicated for the pseudo out-of-sample forecasts, with all indicators assumed to be available for 0, 1, 2 or 3 months within the quarter; and (ii) that seasonal adjustments are performed using the entire series rather than the one up to the evaluation sample.

19. Similar results are obtained for the second quarter following the most recent GDP release (see Table A3.1).

Figure 2. Indicator model performance during 2008-09



Note: The bars denote indicator model forecasts of quarterly GDP growth (non-annualised) assuming 0, 1, 2 or 3 months of indicators for the quarter following the most recent official GDP release are available. One month of indicators is typically available 3-4 months before the official GDP release. The horizontal lines denote official (revised) quarterly GDP growth.

23. Based on revised data for both indicators and quarterly GDP growth, pseudo out-of-sample forecasts suggest that the small-scale indicator models would typically be more accurate than those published in the *OECD Economic Outlook* under the prime responsibility of country desks that presumably monitor large numbers of indicators (Table 2).[20] This suggests that the indicator models may be useful guides for country desks to gauge near-term aggregate economic developments, especially for the first

20. The comparisons replicate the information structure available at the time of the finalisation of the OECD Economic Outlook projections (around mid-May and mid-November of each year).

quarter following the most recent GDP release.[21] An important caveat to these calculations is that GDP revisions for some of the countries under consideration have been large, especially for Russia and India. If GDP and indicator revisions are correlated – *e.g.* a downward revision in GDP may be accompanied by a downward revision in industrial production – this may unduly bias the comparison in favour of the indicator models. Given that unrevised indicator series are unavailable, a comparison of country desk projections and indicator model forecasts in "quasi-real time" is infeasible. The performance of the indicator models in forecasting will ultimately have to be assessed based on real-time data series.

Table 3. Indicator model forecasts are at least as accurate as country desks' forecasts

Root mean squared forecast error, 2009Q1-2013Q3

	Q+1		Q+2	
	Desk	Model	Desk	Model
Brazil	0.73	0.63	0.81	0.81
Russia	1.65	0.94	1.81	1.25
India	1.16	0.87	1.43	1.36
Indonesia[1]	0.43	0.16	0.16	0.23
China	0.32	0.31	0.37	0.47
South Africa[1]	0.39	0.23	0.50	0.39

1. Root mean squared forecast error computed over 2010Q1-2013Q3.

Forecast accuracy of the selected models

Brazil

24. For Brazil, a large number of timely monthly indicators to forecast quarterly GDP growth are available, including industrial production, employment and retail sales (Annex Table A2.1). Monthly data on these indicators become available several weeks in advance of the first quarterly GDP release, with full quarterly information available 2-4 weeks before.[22] Bivariate correlations with quarterly GDP growth are around 0.5-0.8, suggesting that these indicators contain significant information on current GDP growth. The selected model includes industrial production, employment, retail sales, capacity utilisation, OECD CLI as well as the Markit PMI.[23]

25. The selected combination of hard and mixed indicator models outperforms the autoregressive and naive benchmarks based on the RMSFE criterion and displays similar forecast directional accuracy (FDA). Importantly, the monthly indicators appear to contain information on both the first and second quarters following the most recent GDP release.

21 . The China desk routinely uses a similar small-scale indicator model as the one described in this paper in the early stages of the OECD Economic Outlook projections.

22 . Note that the monthly index of economic activity which synthesises other monthly indicators is released two weeks after industrial production but does not raise forecast accuracy relative to the model including only industrial production. It is therefore not included in the selected model.

23. The aggregate index of economic activity that is highly correlated with quarterly GDP growth has the drawback of being released several weeks after industrial production and employment.

Table 4. Brazil: Forecast accuracy (2007Q1-2013Q3)

Average of hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
0 month of indicators for Q+1	1.07	70	0.74	74
1 month of indicators for Q+1	0.83	74	0.80	74
2 months of indicators for Q+1	0.72	78	0.82	74
3 months of indicators for Q+1	0.65	74	0.97	78
Autoregressive benchmark	1.32	78	1.39	78
Naïve benchmark (constant growth)	1.47	-	1.89	-

Russia

26. For Russia, a large number of monthly indicators that are highly correlated with GDP growth are released well in advance of the official GDP figure (Annex Table A2.2). The most highly correlated indicator is the Markit PMI survey, with a bivariate correlation of around 0.9. Among the most highly correlated hard indicators are industrial production growth (0.8); the lag of the OECD CLI and current retail sales (around 0.6); as well as employment growth (around 0.5).

27. The average forecast from the hard and mixed indicator models for Russia outperforms the autoregressive and naive benchmarks by a large margin (Table 5). RMSFEs for both quarters following the most recent GDP release are around 40% lower than for the benchmark models. The FDA for the first quarter following the most recent GDP release is also around 10 percentage points higher than for the autoregressive model, with the indicator model accurately forecasting 70% of growth slowdowns or accelerations.

Table 5. Russia: Forecast accuracy (2007Q1-2013Q3)

Average of hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
0 month of indicators for Q+1	1.01	63	1.46	52
1 month of indicators for Q+1	0.97	67	1.31	56
2 months of indicators for Q+1	0.93	70	1.19	59
3 months of indicators for Q+1	0.92	70	1.19	63
Autoregressive benchmark	1.70	59	2.19	48
Naïve benchmark (constant growth)	1.54	-	2.33	-

India

28. For India, monthly indicators are typically only weakly correlated with quarterly GDP growth. Except for industrial production and the stock price index, bivariate correlations are typically below 0.5 (Annex Table A2.3). Weak correlation of monthly indicators with quarterly GDP growth is reflected in the low proportion of quarterly variation in GDP explained by the selected model (around 0.5, see Table 1), which includes industrial production, production of fertilisers, production of capital goods, production of intermediate goods, the OECD CLI as well as the Markit PMI.

29. As soon as one month of indicators becomes available, the RMSFE of the selected model for the first quarter following the most recent GDP release is about 30% lower than for the autoregressive

benchmark. However, for the second quarter following the most recent GDP release the indicators do not appear to contain useful advance information; the selected model only marginally outperforms the autoregressive benchmark in terms of RMSFE and FDA.

Table 6. India: Forecast accuracy (2007Q1-2013Q3)

Average of hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
0 month of indicators for Q+1	1.30	64	1.31	61
1 month of indicators for Q+1	1.10	71	1.32	61
2 months of indicators for Q+1	1.10	71	1.30	61
3 months of indicators for Q+1	1.11	71	1.27	68
Autoregressive benchmark	1.50	71	1.40	68
Naïve benchmark (constant growth)	1.99	-	1.81	-

Indonesia

30. For Indonesia, full quarterly information on industrial production becomes available only after quarterly GDP is released and is uncorrelated with quarterly GDP growth (Annex Table A2.4). Monthly car sales, merchandise imports and exports as well as the stock price index display bivariate correlations with quarterly GDP growth of around 0.3. The bivariate correlation of the monthly consumer confidence index with quarterly GDP growth is below 0.2. Weak correlations between monthly indicators and quarterly GDP growth are reflected in a fairly low proportion of GDP growth explained by the selected model (around 0.3, see Table 1), which averages across bridge equations that include single indicators: imports, exports, car sales and the Markit World PMI.[24]

31. The selected model's forecast accuracy is high compared with the models for the other EMEs considered in this paper, reflecting significantly lower growth volatility over the period 2007Q1-2013Q3: the standard deviation of quarterly GDP growth for Indonesia over this period was around 0.4% compared with an average of around 1.2% for the other EMEs (see Table 3). For the first quarter following the most recent GDP release, the model significantly reduces RMSFE with respect to the autoregressive benchmark, whereas the reduction for the second quarter is only marginal.

Table 7. Indonesia: Forecast accuracy (2007Q1-2013Q3)

Average of single-indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
0 month of indicators for Q+1	0.38	75	0.40	64
1 month of indicators for Q+1	0.32	68	0.37	75
2 months of indicators for Q+1	0.30	64	0.37	71
3 months of indicators for Q+1	0.30	64	0.37	75
Autoregressive benchmark	0.42	64	0.41	64
Naïve benchmark (constant growth)	0.49	-	0.47	-

24. Forecasts for the monthly indicators are obtained from a VAR including all the indicators simultaneously.

China

32. For China, monthly industrial production and the official PMI survey display bivariate correlations of around 0.8 with quarterly GDP growth (Annex Table A2.5). However, the time series for the official PMI survey is fairly short, limiting its usefulness for estimation purposes. Other monthly indicators of production such as electricity, coke and metal production are also well correlated with quarterly GDP growth, with bivariate correlations around 0.5. The selected model includes industrial production; retail sales; separately coke and cement production; the OECD CLI; as well as the official PMI, with the quarterly bridge equation explaining around two-thirds of quarterly GDP growth.

33. The selected model reduces RMSFE for the first quarter following the most recent GDP release by around 40% compared with the autoregressive benchmark once 2 or 3 months of indicators are available. For the second quarter following the most recent GDP release, gains in forecast accuracy as measured by the RMSFE compared to the autoregressive benchmark remain of the order of 20%. In terms of correctly forecasting growth slowdowns or accelerations, the selected model does not outperform the autoregressive benchmark. However, it should be noted that for China growth slowdowns or accelerations over the period 2007Q1-2013Q2 were typically moderate so that forecast errors were small even when directional changes were forecast inaccurately.

Table 8. China: Forecast accuracy (2007Q1-2013Q3)

Average of hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
0 month of indicators for Q+1	0.54	52	0.61	41
1 month of indicators for Q+1	0.60	48	0.60	44
2 months of indicators for Q+1	0.45	56	0.63	52
3 months of indicators for Q+1	0.44	59	0.52	48
Autoregressive benchmark	0.72	56	0.77	56
Naïve benchmark (constant growth)	0.74	-	0.90	-

South Africa

34. For South Africa, the bivariate correlation of industrial production with quarterly GDP growth is around 0.7, with full quarterly information available around 3 weeks before the official GDP release (Annex Table A2.6). Other monthly indicators fairly highly correlated with quarterly GDP growth include retail sales, car sales, imports and exports, as well as business confidence and an official purchasing managers' index. The selected model includes industrial production, car sales, mining production, the OECD CLI as well as the official PMI. Overall, the selected model explains around three quarters of quarterly GDP growth over the period 1994-2013.

35. The selected model for South Africa significantly outperforms the autoregressive benchmark, with RMSFE around 30% lower for the first quarter following the most recent GDP release and around 20% lower for the second. Moreover, three times out of four the selected model accurately forecasts growth slowdowns or accelerations for the first quarter following the most recent GDP release, and FDA remains above three-fifths for the second quarter following the most recent GDP release.

Table 9. South Africa: Forecast accuracy (2007Q1-2013Q3)

Average of hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
0 month of indicators for Q+1	0.49	63	0.59	63
1 month of indicators for Q+1	0.45	74	0.57	59
2 months of indicators for Q+1	0.40	78	0.53	67
3 months of indicators for Q+1	0.38	78	0.52	63
Autoregressive benchmark	0.63	59	0.65	59
Naïve benchmark (constant growth)	0.57	-	0.79	-

Performance of pure hard and mixed indicator models

36. The pure hard indicator models typically display similar forecast accuracy to the selected models for the first quarter following the most recent GDP release but underperform for the second quarter (Annex Tables A1.1-A1.5). For Brazil, the hard indicator model even forecasts GDP growth for the first quarter following the most recent GDP release a bit more accurately than the selected average model. However, for most countries, except South Africa, the pure hard indicator model displays significantly larger forecast error than the selected average model.

37. The mixed indicator models typically display lower forecast accuracy than the selected models for the first quarter following the most recent GDP release but perform similarly for the second quarter (Annex Tables A1.1-A1.5). For Brazil, Russia and India, the mixed indicator models slightly outperform the selected average model for the second quarter following the most recent GDP release, whereas for China the mixed indicator model displays lower forecasting accuracy for the second quarter but similar accuracy for the first. This suggests that more elaborate weighting schemes, *e.g.* based on the inverse of the out-of-sample forecast error variance (Bates and Granger, 1969), rather than averaging across the hard and mixed models for both quarters may raise forecast accuracy, but statistical tests indicate that in practice gains would be marginal.

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ANNEX 1: DETAILS ON COMPONENT MODELS

Table A1.1. Brazil: Forecast accuracy (2007Q1-2013Q3)

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
A: Hard model				
0 month of indicators for Q+1	1.18	74	0.71	81
1 month of indicators for Q+1	0.78	81	0.81	78
2 months of indicators for Q+1	0.67	70	0.91	74
3 months of indicators for Q+1	0.51	74	1.16	70
B: Mixed model				
0 month of indicators for Q+1	1.04	70	0.90	67
1 month of indicators for Q+1	0.96	74	0.88	70
2 months of indicators for Q+1	0.87	78	0.81	70
3 months of indicators for Q+1	0.89	78	0.91	67
C: Benchmarks				
Selected model[1]	0.65	74	0.97	78
Autoregressive benchmark	1.32	78	1.39	78
Naïve benchmark (constant growth)	1.47	-	1.89	-

Note:

1. Average of hard and soft indicators models with 3 months of indicators for Q+1.

Table A1.2. Russia: Forecast accuracy (2007Q1-2013Q3)

Hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
A: Hard model				
0 month of indicators for Q+1	1.12	63	1.62	52
1 month of indicators for Q+1	1.03	67	1.43	56
2 months of indicators for Q+1	0.93	70	1.20	56
3 months of indicators for Q+1	0.93	70	1.30	63
B: Mixed model				
0 month of indicators for Q+1	1.00	56	1.34	48
1 month of indicators for Q+1	0.98	63	1.24	56
2 months of indicators for Q+1	0.99	63	1.24	67
3 months of indicators for Q+1	0.95	63	1.14	59
C: Benchmarks				
Selected model[1]	0.92	70	1.19	63
Autoregressive benchmark	1.70	59	2.19	48
Naïve benchmark (constant growth)	1.54	-	2.33	-

Note:

1. Average of hard and soft indicators models with 3 months of indicators for Q+1.

Table A1.3. India: Forecast accuracy (2007Q1-2013Q3)

Hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
A: Hard model				
0 month of indicators for Q+1	1.38	57	1.33	64
1 month of indicators for Q+1	1.05	75	1.38	64
2 months of indicators for Q+1	1.05	71	1.42	61
3 months of indicators for Q+1	1.07	61	1.38	57
B: Mixed model				
0 month of indicators for Q+1	1.28	71	1.31	61
1 month of indicators for Q+1	1.27	79	1.27	61
2 months of indicators for Q+1	1.27	71	1.20	61
3 months of indicators for Q+1	1.28	71	1.19	75
C: Benchmarks				
Selected model[1]	1.11	71	1.27	68
Autoregressive benchmark	1.50	71	1.40	68
Naïve benchmark (constant growth)	1.99	-	1.81	-

Note:

1. Average of hard and soft indicators models with 3 months of indicators for Q+1.

Table A1.4. Indonesia: Forecast accuracy (2007Q1-2013Q3)

Hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
A: Hard model				
0 month of indicators for Q+1	0.43	74	0.43	67
1 month of indicators for Q+1	0.42	74	0.44	70
2 months of indicators for Q+1	0.41	78	0.44	70
3 months of indicators for Q+1	0.41	81	0.44	74
B: Mixed model				
0 month of indicators for Q+1	0.42	67	0.46	70
1 month of indicators for Q+1	0.37	74	0.41	78
2 months of indicators for Q+1	0.35	74	0.42	74
3 months of indicators for Q+1	0.35	74	0.41	70
C: Benchmarks				
Selected model[1]	0.30	64	0.37	75
Autoregressive benchmark	0.43	67	0.41	67
Naïve benchmark (constant growth)	0.50	-	0.48	-

Note:

1. Average of single-indicator models with 3 months of indicators for Q+1.

Table A1.5. China: Forecast accuracy (2007Q1-2013Q3)

Hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
A: Hard model				
0 month of indicators for Q+1	0.51	59	0.62	41
1 month of indicators for Q+1	0.76	44	0.61	41
2 months of indicators for Q+1	0.53	52	0.51	48
3 months of indicators for Q+1	0.50	48	0.48	52
B: Mixed model				
0 month of indicators for Q+1	0.61	59	0.64	52
1 month of indicators for Q+1	0.50	67	0.64	56
2 months of indicators for Q+1	0.47	56	0.80	52
3 months of indicators for Q+1	0.46	59	0.63	59
C: Benchmarks				
Selected model[1]	0.44	59	0.52	48
Autoregressive benchmark	0.72	56	0.77	56
Naïve benchmark (constant growth)	0.74	-	0.90	-

Note:

1. Average of hard and mixed indicator models with 3 months of indicators for Q+1.

Table A1.6. South Africa: Forecast accuracy (2007Q1-2013Q3)

Hard and mixed indicator models

	Q+1		Q+2	
	RMSFE	FDA	RMSFE	FDA
A: Hard model				
0 month of indicators for Q+1	0.48	56	0.58	63
1 month of indicators for Q+1	0.42	70	0.57	67
2 months of indicators for Q+1	0.38	67	0.53	67
3 months of indicators for Q+1	0.34	74	0.50	59
B: Mixed model				
0 month of indicators for Q+1	0.53	56	0.61	59
1 month of indicators for Q+1	0.51	63	0.58	63
2 months of indicators for Q+1	0.47	70	0.55	59
3 months of indicators for Q+1	0.48	70	0.57	56
C: Benchmarks				
Selected model[1]	0.38	78	0.52	63
Autoregressive benchmark	0.63	59	0.65	59
Naïve benchmark (constant growth)	0.57	-	0.79	-

Note:

1. Average of hard and soft indicators models with 3 months of indicators for Q+1.

ANNEX 2: DESCRIPTIVE STATISTICS

Table A2.1. Monthly indicators for Brazil

Sample for GDP growth: 1997Q1-2013Q3				
Indicator	**Bivariate correlation[1]**	**ADF test (p-values)[2]**	**First available month**	**Lead with respect to GDP (in weeks)[3]**
Production				
Index of economic activity	0.84	0.00	Jan-03	2
Industrial production	0.81	0.00	Jan-97	4
OECD CLI	0.58	0.00	Jan-97	3
Lag of OECD CLI	0.67	0.00	Jan-97	15
Capacity utilisation rate	0.63	0.00	Jan-97	3
Employment and expenditure				
Employment in industry	0.57	0.00	Dec-00	3
Unemployment rate	-0.37	0.00	Oct-01	6
Retail sales	0.49	0.00	Jan-00	2
New vehicles registrations	0.39	0.00	Jan-05	8
Unit labor cost	0.24	0.00	Jan-97	5
Real effective earnings	0.12	0.00	Feb-02	1
External				
Import volume	0.52	0.00	Jan-97	3
Export volume	0.33	0.00	Jan-97	3
Financial				
Stock price index	0.44	0.00	Jan-97	9
Exchange rate	-0.41	0.00	Jan-97	9
Short-term interest rate (SELIC)	-0.34	0.00	Jan-97	9
Credit outstanding individuals	0.31	0.00	Jan-97	5
Credit outstanding private sector	0.19	0.00	Jan-97	5
Soft				
Markit PMI	0.70	0.01	Feb-06	9
Industrial confidence index	0.45	0.00	Jul-98	10
Consumer confidence	0.10	0.21	Mar-99	7
Markit PMI World	0.58	0.00	Jan-98	8

Notes:

1. Hard indicators in growth rates; soft indicators in levels.

2. A value below 0.1 denotes rejection of the null hypothesis of non-stationarity at the 10% level. Hard indicators tested in growth rates; soft indicators in levels.

3. Number of weeks before GDP release that full quarterly information on indicator is available.

Table A2.2. Monthly indicators for Russia

Sample for GDP growth: 2000Q1-2013Q3				
Indicator	Bivariate correlation[1]	ADF test (p-values)[2]	First available month	Lead with respect to GDP (in weeks)[3]
Production				
Industrial production	0.71	0.00	Jan-00	11
OECD CLI	0.61	0.02	Jan-00	8
Lag of OECD CLI	0.69	0.02	Jan-00	20
Residential housing constructed	0.18	0.00	Jan-00	10
Employment and expenditure				
Retail sales	0.59	0.01	Jan-00	10
Employment	0.37	0.00	Jan-00	6
Unemployment rate	-0.35	0.00	Jan-00	10
Average w age	0.43	0.00	Jan-00	10
External				
Imports (in USD)	0.70	0.00	Jan-00	9
Exports (in USD)	0.68	0.00	Jan-00	9
Nominal exchange rate (to USD)	-0.63	0.00	Jan-00	13
International reserves	0.63	0.00	Jan-00	12
Oil price	0.52	0.00	Jan-00	13
Financial				
M0	0.65	0.00	Jan-00	9
M2	0.72	0.00	Jan-00	9
Stock price index	0.45	0.00	Jan-00	13
Interbank interest rate	-0.40	0.00	Jan-00	13
Soft				
Markit PMI	0.80	0.02	Jan-00	13
Markit PMI World	0.72	0.01	Jan-00	13
Business survey	0.42	0.23	Jan-00	9

Notes:

1. Hard indicators in growth rates; soft indicators in levels.

2. A value below 0.1 denotes rejection of the null hypothesis of non-stationarity at the 10% level. Hard indicators tested in growth rates; soft indicators in levels.

3. Number of weeks before GDP release that full quarterly information on indicator is available.

Table A2.3. Monthly indicators for India

Sample for GDP growth: 1997Q1-2013Q3				
Indicator	Bivariate correlation[1]	ADF test (p-values)[2]	First available month	Lead with respect to GDP (in weeks)[3]
Production				
Industrial production	0.60	0.00	Jan-97	3
IP intermediate goods	0.34	0.00	Jan-97	3
IP capital goods	0.37	0.00	Jan-97	3
OECD CLI	0.40	0.05	Jan-97	3
Lag of OECD CLI	0.44	0.03	Jan-97	15
Fertilizer production	0.32	0.00	Apr-01	4
Electricity production	0.03	0.00	Jan-97	6
Employment and expenditure				
Car sales	0.26	0.00	Jan-97	7
External				
Imports (in USD)	0.37	0.00	Jan-97	6
Exports (in USD)	0.28	0.00	Jan-97	6
Nominal exchange rate (to USD)	-0.32	0.00	Jan-97	9
Financial				
Bombay stock exchange index	0.54	0.00	Jan-97	9
M1	0.35	0.00	Jan-97	10
M2	0.34	0.00	Jan-97	7
Interbank interest rate	0.27	0.00	Jan-97	12
Soft				
Markit PMI	0.38	0.02	Mar-05	8
Markit PMI World	0.31	0.00	Jan-98	8

Notes:

1. Hard indicators in growth rates; soft indicators in levels.

2. A value below 0.1 denotes rejection of the null hypothesis of non-stationarity at the 10% level. Hard indicators tested in growth rates; soft indicators in levels.

3. Number of weeks before GDP release that full quarterly information on indicator is available.

Table A2.4. Monthly indicators for Indonesia

Sample for GDP growth: 2000Q1-2013Q3				
Indicator	**Bivariate correlation[1]**	**ADF test (p-values)[2]**	**First available month**	**Lead with respect to GDP (in weeks)[3]**
Production				
Industrial production	-0.01	0.00	Jan-00	-1
OECD CLI	0.01	0.00	Jan-00	0
Lag of OECD CLI	0.10	0.00	Jan-00	12
Employment and expenditure				
Car sales	0.25	0.00	Jan-00	3
Retail trade	0.04	0.00	Jan-00	4
External				
Imports (in USD)	0.41	0.00	Jan-00	1
Exports (in USD)	0.32	0.00	Jan-00	1
Oil price	0.30	0.00	Jan-00	5
Nominal exchange rate (to USD)	-0.14	0.00	Jan-00	5
Financial				
Djakarta stock exchange index	0.21	0.00	Jan-00	5
M0	0.09	0.00	Jan-00	0
M2	-0.06	0.00	Jan-00	1
Interbank interest rate	0.08	0.00	Jan-00	4
Soft				
Consumer confidence index	0.11	0.11	Jan-00	5
Markit PMI World	0.24	0.01	Jan-00	5

Notes:

1. Hard indicators in growth rates; soft indicators in levels.

2. A value below 0.1 denotes rejection of the null hypothesis of non-stationarity at the 10% level. Hard indicators tested in growth rates; soft indicators in levels.

3. Number of weeks before GDP release that full quarterly information on indicator is available.

Table A2.5. Monthly indicators for China

Indicator	Bivariate correlation[1]	ADF test (p-values)[2]	First available month	Lead with respect to GDP (in weeks)[3]
Production				
Industrial production	0.76	0.00	Jan-92	9
Electricity production	0.57	0.00	Jan-96	5
OECD CLI	0.45	0.00	Jan-92	-3
Lag of OECD CLI	0.41	0.00	Jan-92	9
Production of ferroalloy	0.34	0.00	Jan-92	6
Production of coke	0.34	0.00	Jan-92	6
Production of pig iron	0.34	0.00	Jan-92	6
Production of lubricant oil	0.27	0.00	Jan-92	6
Production of steel	0.25	0.00	Jan-92	6
Production of cement	0.19	0.00	Jan-92	6
Employment and expenditure				
Commercial car sales	0.47	0.00	Jan-05	0
Passenger car sales	0.36	0.00	Jan-05	0
Retail sales (deflated)	0.06	0.00	Jan-93	5
Retail sales (deflated, 2008Q4 excluded)	0.27	0.00	Jan-93	5
Floor space sold	0.20	0.00	Jan-96	7
External				
Exports volume	0.36	0.00	Jan-96	-3
Imports volume	0.35	0.00	Jan-96	-3
Nominal exchange rate (to USD)	-0.23	0.00	Jan-94	3
Visitors arrival	0.16	0.00	Jan-98	5
Financial				
M2	0.36	0.00	Jan-97	-11
Shanghai stock exchange index	0.36	0.00	Feb-92	3
Interbank interest rate (CHIBOR 3-months)	0.19	0.00	Jan-96	3
Outstanding bank loans	0.26	0.00	Jan-97	-11
Fixed asset investment	0.04	0.00	Jan-94	7
Soft				
National source PMI	0.78	0.08	Jan-05	17
Markit PMI	0.50	0.01	Apr-04	17
Real estate climate index	0.26	0.16	Jan-97	9
Markit PMI World	0.33	0.00	Jan-98	17

Notes:

1. Hard indicators in growth rates; soft indicators in levels.

2. A value below 0.1 denotes rejection of the null hypothesis of non-stationarity at the 10% level. Hard indicators tested in growth rates; soft indicators in levels.

3. Number of weeks before GDP release that full quarterly information on indicator is available.

Table A2.6. Monthly indicators for South Africa

Sample for GDP growth: 1994Q1-2013Q3				
Indicator	Bivariate correlation[1]	ADF test (p-values)[2]	First available month	Lead with respect to GDP (in weeks)[3]
Production				
Industrial production	0.65	0.00	Jan-94	4
Industrial production (mining)	0.15	0.00	Jan-94	4
OECD CLI	0.44	0.00	Jan-94	3
Lag OECD CLI	0.56	0.00	Jan-94	15
National leading indicator	0.38	0.00	Jan-94	0
Employment and expenditure				
Retail sales	0.54	0.00	Jan-94	3
Car sales	0.43	0.00	Jan-94	9
External				
Imports (in USD)	0.48	0.00	Jan-94	5
Exports (in USD)	0.46	0.00	Jan-94	5
Exchange rate (to USD)	-0.02	0.00	Jan-94	9
Financial				
Johannesburg stock exchange index	0.40	0.00	Jan-94	9
M0	0.19	0.00	Jan-94	5
M2	0.29	0.00	Jan-94	5
Interbank rate	0.18	0.00	Jan-94	9
Soft				
Business confidence index	0.64	0.93	Jan-04	8
National PMI (employment)	0.60	0.00	Sep-99	9
Markit PMI World	0.69	0.00	Jan-98	8

Notes:

1. Hard indicators in growth rates; soft indicators in levels.

2. A value below 0.1 denotes rejection of the null hypothesis of non-stationarity at the 10% level. Hard indicators tested in growth rates; soft indicators in levels.

3. Number of weeks before GDP release that full quarterly information on indicator is available.

ANNEX 3: COMPARISON OF FORECAST ACCURACY OF EME AND G7 INDICATOR MODELS

Table A3.1. Similar forecast accuracy of EME indicator models to G7 suite

Q+2, root mean squared error, 2007Q1-2013Q3

	0 month of indicators for Q+1	1 month of indicators for Q+1	2 months of indicators for Q+1	3 months of indicators for Q+1	*Standard deviation of GDP growth*
Brazil	0.74	0.80	0.82	0.97	*1.35*
Russia	1.46	1.31	1.19	1.19	*1.79*
India	1.31	1.32	1.30	1.27	*1.43*
Indonesia	0.40	0.37	0.37	0.37	*0.35*
China	0.61	0.60	0.63	0.52	*0.72*
South Africa	0.59	0.57	0.53	0.52	*0.67*
G7 max	1.61	1.64	1.60	1.30	*1.49*
G7 median	0.71	0.67	0.60	0.53	*0.88*
G7 min	0.58	0.55	0.50	0.43	*0.63*

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