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Outperforming IMF Forecasts by the Use of Leading Indicators

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Keywords: IMF WEO forecasts, leading indicators, real-time data

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Katja Drechsel Sebastian Giesen† Axel Lindner‡

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1 Motivation

Forecasts of the global economic activity and of the economic performance in advanced and developing economies are key for many economic decisions such as those of financial institutions and export oriented firms and are important inputs for individual country forecasts. But global and area wide developments are often simply aggregates of selected country forecasts and are not based on direct forecasts for the aggregate. The most important regular publication to state and prospects of the world economy is the World Economic Outlook (WEO) by the International Monetary Fund (IMF), which is published in detail every spring and autumn and is the main basis for the IMF's multilateral surveillance activities. For many economic and political decisions monitoring and forecasting has to be conducted more frequently, in particular because many data that are suitable for the forecast of global economic growth are published at a higher frequency and thus in a more timely manner. Therefore, it seems natural to ask to what extent the forecasts by the IMF for the current and the next year can be improved or even completely replaced by the use of the information of leading indicators prior to the next publication of the WEO.

The study has two main objectives: First, we determine the predictive quality of the IMF's GDP growth forecasts for the global economy and for the group of advanced economies and developing and emerging economies respectively.[1] Second, we select appropriate leading indicators for GDP forecasts of these three regional aggregates and generate indicator-based forecasts. Predictions based on the IMF forecasts in combination with the leading indicator information are produced. Using these two types of forecasts we look at their prediction accuracy compared to the pure IMF forecasts taking into account the 12 different forecast rounds per year. The remainder of the paper is structured as follows: Section 2 describes the IMF WEO data set used in this paper, recalls briefly the main concepts used for the evaluation of forecasts and provides results on the accuracy of IMF forecasts. Section 3 introduces our set of leading indicators and shows how to construct indicator based forecasts and assesses their quality. Section 4 presents our results. Finally, Section 5 provides some concluding remarks and discusses what is left for future research.

[1] The country classification follows the IMF's definition. In autumn 2012 the World Aggregate comprises 186 countries, the Advanced Economies 35 (including the G7) and 151 Emerging and Developing Economies.

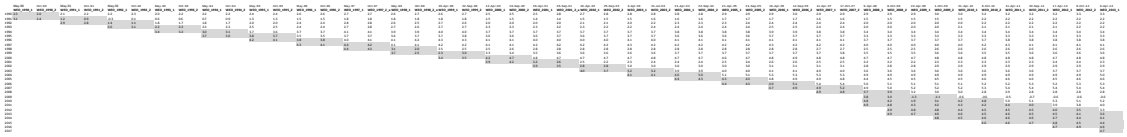
2 Evaluation of IMF Growth Forecasts

In recent years many studies have analyzed the performance of IMF forecasts, in particluar the accuracy and unbiasedness of the WEO forecasts (Pons, 2000; Timmermann, 2007). Most of them are studies comparing institutional and private (international) forecasters, such as IMF, OECD, Worldbank, European Commission and Consensus Economics (see e.g. Pons, 2000; Glück and Schleicher, 2005; Timmermann, 2007; Cabanillas and Terzi, 2012). They evaluate GDP growth forecasts, GDP components (Júlio and Esperança, 2012), inflation (Dreher, Marchesi, and Vreeland, 2008), unemployment rate and ratios of the fiscal surplus to GDP and of external current account surplus to GDP (Atoyan and Conway, 2011). However, the bulk of these studies focus on individual country examinations, in particular the G7 countries (see e.g. Pons, 2000; Batchelor, 2001; Júlio and Esperança, 2012). Only a few studies have analyzed regional aggregates such as the world, industrial countries and developing countries (Artis, 1996; Jakaitiene and Dées, 2012; Golinelli and Parigi, 2013).[2]

2.1 Data Set

The IMF publishes forecasts for the annual growth rate of the gross domestic product for various country groups in the bi-annual World Economic Outlook.[3] WEO forecasts and ex-post data are available electronically at the World Economic Outlook database since 1999. Earlier forecast values are taken from the printed publication of the WEO. In total, the sample from 1992 to 2012 is examined.

Figure 1: Design of the Real-Time Data Set



Note: Ex post real-time data at bi-annual maturity. Values in gray at the end of each column are the IMF forecast values for the current and next year(s).
Source: IMF WEO collections May 1990 to April 2013, authors' illustration.

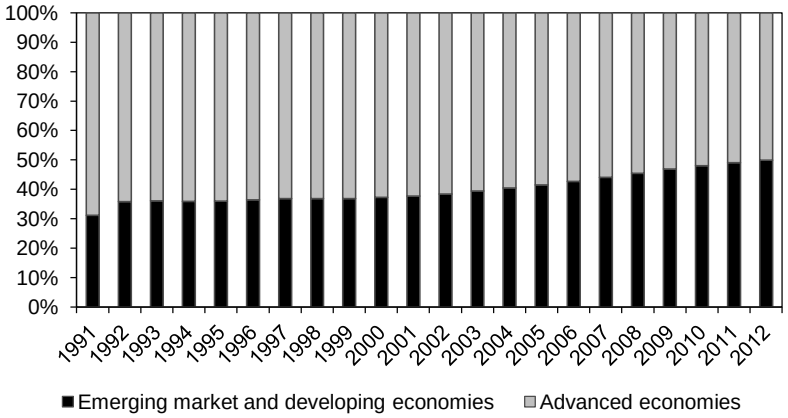
We analyze the forecasts for the total world economy and for the aggregates of advanced economies as well as the developing and emerging countries. It should be noted that the composition and description of the group of countries has changed over time. The main criteria in the WEO for the assignment to the group of advanced economies and the developing and

[2] Note that while Jakaitiene and Dées (2012) use the regional aggregates, they do not work with WEO data, and rather use monthly series to be forecasted, such as industrial production, consumer prices or trade. Golinelli2013 make quarterly forecasts and use own definitions for the group of advanced countries and the group of emerging countries.

[3] Besides the two main forecasts in April and October, updates are published in January and July for key national accounts figures and are available electronically since July 2007. Due to the short history these updates will not be considered in our analysis, though they should be considered for future analyses.

emerging countries are (1) the level of per capita income, (2) the export diversification, and (3) the degree of integration into the global financial system.[4] Reclassifications are only made when there are significant changes, such as the accession of EU member countries to the Euro Area.[5] Still, the share of Emerging Market and Developing Economies has been increasing substantially from 1991 until today due to the emerging Asia effect as well as due to globalization (see Figure 2).[6] Therefore forecasts for the Emerging Market and Developing Economies have become more important.

Figure 2: Contribution to World GDP



Note: Gross domestic product based on purchasing-power-parity (PPP) share of world total.
Source: IMF WEO April 2013.

Generally, the GDP forecasts of the IMF are measured in purchasing power parity (PPP) which has the advantage that price level differences between countries are taken into account (Gulde, 1993). Since 1998 forecasts for the global economy based on market prices are additionally available.[7] The forecasts published by the IMF for the current and the next year have been properly arranged, so that a revision and forecast matrix has been created (see Figure 1).[8]

[4] For more details on the WEO see: http://www.imf.org/external/pubs/ft/weo/faq.htm

[5] In addition, from time to time changes relating to the name are made. In October 2012, for example, the group of 'Emerging and Developing Economies' is renamed to 'Emerging Market and Developing Economies'.

[6] The effects are described by Borin, Cristadoro, Golinelli, and Parigi (2012).

[7] If the differences between market prices and purchasing power parities are rather small and more temporary nature, however, the GDP figures in national currencies are converted at market prices in U.S. dollars. For larger and persistent differences, however, a distortion of the respective weights to aggregate countries GDP is more likely. Therefore it is recommended to work with the weighting scheme based on purchasing power parities.

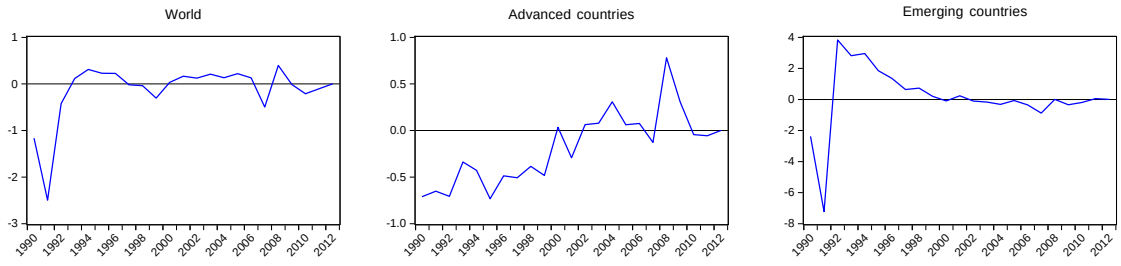
[8] Since 2008 the IMF publishes not only forecasts for the current year but also forecasts for the following 5 years.

2.2 Data Revisions

With each new edition of the WEO ex-post data are changed for all years (see Figure 3). The corresponding revisions are quite substantial, especially for the first half of the 1990s. On the one hand, this results from changes in the set of countries that constitute the aggregates and the recalculations of the individual country weights. On the other hand there are revisions stemming from the revisions of individual country GDPs. In addition to standard maintenance due to new information about the most recent years, the IMF introduced— for example with the System of National Accounts in 1993 (SNA93) — significant enhancements to the standards of economic statistics. The process of adopting the definitions from the new Balance of Payments Manual (BPM) began in the WEO publication in May 1995. Moreover, the EU member states have introduced a consistent system of national accounts (ESA 1995) which has been used in the WEO from 1995 onwards.

Even for the period prior to 1995 data revisions were made to adjust the values to the new standards. The conversion was made country specific and in different times. Further revisions were made to smooth resulting breaks in the time series. For the first half of the 1990s data were substantially revised. In particular, there was a downward revision of the growth rates of the emerging market and developing economies between 1992 and 1995 (see Figure 3). This is mainly due to the fact that many of the transition countries of the former COMECON (especially Russia) massively shrunk due to the change of system in the first half of the 1990s (with growth rates of down to -15%), and that these countries are included in the group of developing and emerging countries only since the spring edition of WEO 2004.[9] For the group of advanced countries slight upward revisions are made over time for the first half of the 1990s. For the period of the financial crisis 2008/2009 data for advanced countries were substantially revised downwards.

Figure 3: Revisions to the WEO GDP over time



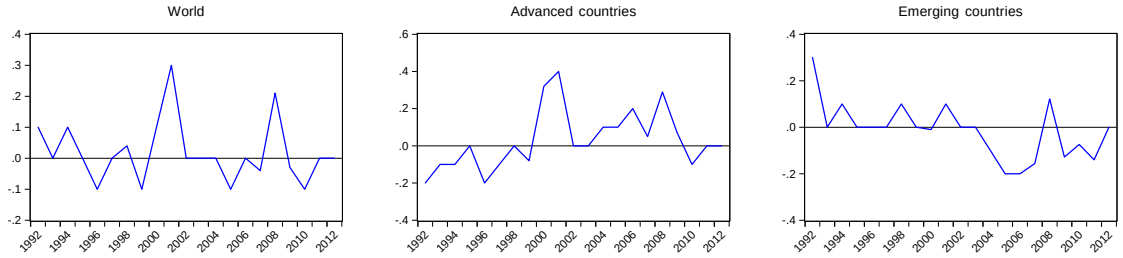
Note: Revisions between the respective initial publication (in $t+1$) and the GDP data published in WEO April 2013 in percentage points. Negative values indicate an upward revision, and positive values a downward revision.
Source: IMF WEO April 2013 and own calculations.

Minor revisions – due to more information for the previous year – are made already within the first year of publication, i.e. from spring to autumn. Figure 4 shows that in upturns (in

[9] Until 2004 these countries formed the separate group countries in transition.

the years 2005-07 and 2010) typically GDP growth was underestimated and subsequently an upward revision followed. Analogously economic downturn periods such as the economic and financial crisis were underestimated and had to be revised downward later. All these revisions of the ex-post values of GDP have a non-negligible impact on the updates of the IMF forecasts. Hence, "Forecasts are only as good as the data behind them" (Croushore, 2006), which should be kept in mind for the following sections.

Figure 4: Revisions to the WEO GDP within the year for the previous year



Note: Revisions of ex-post WEO GDP data from spring to autumn in percentage points. Negative values indicate an upward revision, and positive values a downward revision.
Source: IMF WEO April 2013 and own calculations.

2.3 Forecast Evaluation Measures

For the quality of the IMF forecasts we distinguish between different forecasting rounds (see Table 1). Based on the IMF forecasts for the growth rate of the gross domestic product for the world, for the advanced countries and the emerging economies for the current and following year, the forecast errors are calculated by different error measures. Given the realized values y_t and the predicted values $\hat{y}_t$ at various forecast rounds for each regional aggregate i we calculate the mean forecast error (MFE)

$$MFE^{\text{WEO}} = \frac{1}{n}\sum_{t=1}^{n}\left(y_{i,t} - \hat{y}_{i,t}^{\text{WEO}}\right) = \frac{1}{n}\sum_{t=1}^{n}\hat{e}_{i,t}^{\text{WEO}} \tag{1}$$

and the standard error (root mean squared forecast error - RMSFE)

$$RMSFE^{\text{WEO}} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(y_{i,t} - \hat{y}_{i,t}^{\text{WEO}}\right)^2} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(\hat{e}_{i,t}^{\text{WEO}}\right)^2} \tag{2}$$

We expect that the predictive power of the IMF projections improves considerably over time (from forecast round 1 to 4, see Table 1), as more information becomes available. The analysis is performed in real time, thus, the quality of the specific IMF forecasts is determined by comparison with the first release of the annual growth rate of the respective GDP. Additionally, a pseudo real-time analysis is carried out in which the growth rates of GDP are taken from the the "final" WEO (released in April 2013). These figures are compared for each year with the respective forecasts.

Table 1: IMF Forecast Rounds

	Forecast round	Forecast for			Realization
1	spring WEO in t-1	$\hat{y}_{t-1}^{(3)}$	$\hat{y}_t^{(1)}$		y_{t-2}
2	autumn WEO in t-1	$\hat{y}_{t-1}^{(4)}$	$\hat{y}_t^{(2)}$		y_{t-2}
3	spring WEO in t		$\hat{y}_t^{(3)}$	$\hat{y}_{t+1}^{(1)}$	y_{t-1}
4	autumn WEO in t		$\hat{y}_t^{(4)}$	$\hat{y}_{t+1}^{(2)}$	y_{t-1}
	spring WEO in t+1			$\hat{y}_{t+1}^{(3)}$	y_t

Note: y_t is the actual GDP growth rate at time t. $\hat{y}_t^{(M)}$ is the forecast of the GDP growth at forecast round M for year t.

2.4 Forecasting Accuracy

The quality of the IMF's forecasts is determined for different time periods. Besides the analysis of the overall period (1992-2012), we evaluate a pre-crisis sample (1992-2007) and a (post-)crisis sample (2008-2012) in order to check for the impact of the financial crisis.[10] Table 2 shows the forecast errors for the world, the advanced economies and for the emerging economies (ELSL). As expected, the forecast error decreases significantly for all three regional aggregates from forecast round 1 to 4. This suggests that the GDP forecasts could be improved by more timely forecast updates as soon as new information becomes available.

Table 2: Predictive power of the IMF GDP growth forecast (Real Time)

		MFE			RMSFE		
Sample	Forecast round	World	Advanced	ELSL	World	Advanced	ELSL
1992 - 2012	1	-0.385	-0.518	0.055	1.506	1.556	1.786
	2	-0.242	-0.326	0.102	1.256	1.255	1.596
	3	0.172	0.034	0.256	0.542	0.522	0.750
	4	0.164	0.037	0.210	0.384	0.249	0.527
1992 - 2007	1	-0.205	-0.334	0.301	0.929	1.003	1.482
	2	-0.034	-0.140	0.384	0.898	0.953	1.428
	3	0.223	0.055	0.323	0.519	0.501	0.771
	4	0.231	0.062	0.293	0.380	0.213	0.541
2008 - 2012	1	-0.959	-1.105	-0.731	2.601	2.637	2.525
	2	-0.907	-0.921	-0.800	2.012	1.926	2.044
	3	0.009	-0.033	0.041	0.612	0.584	0.675
	4	-0.048	-0.042	-0.055	0.398	0.341	0.480

Note: The MFE and RMSFE are shown for the IMF's GDP forecast for the world, advanced economies and developing countries (ELSL).

Furthermore the MFE values in Table 2 indicate that the IMF forecast for the world and the advanced countries for the next year (forecast rounds 1-2) is on average too high over the whole

[10] See e.g. Drechsel and Scheufele (2012a) for the crisis impact on forecasting accuracy. Note that for 1991 the GDP data for the ELSL has been revised substantially and the forecast error has huge effects on the overall results; therefore the analysis sample starts in 1992.

period. However, in the WEO forecast the global economic performance of the current year (forecast rounds 3-4) is underestimated on average. In "normal times" (1992-2007) the forecast errors for the advanced countries and the world are significantly lower than for the emerging countries.[11]

For the period after 2008, the forecast errors for the emerging countries are in the first forecast round on average lower than forecasts for the world and for the advanced economies. This is due to the fact that the shrinkage of GDP of emerging countries was comparatively low in 2009.

When comparing the forecast accuracy for the most recent ex-post growth rates with the accuracy based on first releases (see Table 9 in the appendix), we find that the forecast errors for the current and the following year based on the most recent data are marginally larger than for the data published at first. This is probably due to the fact that published real-time realizations for the previous year are still partly based on estimates that are close to the forecasts published in October last year, especially for the case of emerging countries.

While the predictive power of various international institutions have been compared with each other, some researchers also have compared these forecasts with those of naive models (i.e. simple AR or random walk models (see, Arora and Smyth, 1990)) or more structural models inspired by macro-theory (see Fildes and Stekler, 2002). A promising approach to improve macroeconomic forecasts is the use of leading indicators (see, e.g. Emerson and Hendry, 1996; Banerjee, Marcellino, and Masten, 2005; Marcellino, 2006; Clements and Galvão, 2009, and references therein). In our paper we analyze forecasts which are derived only from leading indicators and forecasts which are based on leading indicator information plus the available IMF forecast.

[11] This result has already been shown by Artis (1996) who concludes that conventional forecasting tools are less accurate for developing countries. Arora and Smyth (1990) conclude that for the developing world the simple random walk should be preferred compared to the IMF forecasts.

3 Leading Indicator based Forecasts

3.1 Selection of Leading Indicators

In this section we identify potential leading indicators that reflect the economic dynamics of the world, the advanced economies and the emerging economies, and might therefore be well suited for the prediction of the aggregates' GDP. Indicators should lead or coincide with the macroeconomic dynamics of the particular aggregate, and should have a wide coverage of the economy as a whole (and not just individual sectors). In addition, they should have a high frequency, revisions should be limited, and they should have a long history. We choose only indicators that represent the regional aggregates instead of indicators for individual countries. For the world indicators we have selected the Global Composite Purchasing Managers Index (PMI), Global Manufacturing PMI, OECD Leading Indicators (OECD and OECD + 6 non-member economies), oil price, world trade, world-industrial production, and the MSCI (AC) World Index. For the advanced countries we use (manufacturing) PMI, the oil price, industrial production and trade in advanced countries, and the MSCI World Index. For the emerging countries the following indicators have been selected: the oil price, industrial production in ELSL, trading in the ELSL, and the MSCI Emerging Markets.[12]

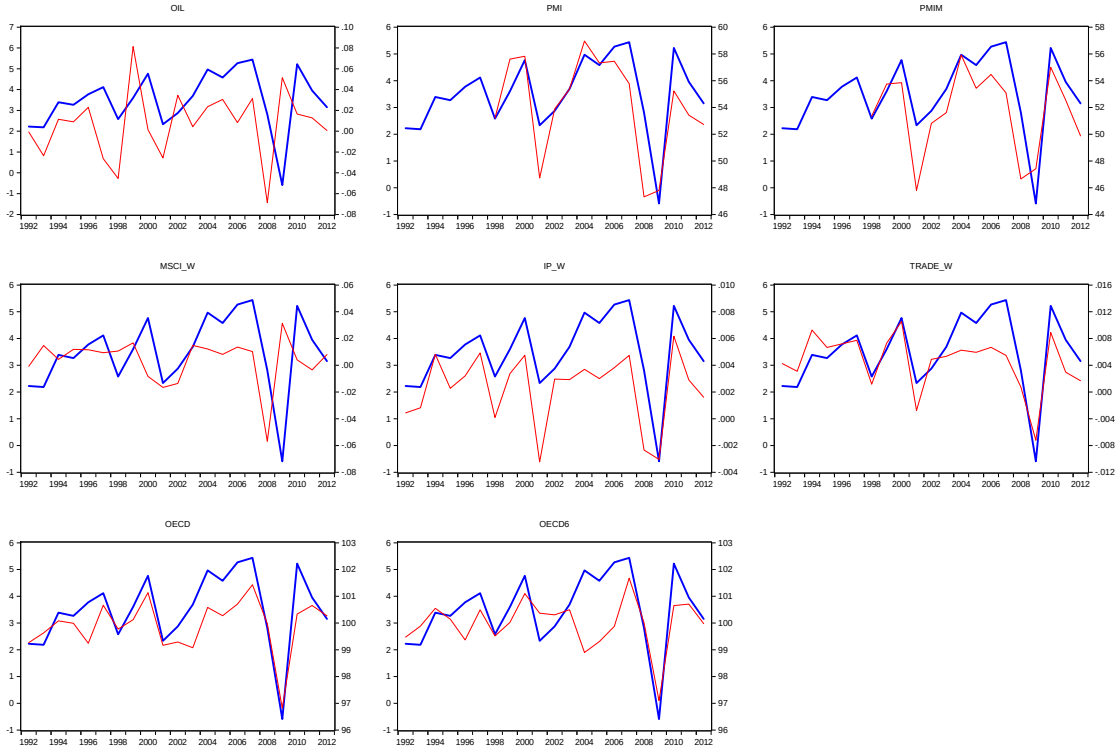
Based on the results of a unit root test (ADF) the indicators are converted from non-stationary in stationary time series if appropriate. As shown in Figure 7 and Table 11, PMI and the OECD Composite Leading Indicators are already stationary. For all other time series growth rates were calculated. Furthermore, the monthly data were also analyzed for seasonal patterns. Since evidence has been found for a seasonal component in the oil price, this time series is seasonally adjusted with the CensusX12-Arima method.

While most indicators are either not revised substantially or are available in real time and back to 1990, the PMI Global is available only from 1998 onwards. For series that are not or only marginally revised, the pseudo-real-time series equals the real-time series . For the OECD time series real-time data are only available from January 2001 onwards and for OECD+6 series since June 2006 (with history back to 1990). To create a pseudo real-time series for the years before, data from the first release in 2001 and 2006 (reaching back to 1990) is used respectively. In a further step, the monthly indicators are converted to the annual frequency of GDP. This can be done, for example, using the average of the existing values, or using the last available value for each year.

For the selection of indicators simple criteria were used to determine the synchronization with global growth. In addition to simple charts (see Figure 4 for the selection of indicators for world GDP), correlation coefficients among the series have been calculated. The correlation between the different time series with the particular aggregate's GDP is large between 1990-2012, but in some cases, revisions may mimic a comovement that is closer compared to the relationship the

[12] The indicators and their properties are described in more detail in the appendix.

Figure 5: Leading Indicators and Global GDP



Note: The chart shows the respective growth rate of global GDP (blue thin line, left axis) and a selection of relevant stationary leading indicators (red thick line, right axis) with data from April 2013.

forecasters have to work with in real time. Finally, we dispense with a comprehensive turning point analysis due to the short history of our time series.

3.2 Methodology and Predictive Quality of Indicator-based Forecasts

This subsection presents the indicator-based forecast design and the evaluation of the forecast quality. First it requires the estimation of GDP growth (y_t) based on their own lagged values (y_{t-i}) and lagged or (for $j = 0$) coincident indicator values (X_{t-j}):

$$y_t = \alpha + \sum_{i=l}^{p} \beta_i y_{t-i} + \sum_{j=k}^{q} \gamma_j X_{t-j} + \varepsilon_t \tag{3}$$

The number of the optimal lags (p and q) is determined by using the Schwarz criterion. Due to the small estimation sample we restrict the number of lags (p, q) to be at most one. The parameters l and k are determined by the availability of GDP or one of the indicators in the respective prediction round. The estimation period is subject to the availability of the different indicators. For example, for world trade the estimation period starts in 1992, while data for

the PMI is available only from 1998 onwards.[13] Due to the short period of time, we work with an expanding estimation window which also reduces the estimation uncertainty and provides more efficient estimates. Since equation (3) is estimated for each forecast period ("adaptive procedure"), the number of regressors and hence the coefficients differ from year to year (or from month to month respectively).[14] For all estimates after 2009 a dummy variable may optionally be introduced to capture the crisis. However, the estimation results show that the dummy variable is insignificant as long as lagged endogenous variables are included. Therefore we skip the dummy variable in favor of the degrees of freedom.

Using the WEO ex post data we have to distinguish 3 cases: First, prior to April of each year, there is no ex post WEO value for the previous year available. Therefore, in the months January to March, the IMF forecast from the previous year is used, which was published in the previous autumn to indicate the previous year value. Second, for the months of April through September, the WEO ex post values are used as exogenous variables as published in April of the current year. Finally for October until December, the revised values for the previous year as published in the October WEO are considered. For the prediction of the next year's GDP growth we consider only lagged indicator values in the regression equation since we do not include indicator forecasts for the following year. This implies that the forecast based on the indicator for the following year contains no information other than the forecast for the current year.

To increase the quality of the forecasts, the corresponding IMF forecast ($\hat{y}_t^{WEO}$) for the current or the following year is included respectively as a regressor in addition to the existing indicator according to the relevant forecast round:

$$y_t = \alpha + \sum_{i=l}^{p} \beta_i y_{t-i} + \sum_{j=k}^{q} \gamma_j X_{t-j} + \delta \hat{y}_t^{WEO} + \varepsilon_t. \tag{4}$$

Based on the optimal estimation equation we can generate a forecast for the respective annual GDP growth rate for the current year and the following year in the frequency of each underlying indicator. Given the monthly frequency of the selected indicators there are 12 forecast rounds during a year.

For every round the forecast quality is evaluated separately. The forecast quality for the indicator forecasts is measured by the mean (absolute) error and the standard error. To evaluate the relative forecast error a simple autoregressive (AR) forecast is generally used in the literature. However, we do not call into question that both the use of leading indicators and the IMF forecast improve the prediction of GDP compared to a univariate benchmark. Therefore we decide to judge our indicator forecast ($\hat{y}_{i,t}^{\mathrm{IND}}$) in comparison to the corresponding IMF forecast ($\hat{y}_{i,t}^{\mathrm{WEO}}$) by calculation the Theil's coefficient of inequality:

[13] The first estimation sample covers 1992 until 1999. For PMI 1998 - 2003.

[14] During the months 1-3, 4-9,10-12 the coefficients of the estimated equations remain constant within a year for some of the indicators, e.g. oil, MSCI, which are not revised.

$$\text{Theil's U} = \frac{\sqrt{\sum_{t=1}^{n}\left(y_{i,t} - \hat{y}_{i,t}^{\text{IND}}\right)^2}}{\sqrt{\sum_{t=1}^{n}\left(y_{i,t} - \hat{y}_{i,t}^{\text{WEO}}\right)^2}} = \frac{\sqrt{\sum_{t=1}^{n}\left(\hat{e}_{i,t}^{\text{IND}}\right)^2}}{\sqrt{\sum_{t=1}^{n}\left(\hat{e}_{i,t}^{\text{WEO}}\right)^2}}. \tag{5}$$

Furthermore, it is already known from the literature that forecast combinations of individual forecasts are often more accurate and reliable and may lead to significant improvements in forecast accuracy than individual forecasts, which are based on a certain model or a single indicator only (Timmermann, 2006; Drechsel and Maurin, 2011). Equal weights (average AV) is one of the preferred forecast combination methods as many studies have shown consistently strong results (see, e.g. Drechsel and Scheufele, 2012b):

$$\hat{y}^{\text{AV}} = \frac{1}{\text{n}^{\text{IND}}} \sum\nolimits_{t=1}^{\text{n}^{\text{IND}}} (\hat{y}_{i,t}^{\text{IND}}). \tag{6}$$

The results of the forecast combination of the single indicator forecasts are compared with the respective results of the IMF forecasts.

The pure error measures above do not indicate whether the difference is statistically significant. A comparison of forecast errors may be complicated if the forecast models are based on different estimated parameters, particularly when models under investigation are nested (see West, 1996). Using the Giacomini and White's (2006) predictive ability method, we can test for equal unconditional predictive ability by

$$H_0: \; E\left[(y_{i,t} - \widehat{y}_{i,t}^{\mathbf{IND}})^2 - (y_{i,t} - \widehat{y}_{i,t}^{\mathbf{WEO}})^2\right] = 0.$$

Dividing the average loss differential by the standard error the test statistic is

$$Z = \frac{(T_2 - T_1)^{-1} \sum_{t=T_1}^{T_2} \left[(y_{i,t} - \widehat{y}_{i,t}^{\mathbf{IND}})^2 - (y_{i,t} - \widehat{y}_{i,t}^{\mathbf{WEO}})^2\right]}{\hat{\sigma}/\sqrt{T_2 - T_1}}. \tag{7}$$

$\hat{\sigma}^2$ is a HAC estimator of the asymptotic variance. The test statistic Z can be evaluated against a standard normal distribution. This approach is very useful as we are not only comparing individual indicator models but also combined indicator forecasts with the IMF forecast.

For robustness we have also calculated the forecast erros in pseudo real time, e.g. we compared the forecast with the 'final' values for each year using data from April 2013. Additionally we have analyzed changes to our results if we evaluate only until 2007.

4 Results

In order to calculate errors of forecasts based on leading indicators we convert monthly data into annual ones in two different ways: either using the latest available value or using the mean value of the current year.[15] The OECD indicator is a particularly informative indicator. Figure 6 shows the time paths of the mean absolute forecast errors (MAFE) for the forecast of world GDP by the use of the OECD indicator, starting with a forecast in January for the growth rate of next year, and ending with the nowcast in December for the current years growth rate. As it is the case for all the indicators analyzed in this paper that have informational content, errors decrease significantly with increasing forecast rounds since the indicators contain more and more information on the real economy. In the months when a new WEO is published, forecasts with help of the indicator do not beat the WEO, but they do so some months later, particularly so relative to the October outlook for next year (t=10). This is even true for a forecast that is solely based on the OECD indicator (dotted line).[16] Because the indicator is leading the business cycle, its predictive power for the current year deteriorates at the end of that year. This is, of course, particularly the case if we use the most recent (instead of the annual average) realization of the indicator.

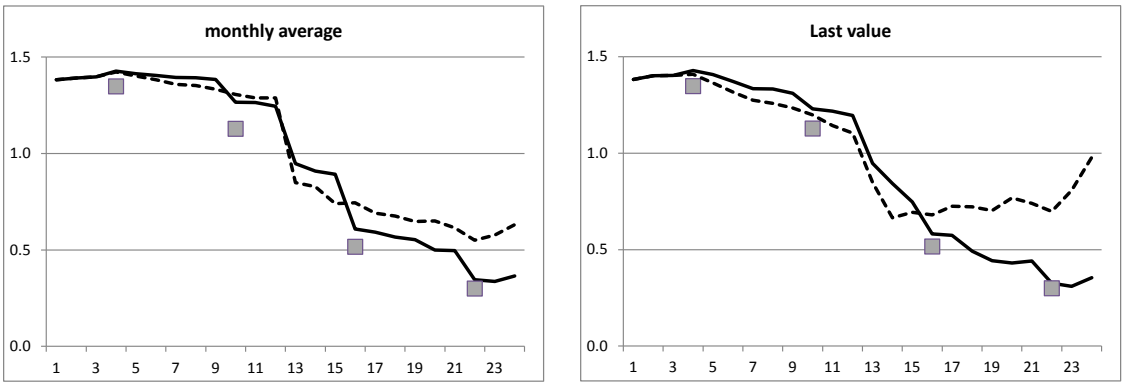
Table 3 shows the MAFE of reasonably informative indicators for the different regional aggregates. Comparing the single leading indicator forecasts (eq.3) to a combination of leading indicator information with the IMF forecast (eq.4), we find that for the current year the majority of indicators perform better in combination with the latest available IMF forecast (i.e. rounds 16-24). For the next year only a few indicator forecasts improve with the combination of IMF forecast. In general, the forecast errors of the indicator-based forecasts, as well as the forecasts of the WEO, are larger for ELSL than for the world or the advanced economies, especially in the prediction of the current year.

If the forecast error based on the forecasts of the IMF is compared with the single indicator forecasts , it turns out that with the help of some indicators the forecast quality can be significantly improved in some forecasting rounds. We find that the OECD leading indicator and the PMI (manufacturing) can significantly improve the forecast quality of the IMF economic outlook. Tables 4 and 5 provide more details on the results based on manufacturing PMI and the OECD composite indicator. The columns differ between the frequency conversion used (mean vs. last value), the sample period (total sample vs. precrisis), and a real-time vs. pseudo real-time analysis. Note that in forecast rounds 1-3, there is no corresponding IMF forecast available, so that no comparison is possible. Table 4 shows that the PMI manufacturing index has concurrent properties and the forecast performance of the pure WEO forecast for world GDP can be increased by almost 50% in the beginning of the current year (round 13-15). The results for PMI, however, might be less reliable than those for the other indicators because the smaller evaluation sample comprises only 8 observations (12 otherwise). For the OECD indicators the

[15] The corresponding tables for all error measures and the mean transformation are available upon request.

[16] For the forecast rounds 1-3 (January-March forecast for GDP growth in the following year) the two lines are the same, as IMF forecasts are only available in the forecast round 4 and onwards.

Figure 6: MAFE for World GDP



Note: The MAFE for indicator forecast based on OECD composite indicator is shown, both for the indicator forecast (dotted line) and taking into account the IMF forecast in addition to the indicator (solid line). The MAFE for the corresponding WEO forecast is marked by the gray quad. Forecast round 1-12 corresponds to the forecast for the following year, 13-24 for the current year's forecast.
Source: IMF WEO April 2013, OECD 2013, own calculations.

last values seem to be important: they can improve the WEO forecast at the beginning of a year by almost 35% (see Table 5).

The OECD leading indicator is not only useful for improving the outlook for the world, but for emerging markets as well, but, remarkably, it does not help to improve the forecast for the advanced countries (see Table 6), although these are the economies the indicator is constructed for. An explanation could be that the information the OECD indicator gives is already incorporated in the IMF forecasts for advanced countries, but the spillovers to the emerging markets are not fully taken into account by the IMF. Besides the OECD indicator, the only indicator that appears to significantly improve the outlook is industrial production of emerging markets economies in March of the year to be forecasted (see Table 8, where it is also shown that this result changes if, instead of the total sample, only pre-crisis periods are examined).

Table 6 shows the estimation results for selected indicator-based forecasts for the different regional aggregates. As can also be concluded from Table 3, the improvement of WEO forecast by selected indicators are higher for the world aggregate than for the emerging economies.

By combining the available individual indicator forecasts to an average forecast (AV) for each regional aggregate (see Table 7), the forecast error deteriorates compared to the indicators with more predictive power (that are shown in Table 6). Hence, in this context, a forecast combination of all single indicator forecasts is not sensible.

It might be asked whether the results are mainly driven by the huge forecasting errors the IMF and virtually all forecasters made on the eve of the Great Recession. Table 5 shows that, if we look only on the years before that event (pre-crisis sample), the OECD indicator can no longer improve the IMF forecast, but the PMI still does. It must, however, be noted that the

Table 3: MAFE for Selected Indicator Forecasts

	World		Emerging		Advanced	
	PMIM	OECD	IP EL	OECD6	PMIM	IP ADV
1	1.698	1.383	1.746	1.826	1.371	1.357
2	1.669	1.402	1.749	1.831	1.354	1.214
3	1.562	1.402	1.618	1.827	1.323	1.390
4	1.807	1.428	1.858	1.797	2.308	1.919
5	1.776	1.408	1.450	1.866	2.336	1.918
6	1.725	1.371	2.075	1.848	2.315	1.941
7	1.674	1.335	1.973	1.794	2.360	2.059
8	1.530	1.333	1.851	1.842	2.251	1.949
9	1.271	1.311	1.752	1.825	2.121	1.881
10	1.089	1.230	1.603	1.569	1.699	1.496
11	1.007	1.218	1.608	1.512	1.598	1.513
12	0.870	1.195	1.520	1.453	1.414	1.345
13	0.845	0.948	1.493	1.527	1.214	1.224
14	0.685	0.843	1.777	1.199	1.224	1.373
15	0.805	0.747	1.700	0.938	1.073	1.577
16	0.487	0.581	1.167	0.593	0.555	0.601
17	0.472	0.575	1.033	0.616	0.589	0.463
18	0.391	0.492	1.517	0.741	0.563	0.525
19	0.409	0.443	1.263	0.608	0.704	0.632
20	0.435	0.431	1.149	0.824	0.555	0.599
21	0.352	0.441	1.183	0.925	0.535	0.460
22	0.209	0.325	0.858	0.730	0.188	0.359
23	0.190	0.310	0.864	0.720	0.200	0.509
24	0.178	0.354	0.895	0.676	0.200	0.335

Note: Forecast round 1 corresponds to the first forecast that is made for a certain year, round 24 is the last forecast round. Forecast round 1-12 corresponds to the forecast for the following year, 13-24 for the current year's forecast. Evaluation period 2000-2012 or 2004-2012 for PMIM. Results are based on last value transformation of the indicators. Gray shades indicate the months of the WEO release.

results, in particular for the PMI, rest on even fewer observations than those for the total time span.

Finally it is interesting to check whether the results depend on whether we use real time data or data that are available at present. This is in particular for the OECD indicator an important issue, since this indicator is frequently being revised in order to maximize its predictive power. Table 5 shows that the results are principally the same for both real time and pseudo real time data, but indeed, for real time data the forecast errors are higher and there is only one month (instead of two) in which the indicator beats the IMF forecast significantly.

Table 4: Theil's U for Indicator Forecasts of PMI Manufacturing (World GDP)

	Total sample				Precrisis sample				Pseudo real-time			
	mean		last		mean		last		mean		last	
1	NA		NA		NA		NA		NA		NA	
2	NA		NA		NA		NA		NA		NA	
3	NA		NA		NA		NA		NA		NA	
4	1.154		1.125		3.070		2.834		1.158		1.125	
5	1.146		1.096		2.992		2.606		1.148		1.092	
6	1.141		1.067		2.941		2.466		1.142		1.059	
7	1.141		1.070		2.928		2.707		1.141		1.061	
8	1.141		0.963		2.923		2.597		1.138		0.948	
9	1.137		0.846		2.920		2.346		1.132		0.816	
10	1.159		0.862		1.661		1.505		1.129		0.855	
11	1.135		0.736		1.594		1.659		1.105		0.755	
12	1.092		0.601		1.516		1.490		1.064		0.630	
13	0.563		0.563		1.362		1.362		0.548		0.548	
14	0.514	*	0.486	*	1.109		0.817		0.495	*	0.466	*
15	0.505	*	0.528	*	1.048		0.934		0.481	*	0.486	*
16	1.047		1.023		1.027		0.710	*	1.029		0.924	
17	1.016		1.010		0.815	***	0.704		0.979		0.905	
18	0.978		0.899		0.654	**	0.744		0.926		0.767	*
19	0.919		1.099		0.629	**	0.511	**	0.864		0.971	
20	0.871		1.036		0.628	**	0.648	**	0.812		0.893	
21	0.795	**	0.784	*	0.559	**	0.481	*	0.735	*	0.588	***
22	0.766	**	0.905		0.839		0.648		0.739		0.696	
23	0.743	*	0.671	***	0.786	*	0.796		0.699		0.414	*
24	0.739	*	0.604	***	0.731	*	0.725		0.612		0.377	*

Note: Forecast round 1 corresponds to the first forecast that is made for a year, round 24 is the last forecast round. Forecast round 1-12 corresponds to the forecast for the following year, 13-24 for the current year's forecast. Evaluation period 2004-2012 or 2004-2007. Gray shades indicate the months of the WEO release.

Table 5: Theil's U for Indicator Forecasts of OECD (World GDP)

	Total sample			Precrisis sample			Pseudo real-time		
	mean	last		mean	last		mean	last	
1	NA	NA		NA	NA		NA	NA	
2	NA	NA		NA	NA		NA	NA	
3	NA	NA		NA	NA		NA	NA	
4	0.994	0.993		1.284	1.266		0.990	0.985	
5	0.996	0.999		1.274	1.237		0.989	0.987	
6	0.997	1.000		1.260	1.202		0.989	0.985	
7	0.999	1.001		1.255	1.177		0.988	0.980	
8	1.007	1.009		1.263	1.195		0.996	0.986	
9	1.012	0.993		1.254	1.163		0.998	0.969	
10	1.058	1.060		1.351	1.243		1.054	1.051	
11	1.063	1.008		1.343	1.203		1.057	1.006	
12	1.058	0.941		1.332	1.240		1.054	0.948	
13	0.745	0.745		1.122	1.122		0.733	0.733	
14	0.695	0.640	*	1.050	0.975		0.681	0.611	*
15	0.676	0.576		1.047	0.986		0.657	0.487	*
16	1.491	1.435		1.605	1.361		1.342	1.292	
17	1.454	1.400		1.501	1.322		1.295	1.190	
18	1.420	1.135		1.446	1.261		1.232	1.202	
19	1.389	1.051		1.383	1.210		1.210	1.116	
20	1.179	0.947		1.338	1.109		1.208	1.011	
21	1.136	0.924		1.315	0.947		1.177	0.887	
22	1.143	1.174		1.335	0.941		1.120	1.210	
23	1.095	1.222		1.277	0.771	***	1.072	1.290	
24	1.104	1.323		1.232	1.062		1.105	1.307	

Note: Forecast round 1 corresponds to the first forecast that is made for a year, round 24 is the last forecast round. Forecast round 1-12 corresponds to the forecast for the following year, 13-24 for the current year's forecast. Evaluation period 2004-2012 or 2004-2007. Gray shades indicate the months of the WEO release.

Table 6: Theil's U for Selected Indicator Forecasts

	World				Emerging			Advanced	
	PMIM		OECD		IP EL	OECD6		PMIM	OECD
1	NA		NA		NA	NA		NA	NA
2	NA		NA		NA	NA		NA	NA
3	NA		NA		NA	NA		NA	NA
4	1.125		0.993		1.213	1.215		1.802	1.778
5	1.096		0.999		0.847	1.251		1.821	1.783
6	1.067		1.000		1.356	1.252		1.802	1.770
7	1.070		1.001		1.216	1.235		1.848	1.767
8	0.963		1.009		1.217	1.245		1.758	1.748
9	0.846		0.993		1.103	1.229		1.650	1.714
10	0.862		1.060		1.146	1.172		2.169	1.964
11	0.736		1.008		1.130	1.116		1.898	1.915
12	0.601		0.941		1.085	1.049		1.627	1.749
13	0.563		0.745		1.099	1.116		1.162	1.355
14	0.486	*	0.640	*	1.214	0.891		1.044	1.418
15	0.528	*	0.576		1.111	0.714	*	1.007	1.267
16	1.023		1.435		1.850	0.842		1.553	1.864
17	1.010		1.400		1.770	0.874		1.700	1.681
18	0.899		1.135		2.371	1.113		1.449	1.688
19	1.099		1.051		1.886	0.847	**	2.021	1.706
20	1.036		0.947		1.880	1.145		1.952	1.700
21	0.784	*	0.924		1.859	1.398		1.596	1.712
22	0.905		1.174		1.929	1.664		0.954	2.940
23	0.671	***	1.222		1.916	1.717		0.811	3.043
24	0.604	***	1.323		1.837	1.685		0.867	2.880

Note: Forecast round 1 corresponds to the first forecast that is made for a year, round 24 is the last forecast round. Forecast round 1-12 corresponds to the forecast for the following year, 13-24 for the current year's forecast. Evaluation period 2004-2012 or 2004-2007. Last indicator values are used. Gray shades indicate the months of the WEO release.

Table 7: Theil's U for Combined Indicator Forecasts

	based on average values			based on last values		
	World	Emerging	Advanced	World	Emerging	Advanced
1	NA	NA	NA	NA	NA	NA
2	NA	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA	NA
4	0.992	1.227	1.621	0.983	1.156	1.656
5	1.008	1.230	1.614	0.959	1.032	1.661
6	0.995	1.214	1.611	1.005	1.212	1.702
7	0.991	1.211	1.611	0.972	1.193	1.626
8	0.984	1.166	1.619	0.894	1.049	1.652
9	0.970	1.157	1.621	0.936	1.153	1.616
10	1.022	1.108	1.741	1.028	1.271	1.782
11	1.011	1.074	1.693	0.830	1.136	1.603
12	0.951	1.018	1.643	0.801	0.960	1.571
13	0.651 *	1.175	1.351	0.651 *	1.175	1.351
14	0.596 *	1.088	1.140	0.686	1.168	1.200
15	0.490 *	0.947	0.940	0.764	1.179	1.405
16	1.348	1.404	1.585	0.932	1.585	1.444
17	1.244	1.381	1.382	0.962	1.390	1.149
18	1.106	1.310	1.387	0.995	1.784	1.309
19	0.977	1.320	1.160	0.765 **	1.443	1.165
20	0.938	1.321	1.190	0.707 ***	1.723	1.386
21	0.771 **	1.376	1.070	0.619 ***	1.732	1.175
22	0.915	1.666	1.221	1.003	1.867	1.681
23	0.808 *	1.744	1.229	0.789 *	1.913	1.490
24	0.809 *	1.677	1.322	0.787 *	1.654	1.425

Note: Forecast round 1 corresponds to the first forecast that is made for a year, round 24 is the last forecast round. Forecast round 1-12 corresponds to the forecast for the following year, 13-24 for the current year's forecast. Evaluation period 2000-2012.Last indicator values are used. Gray shades indicate the months of the WEO release.

Table 8: Theil's U for Indicator Forecasts of Industrial Production (ELSL GDP)

	Total sample			Precrisis sample			Pseudo real-time	
	mean		last	mean		last	mean	last
1	NA		NA	NA		NA	NA	NA
2	NA		NA	NA		NA	NA	NA
3	NA		NA	NA		NA	NA	NA
4	1.315		1.213	1.739		1.571	1.271	1.233
5	1.375		0.847	1.714		1.353	1.319	0.981
6	1.244		1.356	1.616		1.490	1.241	1.303
7	1.268		1.216	1.663		1.698	1.235	1.147
8	1.267		1.217	1.684		1.522	1.231	1.238
9	1.259		1.103	1.659		1.467	1.222	1.070
10	1.203		1.146	1.572		1.474	1.234	1.208
11	1.175		1.130	1.536		1.529	1.241	1.168
12	1.157		1.085	1.540		1.494	1.224	1.268
13	1.099		1.099	1.282		1.282	1.002	1.002
14	0.952		1.214	0.977		1.283	0.966	1.134
15	0.744	*	1.111	0.906		1.291	0.849	0.933
16	1.236		1.850	0.740	**	1.133	1.501	1.582
17	1.329		1.770	0.517	***	1.007	1.205	1.580
18	1.350		2.371	0.836	*	1.701	1.282	2.023
19	1.331		1.886	0.751	***	1.191	1.224	1.628
20	1.540		1.880	0.624	***	0.854	* 1.474	1.674
21	1.598		1.859	0.725	**	1.244	1.430	1.530
22	2.044		1.929	1.072		1.158	1.683	1.848
23	2.053		1.916	0.960		1.149	1.813	1.877
24	2.024		1.837	1.076		1.386	1.780	1.854

Note: Forecast round 1 corresponds to the first forecast that is made for a year, round 24 is the last forecast round. Forecast round 1-12 corresponds to the forecast for the following year, 13-24 for the current year's forecast. Evaluation period 2004-2012 or 2004-2007.

5 Conclusions

The study has shown that simple forecasts using some common early indicators can improve the forecasts of the IMF during certain months of the calendar year, especially when the World Economic Outlook is a few months old and therefore more recent information is available, especially in the first three months of the current year. The fact that the OECD indicator is useful in improving IMF forecasts for emerging markets, but not for advanced economies, might tell us that the cyclical connections between advanced and emerging market economies is not fully understood and not incorporated in the forecasts. However, it should be noted that the results derived in this study are based on a fairly small number of observations. In particular, the results are, to some extent, driven by the large errors of most forecasts, including those of the IMF, on the eve and during the economic crisis of 2008/2009. Thus the robustness of the results derived in this paper should be reviewed regularly in the coming years.

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6 Appendix

Evaluation of IMF-Forecast in Pseudo Real-time

Table 9: Predictive Power of the IMF Forecasts

		MFE			RMSFE		
Sample	Forecast round	World	Advanced	ELSL	World	Advanced	ELSL
1992 - 2012	1	-0.417	-0.381	-0.495	1.548	1.618	2.018
	2	-0.275	-0.189	-0.447	1.298	1.331	1.857
	3	0.140	0.171	-0.294	0.611	0.646	1.551
	4	0.132	0.174	-0.339	0.458	0.512	1.422
1992 - 2007	1	-0.244	-0.093	-0.468	0.930	0.924	1.829
	2	-0.073	0.102	-0.385	0.904	0.920	1.799
	3	0.185	0.297	-0.446	0.564	0.613	1.713
	4	0.192	0.304	-0.476	0.414	0.455	1.592
2008 - 2012	1	-0.973	-1.302	-0.579	2.701	2.874	2.531
	2	-0.921	-1.118	-0.648	2.114	2.176	2.030
	3	-0.004	-0.231	0.193	0.741	0.740	0.844
	4	-0.061	-0.239	0.098	0.576	0.660	0.614

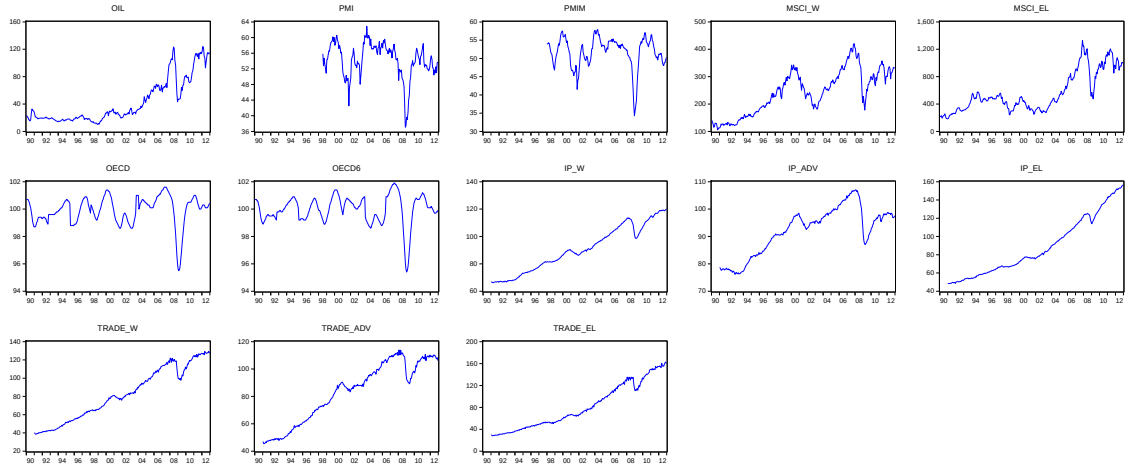
Note: The MFE and RMSFE are shown for the IMF's World, advanced economies and developing countries GDP forecast. The forecasts are compared to the values of GDP published in the WEO April 2013.

Description of Leading Indicators

- Global Composite PMI
  This indicator is published monthly by JPMorgan and Markit in cooperation with the Institute for Supply Management (ISM) and the International Federation of Purchasing and Supply Management (IFPSM). It is based on interviews with companies to current production, new orders, inventories, employment, obtained by supply and prices. The PMI Composite Index is specified in the form of a diffusion index, and is composed of the areas of manufacturing and services. A value above 50 indicates an increase in the variables from the previous month and a value below 50 a drop the variable. It will be published at the beginning of the following month and thus has a significant lead over the official statistics. The PMI index is not revised after publication. Changes arise, however, by seasonal adjustment. However, these are only marginal and can be neglected in the analysis. The index is available since July 1998.

- OECD Leading Indicators (OECD Total, OECD + 6 NME)
  The goal of the Composite Leading Indicators (CLI) of the OECD is to signal early turning points in the business cycle and to provide qualitative rather than quantitative information on short-term economic developments. The OECD series are constructed by aggregating across multiple cross-sectional components, which are based on various criteria, such as

Figure 7: Level values of the indicators



Note: Oil price, MSCI price indices, trade and industrial production volume in US-Dollar. OECD indices and PMI as index.

economic significance, cyclical behavior, availability and quality of underlying data. Until March 2012 the OECD has been using the industrial production as a reference number for its Composite Leading Indicators , as it is available monthly and has a high correlation with GDP. In April 2012, the OECD started to use GDP itself as the reference series, where the official GDP figures are transformed into monthly data. A drawback of the OECD CLIs is that the entire series are subject to large revisions. These revisions arise both because of different filtering methods such as seasonal adjustment or smoothing, and through the aggregation process, as the CLI will already be calculated when more than 60% of the sub-components are available. To estimate the predictive power of the OECD CLIs they should therefore be analyzed in real time. With the help of the 'OECD Main Economic Indicators (MEI) Original Release Data and Revisions Database', the revisions of the amplitude adjusted CLI for individual groups of countries can be traced. For the group of OECD countries (total), which currently comprises 33 countries, real-time data are available since January 2001. For the extended group by China, Brazil, India, Russia, South Africa and Indonesia Country Group (OECD + 6 non-member countries (NME)) data is available in the database through June 2006. The amplitude adjusted OECD CLIs are released with a two-month delay in the middle of the month.

- Price

  The most important benchmark for the world market price for crude oil is the price of North Sea Brent oil, which is (as a daily spot price) published by the U.S. Energy Information Administration (EIA). Until recently, the price of U.S. WTI was a similarly important benchmark, but recently it is less representative for the prices on the world oil market. The price of oil is not subject to revision and is available in real time.

- Trade

  Important data series for world trade come from the OECD (regularly published in the

Table 10: Characteristics of Leading Indicators

Indicator	Source	Frequency[a])	Revision	available since[b])	release during a month	release delay (months)
PMI Global Composite	Markit	M	Yes	Jul 98	beginning (04.-06.)	-1
OECD CLI, OECD Total, amplitude	OECD	M	Yes	Jan 90	mid (09.-13.)	-2
OECD CLI, OECD+Major Six NME, amplitude	OECD	M	Yes	Jan 97	mid (09.-13.)	-2
Oil price Brent US$/Barrel, Wachstumsrate	EIA	M*	No	Jan 91	end	0
Trade	CPB	M	Yes	Jan 91	end (20.-25.)	-2
Industrial Production	CPB	M	Yes	Jan 91	end (20.-25.)	-2
MSCI indices	MS	M*	No	Jan 90	end	0

Note: [a)] M: monthly, M*: data are available daily but are used as input at monthly frequency. [b)] Some data are already available before 1990.

Main Economic Indicators statistics) and the IMF (International Financial Statistics). The OECD data are available as quarterly figures for trade of goods and services, the IMF data are monthly values for trade of goods (since 1991). A monthly data series on international trade of goods is also published by the Dutch research institute CPB in the World Trade Monitor. CBP trade figures are calculated from OECD figures, IMF figures and national sources, including the trade figures from 23 OECD countries and 60 ELSL thus covering almost 97% of total world trade. For the developing countries the series covers about 90% of foreign trade of all ELSL. The CPB data are published with a two-month delay in the second half of the month, and, hence, significantly earlier than the data from the IMF and OECD (van Welzenis and Suyker, 2005). Therefore, they seem to be best suited for forecasting purposes. The time series are revised slightly and are seasonally adjusted.

- Industrial production
  The CPB also publishes monthly data (from 1991) for industrial output. For the aggregation of country data two methods are available – weights based on the volume of industrial production and weights according to the import volumes of the individual countries. The data set obtained by the latter method can be understood as an indicator of global demand for internationally traded goods. But for the forecast of output, the first method is relevant. In accordance with the CPB data on world trade, the data are published with a

two-month delay in the second half of the month. The time series are revised slightly and are calendar-and seasonally adjusted.

- MSCI Index
  The MSCI All Country (AC) World Investable Market Index reflects the daily price performance of stocks in the major industrialized countries, emerging economies and developing countries. It is published by the American financial services provider Morgan Stanley Capital International. The index includes over 9,000 securities from both large- and medium-and small-cap companies from industry segments and from different economic sectors in 45 developed and emerging countries. The index is calculated daily. The historical data are available at a monthly frequency from May 1994 are available. The MSCI World Index is designed to measure the equity market performance of developed markets and comprises 24 developed market country indices. The MSCI Emerging Markets Index reflects the performance of over 2,700 indices in 21 emerging markets. These currently include Brazil, Chile, Colombia, Mexico, Peru, Czech Republic, Egypt, Hungary, Morocco, Poland, Russia, South Africa, Turkey, China, India, Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand. The index covers both large-and medium-and small-cap companies and includes the stock indices in different sectors. It is calculated on a daily basis. The historical data are available in monthly frequency from December 1987.

Table 11: Unit Root Tests

	t-statistic		lags based on AIC
OIL	0.812		13
PMI	-3.250	***	3
PMIM	-4.045	***	2
MSCI W	-1.768		3
IP W	0.097		10
TRADE W	-0.340		11
OECD	-5.288		3
OECD6	-5.868	***	3
MSCI EL	-1.331		1
IP EL	2.360		10
TRADE EL	1.153		11
MSCI ADV	-1.856		4
IP ADV	-2.005		3
TRADE ADV	-1.487		3

Note: Data from April 2013, sample 1991-2012. Actual sample size depends on availability of the indicators. *** Significant at the 1% level, ** significant at the 5% level. *Note:* Sample 1991-2012. Actual sample size depends on availability of the indicators. *** Significant at the 1% level, ** significant at the 5% level.