Outperforming IMF Forecasts by the Use of Leading Indicators*

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Abstract

In this study we analyze the performance of World Economic Outlook (WEO) forecasts by the IMF for the total world and the countries aggregates of both the advanced economies and the emerging and developing economies. With a focus on the forecast for the next and the current year, we find that the forecasts improve substantially with decreasing forecast horizon. Some simple single-indicator forecasts on the basis of data that are available at higher frequency outperform the IMF forecast substantially, especially in the first months of the current year, but in some cases also for the next year.

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

JEL Classification: C52, C53, E02, E32, E37, O19

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1 Motivation

Probably 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 spring and autumn and is the main fundament for the IMF's multilateral surveillance activities. Many data that are suitable for the forecast of global economic growth will, however, be published at a higher frequency than in the WEO and timelier. For that reason, the question arises to what extent the forecasts by the IMF can be improved or even completely replaced by the use of the information of leading indicators prior to next publication of the WEO. The focus of this study is the comprehensive evaluation of the predictive quality of the IMF's forecasts for the growth of the world economy, the advanced countries as well as the developing and emerging countries.[1] After the identification of selected leading indicators we investigate whether the use of leading indicators can improve the IMFs GDP forecasts over time. The study has three objectives: First, we determine the predictive quality of the IMF's growth forecasts for the global economy and for the group of both the advanced economies and the developing and emerging economies. Second, we select appropriate leading indicators for GDP forecasts of these three country aggregates. Finally, we produce indicator-based forecasts and determine the prediction accuracy compared to the IMF forecasts. The remainder of the paper is structured as follows: Section 2 describes the data set used in this paper, recalls the main definitions and provides some results on forecast accuracy for the IMF forecasts. Section 3 introduces our set of leading indicators. Section 4 shows how to construct indicator based forecasts and assesses their quality and - finally - Section 5 presents our results. Afterwards, Section 6 provides some concluding remarks and discusses what is left for future research.

2 Evaluation of IMF Growth Forecasts

2.1 Data Set

In the last years many studies have analyzed the performance of IMF forecasts. Most of them are comparative studies among 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). 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,

[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.

2012). Only a few studies such as have analyzed country aggregates such as the world, industrial countries and developing countries (Artis, 1996; Jakaitiene and Dées, 2012).[2] While the main most of the studies evaluates GDP growth forecasts also GDP components (Júlio and Esperança, 2012), inflation (Dreher, Marchesi, and Vreeland, 2008), unemployment rate and even ratios of the fiscal surplus to GDP and of external current account surplus to GDP (Atoyan and Conway, 2011) are considered. Many papers have analyzed the forecast accuracy of the WEO forecasts, and check for unbiasedness of the forecasts (Pons, 2000; Timmermann, 2007).

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. Since 1999, the forecasts and relevant figures are available electronically at the World Economic Outlook database. Earlier forecast values are taken from the printed publication of the WEO. In total, the sample from 1990-2011 is examined.[3] For this study, the forecasts for the total world economy and the development for the aggregate of advanced economies and the developing and emerging countries are relevant. However, the composition and description of the group of countries has significantly changed over time. The main criteria in the WEO for the assignment to the group of advanced economies and the developing and 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 the new EU member countries to the Euro Area. 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'. Generally, the GDP forecasts of the IMF are measured in purchasing power parity (PPP). Since 1998 forecasts for the global economy based at market prices are additionally available. The use of purchasing power parities has the advantage that price level differences between countries are taken into account (Gulde, 1993). 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. The forecasts published by the IMF have been properly arranged, so that a forecast matrix could be created.[5]

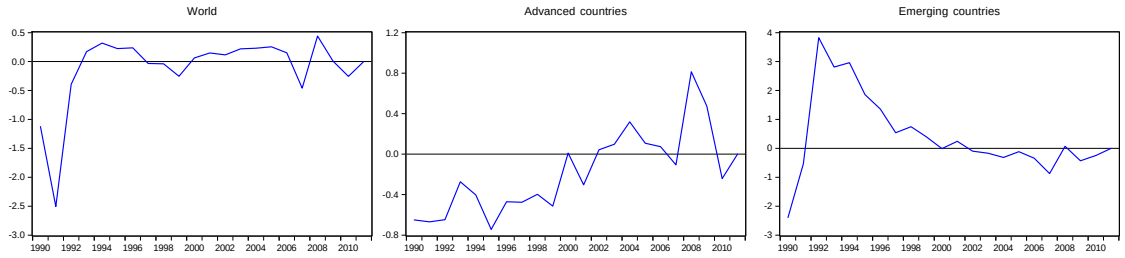
[2] Note that while **?** use the country aggregates, they do not work with WEO data, and rather use monthly series to be forecasted, such as industrial production, consumer prices or trade.

[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 short history these updates will not be considered in our analysis yet, however they should be considered for future analyses.

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

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

Figure 1: Revisions to the WEO over time



Note: Revisions between the respective initial publication in the following year and the data as WEO October 2012 in percent. Negative values indicate an upward revision, and positive values a downward revision.

2.2 Data Revisions

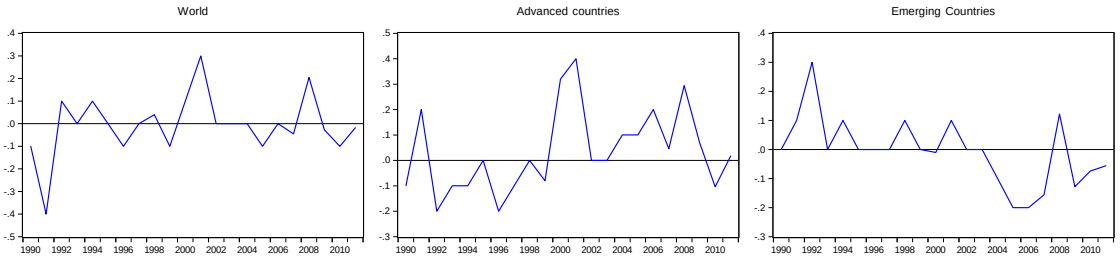
With each new edition of the WEO ex-post data are changed for all years (Fig. 1). The revisions in the WEO are quite considerable, especially for the first half of the 1990s. On the one hand, this results from changes in the allocation of the group of countries and the group recalculations of the individual country weights. On the other hand there are revisions stemming from the revisions of individual country GDPs. In addition to standard maintenance due new information for the last few 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). All national accounts data are presented in the WEO from 1995 onwards on the basis of the new system. Even for the period prior to 1995 data revisions were made to adjust the values to the new standards. However, it should be noted that 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 (see Figure 1). 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 up to -15%), and that these countries are included in the group of developing and emerging countries only since the spring edition of WEO 2004.[6] For the group of advanced countries slight upward revisions are made over time for the first half of the 1990s. In the crisis period downward revisions are obvious.

Minor revisions – due to more information for the previous year – are made already within a year, i.e. from spring to autumn. Figure 2 shows that in upturns (in the years 2005-07

[6] Until 2004 these countries has been separately in the group countries in transition.

and 2010) typically GDP growth was underestimated and subsequently an upward revision followed. Analogously economic downturn periods as the economic and financial crisis are 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, taking up the words by Croushore (2006) "Forecasts are only as good as the data behind them.", which should be kept in mind for the following sections.

Figure 2: Revisions to the WEO within the year for the previous year



Note: Revisions of ex-post WEO data from spring to autumn in percent. Negative values indicate an upward revision, and positive values a downward revision.

2.3 Forecast Evaluation Measures

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. For the two forecast years we derive from the realized values y and the predicted values $\hat{y}$ for each country i aggregate the median forecast error (mean forecast error - MFE)

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

the mean absolute error (mean absolute forecast error - MAFE)

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

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

$$RMSFE^{\text{WEO}} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(y_{i,t} - \hat{y}_{i,t}^{\text{WEO}}\right)^2} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(\hat{e}_{i,t}^{\text{WEO}}\right)^2} \tag{3}$$

The analysis is performed as a real-time analysis where 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 most recent WEO (released in October 2012). These figures are compared for each year with the respective forecasts. For the quality of the IMF forecasts we also distinguish between different forecasting rounds. We expect that the predictive power of the IMF projections improves considerably over time (from forecast round 1 to 4) if more information becomes available (see Table 1).

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}

Note: y_t is the actual GDP growth rate at time t. $\hat{y}_t^{(M)}$ is the forecast of the GDP growth rate at the forecast round M for time 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 (1990-2011), we evaluate a pre-crisis sample (1999-2007) and a (post-) crisis sample (2008-2011) in order to avoid distortion by the significant impact of the financial crisis.[7] 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 country aggregates from forecast round 1 to 4.

For the first two forecast rounds, the IMF forecast for the next year is on average too high over the whole period. However, in the WEO forecast the global economic performance of the current year (forecast rounds 3-4) is underestimated on average. A comparison of the columns shows that the forecast errors for the advanced countries and the world in "normal times" (1990-2007) are significantly lower than for the emerging countries.[8]

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 advanced economies. This is due to the fact that the shrinkage of emerging countries GDP was comparatively low in 2009. When comparing these results for real-time data with those based on the pseudo-real-time data (see Table9 in the appendix), it is evident that for the global GDP forecast the forecast errors for the following year in pseudo real-time are smaller. In contrast,

[7] See e.g. Drechsel and Scheufele (2012a) for the crisis impact on forecasting accuracy.

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

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

Sample	Forecast Round	World	Advanced	ELSL
1990 - 2011	1	1.6522	1.5961	1.7784
	2	1.3751	1.2943	1.5931
	3	0.6279	0.5322	0.9178
	4	0.4641	0.2719	0.9997
1990 - 2007	1	1.2214	1.0979	1.4665
	2	1.0898	1.0026	1.4024
	3	0.6210	0.5012	0.9631
	4	0.4694	0.2393	1.0816
2008 - 2011	1	2.8268	2.8726	2.7321
	2	2.2090	2.1266	2.2284
	3	0.6566	0.6474	0.6928
	4	0.4408	0.3804	0.5250

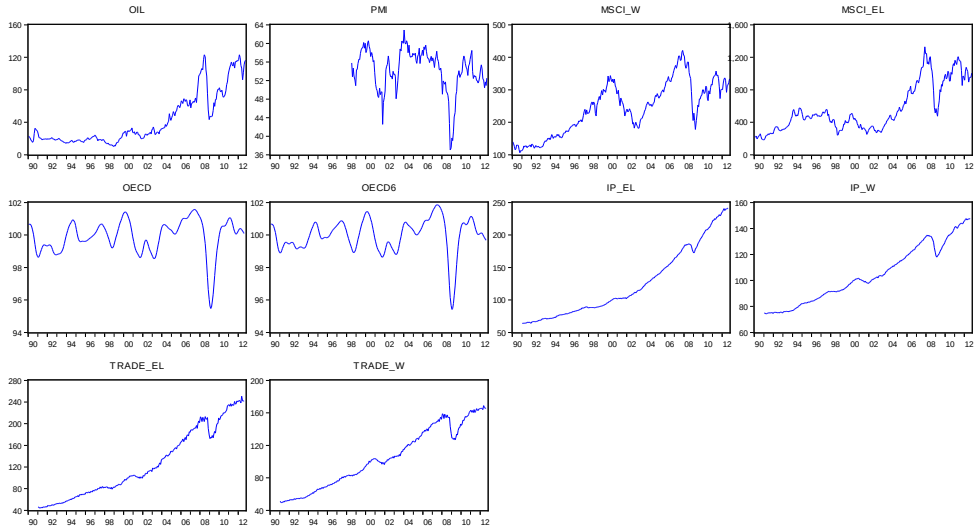
Note: The RMSFE is shown for the IMF's GDP forecast for the world, advanced economies and developing countries.

the emerging countries forecast error based on the pseudo real-time data is significantly larger than for real-time data. This is probably due to the fact that published real-time realizations for the previous year are probably 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 have compared these forecasts with those of naive models (i.e. simple random walk models (see, Arora and Smyth, 1990)) or more structural models inspired by macro-theory (see Fildes and Stekler, 2002). A promising new approach to improved 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).

3 Selection of Leading Indicators

In this section we identify leading indicators that reflect the economic dynamics of the world, the advanced economies and the emerging economies aggregate as a whole, and therefore probably well suited for the prediction of the aggregate's GDP. For the selection of indicators their relevance is essential. Besides economic reasons for the choice, leading or synchronization properties of the indicator have to exist. Further, indicators should have a wide coverage of the economy as a whole (and not just individual sectors). Finally, the selection of suitable leading indicators plays a key role to its practicability. Indicators should have a very high frequency, and should be very limited to revisions. In addition they should have a long history. For each country aggregate different indicators are chosen that

Figure 3: 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.

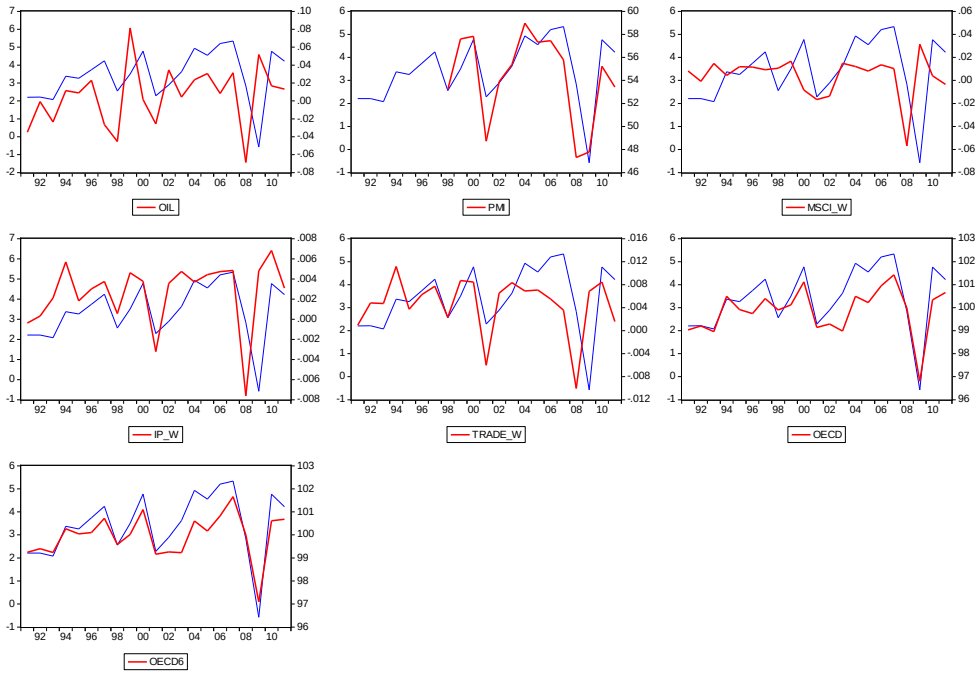
represent the aggregate instead of individual country indicators. For the world indicators we have selected the Global Composite PMI, OECD Leading Indicators (MEI, OECD + 6 NME), oil price, world trade, world-industrial production, MSCI (AC) World Index. For the advanced countries PMI, oil price, industrial production and trade in advanced countries, and the MSCI World Index. For the emerging countries the following indicators have been selected: oil price, industrial production in ELSL, trading in the ELSL, MSCI Emerging Markets. The indicators and their properties are briefly described below and more detailed in the appendix.

3.1 Data Description

The indicator series were first examined by a unit root tests (ADF) tests, and converted from non-stationary in stationary time series. As shown in Figure 3 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 the oil price pointed seasonal effects, this time series is seasonally adjusted with the CensusX12-Arima method.

While most indicators 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, a pseudo-real-time series is produced, i.e. a time series is generated to simulate the respective availability of the indicator in real time. For the OECD time series real-time data are only

Figure 4: 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 leading indicators (red thick line, right axis). The leading indicators were transformed into stationary time series.

available from 2001.1 and for OECD+6 series since 2006.6. To create a real-time series for the years before data from the first release in 2001 and 2006 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 the year. A preliminary allocation of each indicator to a specific transformation method does not take place.

For the selection of indicators simple criteria were used to determine the synchronization with the 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 1990-2011, but in some cases, revisions may mimic a comovement, which is closer compared to the relationship the forecasters have to work with in real time. Finally, we dispense with a comprehensive turning point analysis due to the short history

4 Predictive Quality of the Indicator-based Forecasts

4.1 Methodology

The aim of this subsection is the creation of indicator-based forecasts and the determination of the forecast quality. It requires the estimation of GDP growth (y_{t+h}) based on their own values (y_{t-i}) and lagged or for $j = 0$ coincident indicator values (X_{t-j}):

$$y_{t+h} = \alpha + \sum_{i=l}^{p} \beta_i y_{t-i} + \sum_{j=k}^{q} \gamma_j X_{t-j} + \varepsilon_{t+h} \tag{4}$$

The number of the optimal lags (p and q) is determined by using various information criteria. Due to the length of the indicator time series (the minimum of the observed series is 14 years), 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 1991, while data for the PMI is present only from 1998 onwards.[9] Due to the short period of time, we will work with an expanding estimation window. Since equation 4 is estimated for each forecast period, the number of regressors differ from year to year (or from month to month respectively).[10] For all estimates after 2009 a dummy variable may optionally 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.

Note that prior to April of each year, there will be no WEO value for the previous year. Therefore, in the months January to March, the IMF forecast is used, which was published in the previous autumn. For the months of April through September, the WEO values are used as exogenous variables as published in April of the current year. For October until December, the revised values 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 for the following year or the current year is included as a regressor in the regression in addition to the existing indicator respective to the forecast round.

[9] The first estimation sample covers 1991 or1992 until 1999. For PMI 1998 - 2003.

[10] During the month 1-3, 4-9,10-12 the estimation equations remain constant within a year. Since most indicators differ only for the latest values, the history of the time-series – which is used in the estimation equation – remains the same.

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. The individual forecasts are judged according to their forecast rounds. The forecast quality for the indicator forecasts is measured by the mean (absolute) error and the standard error. Using the actual corresponding IMF forecast as benchmark forecast the relative forecast error (Theil's coefficient of inequality) is calculated. In addition, a simple autoregressive (AR) forecast of GDP could be considered as a further reference forecast.

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

Furthermore, it is already known from the literature that forecast combination of individual forecasts is often more accurate and reliable and may lead to significant improvements in forecast accuracy than individual forecasts themselves, 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).

$$\hat{y}^{\text{AV}} = \frac{1}{\text{Ind}} \sum_{t=1}^{\text{Ind}} \left(\hat{y}_{i,t}^{\text{Ind}}\right) \tag{6}$$

The results of the forecast combination of the single indicator forecasts are compared with the respective results of the IMF forecasts. While during the analysis of the IMF projections (Section 2) an investigation for real-time data and pseudo real-time data has been made, the analysis of the indicator forecasts is conducted only in real time, i.e. the predictions are compared with the respective initial publication of the WEO.

5 Results

The MFE, the MAFE and RMSFE for all leading indicator forecasts are evaluated. We have distinguished in our analysis two ways of transforming monthly data in annual ones, either by using the latest available value or the mean value of the available months.[11] The results show that the forecast errors decrease significantly with increasing forecast rounds since the indicators contain more information on the real economy (see, e.g. Table 3 for

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

the mean absolute forecast error (MAFE) for the forecast of world GDP based on the most recent indicator value). Note that the estimation equations for the forecast rounds 1-3 (January-March forecast for GDP growth in the following year) do not contain IMF forecasts as a regressor, as these are only available in the forecast round 4 and onwards. Hence, there is initially an improvement in MAFE in forecast round 4 for most indicators.

Table 3: MAFE of Indicator Forecasts (World)

Round	OIL	PMI	MSCI W	IP W	TRADE W	OECD	OECD6	AV
1	1.2111	1.7048	1.4961	1.5429	1.4985	1.7395	1.8129	1.5006
2	1.6742	1.7734	1.8158	1.7160	1.5980	1.7525	1.8679	1.6483
3	1.5550	1.6868	1.6620	2.0173	1.5253	1.7724	1.8894	1.6434
4	1.5103	1.8373	1.6897	1.4677	1.4058	1.5906	1.8307	1.5303
5	1.6575	1.8025	1.6549	1.6664	1.4549	1.6153	1.8240	1.5718
6	1.4729	1.5499	1.7077	1.6495	1.4466	1.5666	1.7955	1.4935
7	1.4342	1.3313	1.7140	1.5562	1.3253	1.5739	1.8128	1.4816
8	1.1870	1.1576	1.7239	1.8255	1.5411	1.5507	1.7955	1.5084
9	1.6412	1.2549	1.6416	1.7371	1.4625	1.5040	1.7788	1.5257
10	1.8262	1.2363	1.3572	1.3339	1.2074	1.3892	1.4830	1.3728
11	2.0511	1.1188	1.0328	1.6005	1.6256	1.3435	1.4319	1.4363
12	1.6242	1.0842	0.8751	1.4727	1.3092	1.3471	1.4125	1.2805
13	1.4211	0.6924	1.1237	1.3778	1.6541	1.2506	1.2102	1.0762
14	1.3837	0.7346	1.1377	1.6156	1.7200	1.1486	1.0800	1.0772
15	1.4265	0.7581	1.2354	1.3152	1.6712	1.1239	0.9899	0.9503
16	1.3105	0.7462	0.9730	1.1039	1.4015	0.8406	0.8225	0.8622
17	1.1793	0.7649	0.8035	1.1551	1.4803	0.7698	0.8101	0.8295
18	1.2247	0.7595	0.9674	1.2686	1.4126	0.7710	0.8034	0.8782
19	1.2587	0.7697	1.0101	1.4263	1.3290	0.7666	0.8432	0.9249
20	1.2671	0.7721	0.9808	1.4904	1.5877	0.7884	0.8527	0.9293
21	1.2680	0.8265	0.9840	1.2053	1.4228	0.8136	0.8720	0.8780
22	1.4081	0.8974	1.1639	1.4629	1.5134	0.7906	0.7893	1.0023
23	1.3624	0.9447	1.1038	1.1916	1.4451	0.8488	0.7609	0.8867
24	1.4087	0.9621	1.0698	1.3412	1.5965	0.9797	0.8086	0.9265

Note: Period 2000-2011, for PMI 2004-2011. The latest available month of the indicator is used as annual value. 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. In the last column (AV), the results of the forecast combination are presented. From 2000-2003, the average forecast is build without the PMI.

By combining the available individual indicator forecasts to an average forecast (AV), the forecast error improves only compared to the indicators with less predictive power. Tables 3 and 6 show that the single indicator forecasts for the world based on PMI and OECD indicators (respectively the last available value) are better than the average forecast for the majority of forecast rounds.

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 (see Table 4 and 5). However, while the combined forecasts (AV) for

Table 4: MAFE of Indicator Forecasts (Advanced Countries)

Round	OIL	PMI	MSCI ADV	IP ADV	TRADE ADV	AV
1	1.0600	1.6764	1.2243	1.5687	1.2804	1.2679
2	1.2868	1.7266	1.2709	1.7137	1.2245	1.2859
3	1.2485	1.7378	1.2176	1.6210	1.5203	1.2683
4	1.4668	1.8557	1.4045	1.3726	1.2960	1.3193
5	1.3237	1.9119	1.2614	1.3203	1.3288	1.2774
6	1.1948	1.9057	1.3816	1.1921	1.2314	1.1380
7	1.3249	1.8702	1.1917	1.4724	1.3343	1.2591
8	1.1879	1.8618	1.3848	1.0740	1.1409	1.1434
9	1.4343	1.8279	1.1938	1.1403	1.2521	1.1243
10	1.5868	1.1553	1.3738	1.3365	1.2070	1.2527
11	1.5104	0.9746	1.4062	1.1349	1.1868	1.1603
12	1.6500	0.9625	1.2489	1.0366	1.3867	1.2649
13	2.0447	3.4665	1.4496	1.0167	1.8905	1.6707
14	1.9105	3.5595	1.4948	1.0434	2.1397	1.7663
15	2.0470	3.5030	1.5166	0.9615	1.6026	1.6398
16	1.9715	0.8875	1.4398	0.9255	1.8943	1.4166
17	1.8060	0.9248	1.2373	1.1424	2.0206	1.2831
18	1.7629	0.9776	1.3603	1.1191	1.6022	1.2522
19	1.8963	0.9837	1.4617	1.2334	2.1098	1.5010
20	1.9122	1.0579	1.4374	1.1981	1.5576	1.3472
21	1.8935	1.0194	1.4065	1.2272	1.7688	1.4019
22	1.9680	0.8782	1.4491	1.4798	1.9582	1.5266
23	1.9225	0.9103	1.3728	1.3701	1.8735	1.3528
24	1.9480	0.9275	1.4230	1.2080	1.9357	1.4458

Note: Period 2000-2011, for PMI 2004-2011. The latest available month of the indicator is used as annual value.

the advanced countries are more precise than world GDP forecasts for the next year, they are less precise than forecasts for the world and the developing countries in the current year.

Comparing the forecast error based on the single indicator forecasts with the forecasts of the IMF, it turns out that with the help of some indicators of the forecast quality can be significantly improved in some forecast rounds (Table 6-6). In forecast rounds 1-3, there is no corresponding IMF forecast available, so that no comparison is possible. For the world production, the IMF forecasts for the following year can be improved by the Purchasing Managers Index PMI and MSCI AC World. This applies even more strongly to the forecast of the current year in the months of January to March, where an improvement of over 50% compared to the IMF forecast, can be achieved. Also OECD leading indicators perform well for the current year's forecast. After the publication of the World Economic Outlook in the spring (forecast round 16) indicators can no longer improve the IMF forecast for the current year.

Table 5: MAFE of Indicator Forecasts (Developing Countries)

Round	OIL	MSCI EL	IP EL	TRADE EL	AV
1	1.5050	1.6828	1.8947	1.7302	1.6632
2	2.0192	1.7995	1.7822	1.7697	1.8426
3	1.8061	1.5971	1.8187	1.6823	1.7055
4	1.9496	1.8000	1.9486	1.9806	1.7630
5	2.1715	1.8462	1.8535	1.9226	1.9428
6	1.8402	1.9065	1.9421	1.9007	1.8974
7	1.7796	1.8550	1.9417	1.9314	1.8419
8	1.4637	1.7715	1.9954	1.9584	1.6989
9	2.0071	1.6347	1.9625	1.9065	1.8479
10	1.8883	1.8214	2.1442	2.2252	1.9608
11	2.2114	1.7295	2.1621	2.0966	1.8978
12	1.8891	1.1754	2.2133	2.4595	1.8537
13	1.5879	1.1281	1.7250	1.7220	1.4884
14	1.6043	1.2421	1.7085	1.6474	1.4762
15	1.6424	1.1784	1.6656	1.7446	1.5039
16	1.0600	0.6540	1.2172	1.1062	0.8706
17	1.0778	0.6039	1.3507	1.1059	0.9135
18	1.0353	0.6231	1.2754	1.1668	0.9287
19	0.9922	0.6832	1.2696	1.0082	0.8543
20	0.9174	0.6725	1.4934	1.1149	0.9365
21	0.9934	0.6584	1.1964	1.2569	0.9321
22	1.4147	1.2192	1.2992	1.3141	1.1927
23	1.3969	1.1012	1.5546	1.3124	1.2841
24	1.4727	1.0382	1.4805	1.5107	1.2464

Note: Period 2000-2011. The latest available month of the indicator is used as annual value.

The most powerful indicators for world production, namely the most recent monthly PMI data, have, from the summer of the previous year to March of the projected year, a higher explanatory power than the IMF forecast, regardless of whether they are used alone or in conjunction with the IMF forecasts. These indicator forecasts also perform better than the weighted average of all indicator forecasts (Table 6). Industrial production in the advanced countries is one of the indicators that seem to improve the IMF's forecast for some months – especially from January to March (rounds 13-15) –for the current year forecast (Table 7). For the production growth in the developing and emerging countries, there is only one indicator that has a slightly higher predictive power than the IMF forecasts: The average annual index of stock prices in the developing and emerging countries MSCI EL performs slightly better in the months of January to March (rounds 13-15) in predicting output growth in the current year than the World Economic Outlook of the IMF. The results show that forecast averaging has only good performance for the World Aggregate (compared to IMF forecast, but not to forecasts based on PMI and OECD), but neither for the advanced nor the emerging economies.

The analysis shows that with a different frequency transformation, namely the respective mean of annual values relating to the available months, the most powerful indicator,

Table 6: Theil's U of Indicator Forecasts (World)

Forecast	OIL	PMI	MSCI W	IP W	TRAD W	OECD	OECD6	AV
1	NA	NA	NA	NA	NA	NA	NA	NA
2	NA	NA	NA	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA	NA	NA	NA
4	1.1772	1.0498	1.1525	1.0449	1.0114	1.1340	1.2152	1.0545
5	1.1633	1.0441	1.1144	1.0467	1.0394	1.1239	1.2024	1.0577
6	1.0431	0.9005	1.1285	1.1041	1.0141	1.0869	1.1818	1.0024
7	1.1184	0.7980	1.1125	1.0116	0.9793	1.0717	1.1856	0.9971
8	0.8524	0.7000	1.0984	1.1894	1.1045	1.0345	1.1794	0.9698
9	1.1336	0.6771	1.1109	1.1277	1.0722	0.9833	1.1605	1.0023
10	1.4667	0.8504	0.9522	1.0233	1.0794	1.0907	1.1545	1.0399
11	1.6179	0.7595	0.8247	1.2438	1.3367	1.0431	1.1141	1.0973
12	1.5229	0.7165	0.6883	1.1010	1.1207	1.0283	1.0778	0.9908
13	1.2824	0.4658	0.9400	1.0677	1.4456	1.0723	0.9542	0.8654
14	1.2997	0.5104	0.9368	1.2459	1.5499	0.9772	0.8523	0.8500
15	1.2968	0.5160	1.0774	0.9984	1.4015	0.9801	0.7811	0.7917
16	2.7594	1.7319	2.3096	2.4526	3.1385	1.8001	1.6367	1.7882
17	2.7057	1.7452	1.6733	2.8153	3.3769	1.7093	1.6172	1.7318
18	2.6927	1.7436	2.0724	2.9314	3.1501	1.7193	1.6048	1.8192
19	2.6455	1.7494	2.1743	3.1729	3.1365	1.7148	1.6837	1.8833
20	2.7147	1.7575	2.1162	3.4346	3.5225	1.8419	1.8040	2.0350
21	2.6363	1.8331	2.2346	2.9731	3.2334	2.0717	2.0286	1.9990
22	4.5202	2.6073	3.8466	4.8754	5.1498	3.5574	3.0232	3.4469
23	4.4485	2.6883	3.4323	4.4225	5.2245	3.8966	3.3475	3.3089
24	4.4877	2.7024	3.3750	4.2144	5.5383	4.2692	3.4925	3.3840

Note: Period 2000-2011, for PMI 2004-2011. The latest available month of the indicator is used as annual value.

the PMI, loses precision considerably. Otherwise, results differ only slightly from those described above. In some cases, the prediction accuracy in the first three months of the year predicted is improved (rounds 13-15) by using the annual mean instead of the most recent value. Furthermore oil seems a promising indicator for improving the world GDP forecast of the next year. Interestingly forecast averaging for the advanced countries yields slightly better results when the monthly averages are considered. For ELSL, the forecasts for the next year using the MSCI are in the summer months – before the publication of the IMF's autumn forecast – slightly better. A variation of the sample period shows that the effects of the crisis have a significant influence on the overall results. A forecast comparison until 2007, i.e. excluding the financial crisis, yields consistently and significantly lower forecast errors. The result that forecasts based on the latest monthly value of Purchasing Managers' Index and OECD CLIs beat the IMF forecasts for world GDP from January to March does not remain. However, during these months the average forecast is better than the IMF forecast. In the pre-crisis period the improvement compared to the pure IMF forecast is almost 30% for the next years forecast of advanced countries GDP and almost 40% for the current year forecast of emerging countries' GDP. Finally it can be

Table 7: Theil's U of Indicator Forecasts (Advanced economies)

Round	OIL	PMI	MSCI ADV	IP ADV	TRADE ADV	AV
NA	NA	NA	NA	NA	NA	
NA	NA	NA	NA	NA	NA	
NA	NA	NA	NA	NA	NA	
1.1248	1.2569	1.0983	1.0863	1.0766	1.0766	
1.1032	1.2691	1.1099	1.0234	1.1347	1.1347	
1.0667	1.2202	1.1143	1.0435	1.0887	1.0887	
1.0964	1.2172	0.9281	1.0903	1.1541	1.1541	
1.0099	1.2041	1.0644	0.9596	1.0427	1.0427	
1.0991	1.1849	1.0114	0.9836	1.0616	1.0616	
1.4170	1.1322	1.3602	1.2873	1.4284	1.4284	
1.3991	0.8700	1.2866	1.1436	1.3952	1.3952	
1.4948	0.9112	1.2588	1.1707	1.4800	1.4800	
1.8484	4.2827	1.2465	0.9376	1.7970	1.7970	
1.8475	4.4455	1.2789	0.9466	1.9086	1.9086	
1.8865	4.4552	1.3092	0.8220	1.6239	1.6239	
5.5227	2.5232	4.2255	2.5461	5.2724	5.2724	
5.2568	2.5907	3.7132	3.3086	5.6228	5.6228	
5.2517	2.7453	4.0624	3.4109	4.6839	4.6839	
5.4419	2.7645	4.0834	3.7730	5.9477	5.9477	
5.4038	2.9455	4.1537	3.8123	4.8602	4.8602	
5.3840	2.9446	4.0593	3.9694	5.1375	5.1375	
10.3108	3.7858	7.3081	7.9235	10.4156	10.4156	
10.3473	3.7214	6.8527	7.9210	10.0191	10.0191	
10.2931	3.7788	6.9767	7.1602	10.5195	10.5195	

Note: Period 2000-2011, for PMI 2004-2011. The latest available month of the indicator is used as annual value.

shown that the results discussed above are in general slightly better than the results of the predictions based only on pure indicators, i.e. which does not include the IMF forecasts additionally.

Table 8: Theil's U of Indicator Forecasts (Developing countries)

Round	OIL	MSCI EL	IP EL	TRADE EL	AV
1	NA	NA	NA	NA	NA
2	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA
4	1.2910	1.0649	1.2552	1.2621	1.1747
5	1.4204	1.1861	1.1951	1.2282	1.2073
6	1.2265	1.1425	1.2438	1.2412	1.1709
7	1.1579	1.2103	1.2063	1.2290	1.1709
8	0.9224	1.0859	1.2501	1.2606	1.0965
9	1.2166	1.0888	1.2389	1.2436	1.1664
10	1.2975	1.2775	1.6177	1.7122	1.3634
11	1.4698	1.2398	1.6464	1.7159	1.3843
12	1.3901	0.9081	1.6435	1.8522	1.3908
13	1.2172	0.9117	1.1547	1.2482	1.0793
14	1.2571	0.9470	1.1391	1.1714	1.0520
15	1.2298	0.9446	1.1942	1.3062	1.1047
16	1.5852	1.0948	2.0252	1.7971	1.4383
17	1.6642	1.0542	2.2836	1.7767	1.5059
18	1.5960	1.0446	2.1249	1.9763	1.5310
19	1.5065	1.1050	2.1403	1.5853	1.4052
20	1.4388	1.1269	2.3776	1.9310	1.5733
21	1.4935	1.0881	2.0075	2.0115	1.4887
22	3.2787	2.9468	3.4726	3.0931	2.9378
23	3.3558	2.7196	3.8935	3.4709	3.1252
24	3.4265	2.6336	3.5521	3.4469	3.0128

Note: Period 2000-2011. The latest available month of the indicator is used as annual value.

6 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 could be missed, especially in the first three months of the current year. However, it is noteworthy that indicator forecasts for the following year based on the purchasing manager index of industrial production perform better than the October forecast of the IMF. 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 a large 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 will also increase the average forecast errors. That's why in the coming years robustness of the results should be reviewed regularly.

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7 Appendix

Evaluation of IMF-Forecast in Pseudo Real-time

Table 9: Predictive Power of the IMF Forecasts

Sample	Forecast Round	World	Advanced	ELSL
1990 - 2011	1	1.5197	1.6267	1.9644
	2	1.2747	1.3428	1.8129
	3	0.6392	0.6482	1.6615
	4	0.5361	0.5128	1.7092
1990 - 2007	1	0.9217	0.9624	1.7592
	2	0.8699	0.9208	1.7253
	3	0.5934	0.5955	1.7979
	4	0.5097	0.4411	1.8711
2008 - 2011	1	2.9178	3.1553	2.6657
	2	2.3055	2.4211	2.1456
	3	0.8054	0.8359	0.8688
	4	0.6359	0.7442	0.6758

Note: The RMSFE is 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 October 2012.

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. They are aggregated time series, which are constructed by aggregating across multiple cross-sectional components, which are

based on various criteria, such as 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.

- **Oil 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 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. The MSCI World Index 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 10: Characteristics of Leading Indicators

Indicator	Source	Frequency[a])	Revision	available since[b])	release during a month	release delay
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)] Q: Quarterly, M: monthly, M*: data are available daily but are used at monthly frequency. [b)] Some data are already available before 1990.

Table 11: Unit Root Tests

	t-statistic		lags based on AIC
OIL	0.9514		13
PMI	-3.2244	**	3
MSCI W	-1.7506		3
IP W	0.6482		10
TRADE W	-0.3958		12
OECD	-3.4840	***	7
OECD6	-3.8011	***	7
MSCI ADV	-1.8326		4
IP ADV	-2.0799		3
TRADE ADV	-1.4625		3
MSCI EL	-1.3176		7
IP EL	2.7423		7
TRADE EL	0.7028		11

Note: Total sample depending on availability of the indicators. *** Significant at the 1% level, ** significant at the 5% level.