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FORECASTING WORLD OUTPUT: THE RISING IMPORTANCE OF EMERGING ECONOMIES

by Alessandro Borin*, Riccardo Cristadoro*,
Roberto Golinelli** and Giuseppe Parigi*

Abstract

Assessing the global economic outlook is a fundamentally important task of international financial institutions, governments and central banks. In this paper we focus on the consequences of the rapid growth of emerging markets for monitoring and forecasting the global outlook. Our main results are that (i) the rise of the emerging countries has sharply altered the correlation of growth rates among the main economic areas; (ii) this is clearly detectable in forecasting equations as a structural break occurring in the 1990s; (iii) hence, inferences on global developments based solely on the industrialized countries are highly unreliable; (iv) the otherwise cumbersome task of monitoring many – and less studied – countries can be tackled by resorting to very simple bridge models (BM); (v) BM performance is in line with that of the most widely quoted predictions (WEO, Consensus) both before and during the recent crisis; and (vi) for some emerging economies, BMs would have provided even better forecasts during the recent crisis.

JEL Classification: C22, C53, E37, F47
Keywords: GDP forecast, emerging and Asian markets, bridge models, forecasting ability.

Contents

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1. Introduction[1]

The assessment of current and future global economic outlook is a key issue for international financial institutions, governments and central banks. Over the last twenty years, the rapid growth of the emerging countries has deeply changed the economic landscape: the world trade share of Asian most dynamic economies almost doubled, from about 13% in 1990 to 23% in 2008,[2] and their aggregate GDP now accounts for more than a quarter of world output, whereas it was less than 12% in 1990. The rise of China played a crucial role in this process, as it progressively became a new center of gravity for the other Asian economies.

During the last decade, Brazil, Russia and India also entered a path of rapid growth, and the BRIC (from the initials of Brazil, Russia, India and China) came to the fore of economic analysis as witnessed by the replacement of the G8 group of countries by the G20 as the main global economic forum. However, while reliable tools and data have long been available to analyze cyclical developments in advanced countries in a timely and comprehensive fashion, this is not true for emerging economies.

The recent literature still analyses and forecasts the global economic trends mainly focusing on either the G7 or the OECD countries (Arouba et al, 2010, Kose et al, 2008, Golinelli and Parigi, 2007) and Chauvet and Yu, 2006).[3]

Is this approach still sound? We do not believe so. We provide some new and original evidence on the excessive limitations of this approach and propose a viable alternative by modeling explicitly both the advanced and the main emerging economies contributions to the world economic growth.

In recent years the elasticity of world GDP growth to emerging markets' GDP growth rose to 0.4 from virtually zero. Two phenomena explain this and became apparent in the data during the nineties: an *emerging Asia effect,* mainly driven by the rise of China as a new center of gravity, and a *globalization effect*, whereby rising trade flows and stronger financial linkages proceeded almost in parallel with the expansion of new economic powers.

The first objective of this paper is to prove that these phenomena must impose a significant change in our way of monitoring and forecasting the world economy. A second objective is to present an easy, almost automatic, way of obtaining a timely assessment of global economic activity.

That something is amiss in a "business as usual" approach is shown by the dramatic failure of the traditional as well as more innovative forecasting models during the last crisis. No matter what argument one proposes to explain this failure, it has surely underscored the importance of frequent

[1] Paper presented at 6th Eurostat Colloquium on "Modern Tools for Business Cycle Analysis: the Lessons from Global Economic Crisis", Luxembourg, September, 26-29 2010, at the workshop: "The Chinese Economy", Venice, November 25-27 2010, and at the 4th Italian Congress of Econometrics and Empirical Economics, ICEEE, Pisa, January 19-21, 2011. We are grateful to two anonymous referees, Adrian Pagan, Domenico Sartore and to conference participants for helpful comments and suggestions; the usual disclaimer applies. PRIN founding is gratefully acknowledged (R. Golinelli).

[2] In many instances we choose to report statistics relative to the period prior to the global financial crisis to avoid a the contamination of underlying trend movements with sharp contractions and rebounds due to the crisis.

[3] GVAR models are more general but they have not been devised for short run analysis and forecasting (see Pesaran et al, 2004 and 2009).

forecast updates in a rapidly changing environment.[4] Updating predictions is however far from being a simple work, as it implies the maintenance and estimation of high dimension models, as well as very complex data base.

Our proposal for a monthly assessment of global perspectives is to estimate, for the main advanced and emerging countries, very simple *bridge models* (BM) i.e. equations where the information content of short run indicators is 'translated' into the more coherent and complete 'language' of GDP and national accounts. Our BM are based solely on industrial production in order to show the advantage of this approach without incurring in criticisms of "data mining".

GDP forecasts are obtained via BM for fifteen developed and developing countries/areas, subsequently aggregated into three main groups:

- the *JEU* (Japan, USA, and European Union);
- the *ASE* (China, India, Hong Kong, Korea, Singapore, Taiwan, Indonesia, Malaysia, Philippines and Thailand);
- the *BRRU* (Brazil and Russia).

Finally we specify a *world bridge model* (WBM), where world GDP growth is the aggregation of the growth rates of these three main areas. this is to our knowledge the first attempt to "nowcast" (Banbura et al. 2010) and forecast GDP growth for advanced and emerging markets and hence, the world.

BM forecasts for the growth rates of the main countries and areas outperform those of simple benchmarks (like AR). Comparing WBM predictions with those of the *annual* growth rate of the world output published in the IMF-WEO provides further validation: WBM forecasts are not too far off from the results of the sophisticated forecast techniques adopted by the IMF. In particular, as the date of the WEO projection gets older the WBM quick assessment becomes a valuable way to "*update*" the last available WEO, or even to "*anticipate*" the next nearby release. For most of the countries and areas considered, the accuracy of BM forecasts appears also in line (and sometimes even more precise) with those released every month by the *Consensus Forecasts.*

Focusing on the most recent and dramatic recession, we show that the simple BM proposed track economic developments at least as well as other, more sophisticated model. In particular augmenting the BM with an indicator that takes into account the "confidence" effects, like the PMI, limits the undershooting of the actual GDP dynamics that becomes apparent in the case of the BM based solely on industrial production.

We have chosen to focus on the forecast of world GDP growth because it is immediately and more easily comprehensible as an indicator of global activity, compared for instance with cyclical, synthetic indicators of economic activity.[5]

The paper is organized as follows. In the *second* section we show the impact of emerging Asia on world trade and output and its consequences in forecasting world GDP. In the *third* section we present simple *bridge models* that, through the use of monthly and timely indicators, provide an easy way to frequently revise prediction of each country quarterly GDP. In the *fourth* section we assess the BM performance comparing it with the projections of the IMF-WEO and the *Consensus Forecast*; finally, we provide a closer assessment of the BM during the recent recession. Section *five* concludes.

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[4] The International Monetary Fund (IMF) decided to publish two updates of its World Economic Outlook (WEO) projections, in January and July, to bridge the complete WEO projections released in April and October, in conjunction with the semi-annual meetings of the Fund.

[5] See Camacho et al. (2008); Barhoumi et al. (2009) for alternative ways of performing a similar task for euro area growth. See Altissimo et al. (2010) for the second route, instead, to obtain a monthly indicator of euro area growth.

2. The rising importance of emerging markets

2.1 Change in weights and correlation pattern among main world areas[6]

In 1990, the GDP of Japan, the European Union (15) and the United States (JEU hereafter) altogether accounted for 55.8% of the world output (evaluated at purchasing power parities, PPP hereafter); by 2008, their combined share was only 46.3%. In the meantime, China's weight alone grew from 3.6 to 11.5% (see table 1).

Table 1. World GDP and countries' shares

(based on PPP valuation of country GDP)

	1990	1995	2000	2005	2008
World *(Billions of US Dollars based on PPP)*	*3,448.1*	*5,077.0*	*6,358.8*	*10,333.5*	*15,858.9*
			share of world total		
Japan	8.2	8.5	7.2	5.5	4.7
EU 15	44.1	39.6	34.9	34.5	31.9
United States	11.2	11.3	12.1	8.6	8.1
China	1.5	2.5	3.9	7.4	9.0
NIEs(1)	7.8	10.7	10.8	9.8	8.8
Other Developing Asian Economies(2)	3.1	4.5	5.1	5.0	5.0
Russia	1.5	1.6	1.7	2.4	3.0
Brazil	0.9	0.9	0.9	1.1	1.2

source: IMF-WEO

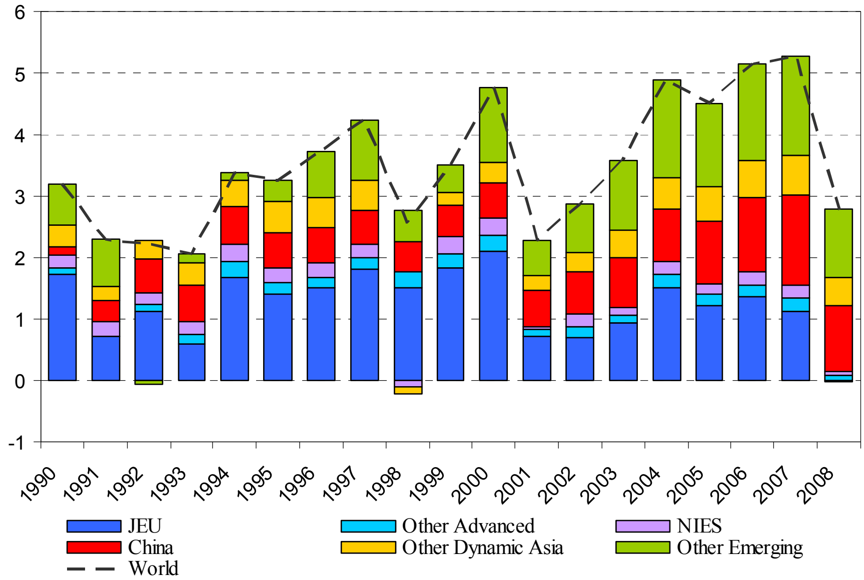
(1) It includes Hong Kong, Rep. of Korea, Singapore, Taiwan.

(2) It includes India, Indonesia, Malaysia, Philippines, Thailand and Viet Nam.

Furthermore, in the last decade, more than 60% of world output growth originated in the emerging world (in particular, China), with respect to just about 40% in the nineties (see fig. 1).

Fig.1 - Contributions to World GDP growth

(yearly data, composition based on PPP valuation of country GDP)



source: IMF WEO October 2010

[6] In comparing GDP levels and growth rates, as well as in weighting trade flows and correlation patterns we focused on the period prior to the world economic crisis (i.e. prior to 2009), since this allows a clearer picture of underlying medium term trends, unhindered by the strong and uneven impact of the crisis itself. We turn to an analysis of the impact of the financial turmoil on economic performance of the main areas and its predictability in the last section of the paper.

The rise of new global players is even more stunning when we consider trade flows: since the mid-nineties, the shares of Chinese exports have rapidly increased in all destination markets. In 2008 they accounted for 18.8, 16.5 and 13.3% of the Japanese, the US and the EU imports, respectively. At the same time, trade within the most industrialized countries shrunk as a share of the total, facing the growing importance of emerging economies. In the case of Japan, the cumulative weight of the US and the EU in its total export dropped dramatically: from 31% in 2000 to about 19 in 2008. On the contrary, intra regional trade among the East Asian countries gained importance over the last decade. At present, more than one third of Chinese trade takes place with Japan and other East Asian countries; for the latter, the weight of intra-regional trades exceed 50% of total exchanges (see Table B1 in Appendix B).

The integration of China within the international production chain crucially contributed to this phenomenon. The growth of the Chinese exporting sector has intensified the fragmentation of production processes among Asian partners, while China has become the central hub of this regional network.[7] In particular, China turned out to be a favourite location for assembling parts and components produced in other East Asian economies. Although the rising prominence of the *processing trade* may artificially boost the weight of intra-regional trade in East Asia, it also reveals an increasing interdependency among the economies belonging to the same production network.

Along with the rising weight of emerging areas, also the correlation pattern among world economies changed. Table 2 shows the correlations of annual GDP growth rates in the main countries and economic areas computed at three time intervals about twenty years apart. On the main diagonal there appears the average pairwise correlation within each country group, the off-diagonal figures measure the correlation among them. We focus on the G6 group of western advanced economies (*i.e.* the G7 without Japan), two groups of East Asian dynamic economies (Newly Industrialized Asian Economies, NIEs, and Developing Asia, excluding China), Brazil and Russia; Japan and China have been singled out from the respective reference groups, given the peculiar evolutions of their economies.

The maximum correlation between the G6 and world GDP is attained during the seventies and eighties (0.93), while it almost halved in the most recent period (0.49). Comovements between Japan and the G6 follow a similar pattern, while during the last twenty years Japan's correlation with other Asian economies rose. Similarly, comovements among growth rates of Asian economies have steadily increased over time, both within NIEs and Developing Asian economies, and between these country clusters. Looking more in details at the evolution of GDP comovements within east Asia, we observe a sharp increase of the pairwise correlations between China and most of the other Asian countries in the last twenty years, with the only exceptions of India and Philippines. The correlation of growth rates between emerging economies and the G6 remained quite low, while over the last twenty years the correlation with the world growth rose sharply for emerging Asian economies, Brazil and Russia. The fact that China growth is not correlated to that of the advanced countries, while not a prove of an absence of interdependencies suggests indirectly that considering it when forecasting world output might give additional information with respect to the behaviour of the GDP of industrialized countries.

We can tentatively conclude that: (*i*) the rising importance of emerging markets is clearly visible in terms of GDP and trade flows as well as in terms of contribution to overall world growth; (ii) the fast growth of emerging markets gave rise to new regional centers of gravity that have affected the linkages among world economic areas and the degree of comovement within and across the different country groups.

[7] Wang and Wei (2008), Koopman et al (2008), Amiti and Freund (2008), Fontagné et al. (2008), He and Zhang (2008), Schott (2008), Sasaki and Ueyama (2009), Park and Shin (2009).

Table 2. - Contemporaneous correlations of annual GDP growth
(annual data; intra group average correlation on the principal diagonal)

	1951-1970							
	WORLD	G6(1)	Japan	China	Oth. Dev. Asia. (2)	NIEs(3)	Russia	Brazil
G6(1)	**0.72**	0.14						
Japan	**0.42**	0.31	1					
China	0.37	0.04	-0.29	1				
Other Developing Asia(2)	0.15	-0.22	**0.44**	-0.10	-0.04			
NIEs(3)	0.05	-0.10	-0.15	0.05	0.20	0.16		
Russia	0.32	-0.18	0.08	0.04	0.24	-0.02	1.00	
Brazil	-0.14	-0.23	0.25	-0.27	0.23	0.02	0.02	1.00
	1971-1990							
	WORLD	G6(1)	Japan	China	Oth. Dev. Asia. (2)	NIEs(3)	Russia	Brazil
G6(1)	**0.93**	**0.54**						
Japan	**0.63**	**0.63**	1					
China	0.05	0.23	0.21	1				
Other Developing Asia(2)	0.11	0.11	0.21	-0.03	0.24			
NIEs(3)	**0.80**	**0.76**	**0.41**	0.08	0.16	0.39		
Russia	**0.50**	0.37	0.00	0.00	0.21	**0.61**	1.00	
Brazil	**0.53**	0.31	0.12	-0.21	-0.31	0.25	**0.42**	1.00
	1991-2008							
	WORLD	G6(1)	Japan	China	Oth. Dev. Asia. (2)	NIEs(3)	Russia	Brazil
G6(1)	**0.49**	**0.46**						
Japan	**0.45**	0.01	1					
China	-0.01	-0.10	0.18	1				
Other Developing Asia(2)	**0.52**	-0.10	**0.62**	**0.51**	**0.45**			
NIEs(3)	0.15	0.13	**0.67**	**0.40**	**0.63**	**0.61**		
Russia	**0.65**	0.00	0.21	-0.51	0.20	-0.16	1.00	
Brazil	**0.52**	0.00	**0.30**	0.35	**0.59**	0.29	0.20	1.00

Values greater than 0.4 in bold scripts.

(1) It includes Canada, France, Germany Italy, U.K., U.S.A. **(2)** It includes India, Indonesia, Malaysia, Philippines, Thailand and Viet Nam. **(3)** It includes Hong Kong, Rep. of Korea, Singapore, Taiwan.

source: A. Maddison - OECD, IMF WEO October 2009

2.2 "Emerging Asia" and "Globalization" effects and the assessment of the global economic outlook

This evidence raises a question about the importance of emerging countries to assess the global economic outlook and to forecast world GDP growth. As a first step in addressing more formally this issue, we estimate the contributions to world GDP growth of different countries/groups. There exists an accounting relationship that links the aggregate world GDP to its components, as is clear from in figure 1. However, the extent to which each country affects world GDP growth may differ from its weight in the accounting identity, since it may play a leading role in the global economy influencing the evolution of many other countries. To investigate this point we estimate the following relationship:

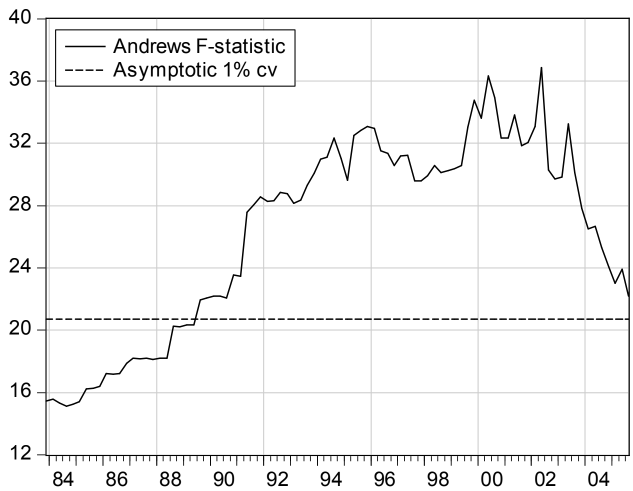
$$\Delta y_t^W = \alpha + w^{JEU}\Delta y_t^{JEU} + w^{ASE}\Delta y_t^{ASE} + w^{BRRU}\Delta y_t^{BRRU} + u_t \qquad (1)$$

where u_t are the errors, that should mainly contain the contribution of countries not included in the analysis; α is a constant and w_i represents the elasticity of world GDP growth to aggregate *i*'s output growth (*i = JEU, ASE, BRRU*).[8]

A simple OLS estimate of equation (1) is likely affected by endogeneity for two main reasons: simultaneity/reverse causality (*i.e.* world growth may drive the dynamics in some areas, rather than the opposite) and omitted variables bias (*i.e.* output growth of countries excluded from (1) may significantly affect the evolution of those included). These endogeneity problems can be dealt with instrumental variables (IV) employing the first lag of the dependent and the explanatory variables as instruments. Estimates for the whole sample period (1979q1 - 2010q1) are presented in the first column of table B2 (in the Appendix B). The choice of the IV estimator appears justified by the results of the Hausman test and the Godfrey test that does not detect significant autocorrelation in the residuals. The estimated coefficients for the whole sample highlight the relevance of *JEU* in explaining the world GDP evolution, while the elasticity associated with the *ASE* output growth is not statistically significant.

As we are mainly interested in evaluating this relationship over time, we computed the Andrews-Quandt test for the detection of breaking points in the coefficients. Figure 2 shows the behaviour of the likelihood ratio *F*-statistic over the time span considered (1983-2006). The *F*-statistic progressively rises until 1994, then it fluctuates around values largely above the 1% confidence level until 2003. This clearly shows an instability "phase" during the period 1994-2003, while it is hard to commit to a specific break date since a maximum in the statistic can be due to the presence of a random spike (the second quarter of 2002, according to the Andrews-Quandt sup *F* statistic).

Fig.2 – Results of the Andrews (1993) statistic for breaking points



([1]) Andrews-Quandt *sup F* statistic and the asymptotic 1% critical value.

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[8] Country groupings (JEU, ASE and BRRU) are defined in the introduction. Details about GDP and other data sources are in the Appendix A1; GDP growth is given by the first differences of log-levels. We found that $y_t^W - w^{JEU} y_t^{JEU} - w^{ASE} y_t^{ASE} - w^{BRRU} y_t^{BRRU} \sim I(1)$ hence a stable cointegrating relationship cannot be found due to pervasive and significant parameters (weights) changes over the sample period, as one could expect given the evidence in Section 2.

We chose to split the sample into two subperiods: 1979q1 – 1993q4 and 1994q1 – 2010q1, consistently with the evidence provided by the F-statistic. IV estimation results for the two periods are reported in column 2 and 3 of table B2 in Appendix B. The elasticity of world GDP growth to that of the *ASE* group sharply increases from about zero in the first part of the sample to a statistically significant 0.4 in the second, while, not surprisingly, the coefficient associated to *JEU* reduces from 0.8 to 0.5. The relationship between world and *BRRU* GDP growth rates is more stable (with an elasticity around .065 in both periods). As shown in column 4, the difference of the estimated coefficients between the two periods is statistically significant both for the *JEU* and the *ASE* groups, providing further evidence in favour of our partition of the sample. This suggests that the relevant factor in the recent evolution of world output has been the robust growth of East Asian economies ("*emerging Asia effect*").

The changes in the interdependencies among growth rates can be further analysed by making use of a VAR(1) model for Δy_t^{JEU}, Δy_t^{ASE} and Δy_t^{BRRU}, which provides a parsimonious data-congruent representation of the dynamic relationships among the GDP growth of the three groups of countries:[9]

$$\begin{pmatrix} \Delta y_t^{JEU} \\ \Delta y_t^{ASE} \\ \Delta y_t^{BRRU} \end{pmatrix} = \begin{pmatrix} \alpha^{JEU} \\ \alpha^{ASE} \\ \alpha^{BRRU} \end{pmatrix} + \begin{pmatrix} w_{11} & w_{12} & w_{13} \\ w_{21} & w_{22} & w_{23} \\ w_{31} & w_{32} & w_{33} \end{pmatrix} \begin{pmatrix} \Delta y_{t-1}^{JEU} \\ \Delta y_{t-1}^{ASE} \\ \Delta y_{t-1}^{BRRU} \end{pmatrix} + \begin{pmatrix} v_t^{JEU} \\ v_t^{ASE} \\ v_t^{BRRU} \end{pmatrix} \tag{2}$$

The estimates have been computed over the whole sample and over the two subperiods, previously identified. Table B3 presents the p-values for non-Granger causality tests (NGC), and the correlation coefficients between VAR shocks. In the first subperiod, NGC never rejects the null of no explanatory power of the past values of each aggregate's growth to the others, while in the second subperiod emerges a significant role of the *ASE* growth in explaining the future dynamics of both *JEU* and *BRRU* (this last group, in turn, contributes to predict the *JEU* growth since the mid-90s). The evidence about a relevant predictive power of the Asian emerging economies with respect to the evolution of *JEU* GDP is confirmed by the estimates obtained over the whole sample (column 1), although these results hide the deep changes occurred between the two subperiods. Moreover, the simultaneous correlation between *JEU* reduced-form shocks and both *ASE* and *BRRU* innovations rises sharply in the second part of the sample, signalling a general increase in the international integration of the economies during the last fifteen years ("*globalization effect*").

The changes in the propagation of shocks are summarised by the generalised impulse-response functions (G-IRF, see Pesaran and Shin, 1998), derived from the VAR estimates (see figure B1 in Appendix). Again, both the impact and the persistence of the effects of *ASE* shocks on the *JEU* and *BRRU* growth are evident only in the second subperiod. The effect of the *ASE* shock always tends to last about 3-4 quarters, while neither *JEU* nor *BRRU* shocks seem to play a significant effect in shaping the future path of emerging Asian economies GDP growth. Nevertheless, from the G-IRF plots also emerges the increased interdependence among the three groups.

Overall, our findings make evident that knowledge about a wealth of short run indicators for *JEU* countries alone is no longer enough for a good understanding of the world dynamics.

[9] The first-order dynamics is enough to have non-autocorrelated reduced-form residuals.

3. Assessing out-of-sample bridge models' ability in forecasting quarterly world GDP

From this discussion we can conclude that a reliable assessment of the evolution of the global economy cannot be attained by focusing solely on developed countries, at least since the early 2000. Failure to recognize this fact, still not fully taken into account in the recent literature, might seriously bias the analysis. It is however costly to monitor a large number of economies, some of which are relatively little studied and poor in terms of data quality. Here we propose a way of dealing with this problem at a minimum cost.

In short-term forecasting there are two main family of tools commonly used: *bridge models* (BM), based on a small and carefully selected set of indicators, and *factor models* (FM), estimated on a large panel of data.[10] This paper deals essentially with the first one, that has been extensively applied in short run forecasting exercises for the Euro Area, the G7 countries, and Italian GDP; see Baffigi et al. (2004), Golinelli and Parigi (2007; 2008). This choice is motivated by the consideration that BM may be particularly effective in short-term forecasting in emerging economies, where only a limited number of high frequency indicators is generally available. This is confirmed by a IMF (2010) study[11] that develops indicators for tracking growth in various countries: while for advanced economies the use of a large set of variables results in accurate forecasts, results are much poorer for emerging countries.

We build simple bridge models with industrial production (IP) as the only RHS variable[12] to deliver early GDP estimates for *JEU*, *ASE* and *BRRU* countries. We construct a *World Bridge Model* (WBM) whereby World GDP is computed using an aggregator equation of these three country groupings.[13] IP has been chosen since it is reliable as a coincident indicator of GDP and it is usually subject only to small revisions. We focus solely on IP not to incur in the critique of selecting artificially good models (i.e. with best performing indicators) just because our knowledge of "future" (actually past) events creeps into the BM specification. Consequently, one can think of the WBM predictions presented in this and the next section as a lower bound of the forecasting ability of short run indicators. This is confirmed by comparing – over the common sample 2000q1-2003q4 – the forecasting performance of our raw BMs with that of the carefully specified BMs for the advanced countries reported in Golinelli and Parigi (2007). The superiority of the latter BMs in forecasting GDP is manifest: considering the estimates of current GDP growth (the so called nowcast case) carefully chosen indicators reduce the root mean square errors from 0.69 to 0.31 for Japan, from 0.20 to 0.14 for the European Union and from 0.57 to 0.25 for the US.

We define a simple BM for country *i*, as a fourth order autoregressive distributed lags model – ARDL(4,4) – in error-correction form for the log-levels of GDP and IP:

$$\Delta GDP_t^i = \alpha^i + \sum_{j=0}^{3} \beta_j^i \Delta GDP_{t-j}^i + \sum_{j=1}^{3} \gamma_j^i \Delta IP_{t-j}^i + \pi_{GDP}^i GDP_{t-1}^i + \pi_{IP}^i IP_{t-1}^i + \varepsilon_t^i \qquad (3)$$

where $\alpha^i, \beta_j^i, \gamma_j^i$ and π_{GDP}^i, π_{IP}^i are the short- and long-run country specific parameters, and ε_t^i are country specific white noise errors.[14]

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[10] For a comparison and a discussion of BM and DF approaches see Bulligan et al. (2010).

[11] See Appendix 1.2 of Chapter 1 in IMF, WEO October 2010.

[12] Apart from lagged values of the dependent variables.

[13] Examples of aggregator equations can be found in Baffigi et al., 2004, and Golinelli and Parigi, 2007.

[14] Four more parsimonious models, nested in (3), can be obtained by imposing parameter restrictions: (3-i) the ARDL(3,3) in log-levels: ; (3-ii) the ARDL(2,2) in log-levels: ; (3-iii) the ARDL(1,1) in differences (i.e. which omits all log-levels): ; and (3-iv) the static model in differences ARDL(0,0): . We select the best model out of these five alternatives by minimizing the Schwarz criterion, because of our preference for parsimony in forecasting with potentially mis-specified models. Alternative criteria, more prone to (over)fitting, such as Akaike or R^2-bar, would lead to noisier forecasts.

All BMs are conditioned on simultaneous IP (through the β_0^i parameter), which is available well before the GDP data of the corresponding quarter. However, when forecasting the current quarter, usually not all three months are known and, in any case, IP observations cannot be available for further horizons. In these circumstances, missing IP data are forecast by auxiliary models. We consider four alternative scenarios corresponding to different situations of data availability in typical forecasting practices: when forecasting GDP one quarter ahead (*i.e.* in the current quarter), the conditioning IP may be known just for the first month of the quarter, or for the first two, or, finally, for all three months (this is the so called *nowcast*). In the first two instances, IP has to be predicted for two or one step ahead prior to forecasting GDP. More generally, in the h-quarter ahead GDP forecast, when h > 1, IP forecasts are needed at least for (h-1) × 3 months and in the worst case for (h-1) × 3 + 2 months of the forecast horizon.

In all scenarios but the nowcast, auxiliary models are needed, and their reliability in predicting the IP clearly influences the forecasting ability of BMs. In this paper, we use only one auxiliary model: a simple AR(p) for monthly IP log-differences.[15]

For each country, the ordinary least squares (OLS) estimates of both models (AR for IP and BM for GDP) have been obtained through rolling regressions.[16]

The pseudo out of sample forecasting exercise covers 10 years and is structured as follows. October 1999 is the month in which we start to simulate the behavior of a forecaster who wants to predict world GDP ("first round"): IP is available up to August 1999 (1999m8, two months before the calendar date) and GDP up to the second quarter of 1999 (1999q2). In order to obtain predictions over the following two years (2000-2001), IP has to be forecast up to 28 months ahead and BM up to 10 quarters ahead. In this first round, the BM estimation period ends in 1999q2 and starts 80 quarters earlier for *JEU* countries, 60 quarters for the others groups of countries. These steps are repeated for the next 119 months, the latter round being September 2010, when IP is known up to 2010m7 and forecast up to 2011m12 (*i.e.* 16 months ahead) and GDP is known up to 2010q2 and forecast up to 2011q4 (6 quarters ahead).[17]

Though BM are normally used only for short run predictions, nonetheless in each forecast round we extrapolate GDP dynamics up to two years, in order to give an extended assessment of the forecasting ability of our approach at longer horizons.[18] Overall, our exercise delivers 40 pseudo out of sample forecast errors for each of the first three 1-step ahead scenarios described above (120 forecasts errors). In addition, we measure forecast errors for 2-, 4- and 6-steps ahead. We compute statistics about BM forecasting ability (mean error, ME, and root mean squared error, RMSE), and compare them with benchmark models (AR quarterly model for world, *JEU, ASE* and *BRRU* GDP growth rates) using Fair and Shiller (1990), and Giacomini and White (2006) tests (FS and GW henceforth). AR benchmark models are estimated through rolling windows and used in predictions over the same spans of data as those of the BMs.[19]

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[15] Though the retained data transformation is $\Delta_1 log\ IP$, i.e. month-on-month percent variations, we also considered two other data transformations: 12-month differences (i.e. year-on-year percent variations), and both 1 and 12 month variations. Results in terms of IP forecasting ability are little affected by these alternative data transformations.

[16] The size of the rolling widow to estimate AR models parameters is set to 7 years (84 months) for all countries, as in Bulligan *et al.* (2010). To estimate BM model parameters we set windows of 20 years (80 quarters) for the *JEU* countries, to exploit more information under the assumption of stable parameters. To avoid the effects of possible breaks and regime shifts in the *ASE* and *BRRU* specifications we chose a shorter window of 15 years (60 quarters).

[17] A table with a detailed explanation of each forecast round, reporting – at each step – the calendar of data releases for both GDP and IP, together with the AR forecast horizon for IP and the BM forecast horizon for GDP, is available upon request.

[18] Next section will further exploit the 2 year horizon by comparing our forecasts with those of the WEO and *Consensus Forecast*.

[19] In each of the 120 monthly rounds and for each country, the benchmark AR models for first-difference log-GDP are selected by using the Schwarz criterion over a range of lags from 0 to 4.

Along the rows of table 3, we report the results for *JEU, ASE* and *BRRU* and world GDP. Along the columns six different forecast horizons are evaluated: the first three are those described in 1-step ahead scenarios from # 1 to # 3, the following three report the results at longer horizons. Errors are computed as "forecast – actual".

Results show that in the short run, BM forecasts are usually unbiased (see the ME results), and significantly outperform the benchmark. This conclusion is valid for world GDP and across country groups, but is starker for *JEU*, that have normally lower RMSE than *ASE* and *BRRU*. Ratios of BM RMSE over that of AR benchmarks are almost always below one over horizons up to six months, showing a clear deterioration only at the end of the forecasting horizon (six quarters).[20]

Table 3 – Assessment of the forecasting ability of the *Bridge Models*[1]

	GDP forecast horizon					
	1 qrt			*2 qrts*	*4 qrts*	*6 qrts*
	with 1m	*with 2m*	*with 3m*			
World						
ME	0.117	0.121	0.140	0.259	0.437	0.590
RMSE	0.422	0.387	0.370	0.677	1.697	2.551
ratio to AR	**0.710** [a]	**0.651** [a]	*0.622* [a]	**0.606** [a]	0.851 [a]	0.980 [a]
JEU						
ME	-0.063	-0.042	-0.023	-0.102	-0.377	-0.770
RMSE	0.338	0.308	0.277	0.648	1.898	3.029
ratio to AR	**0.590** [a]	**0.534** [a]	**0.481** [a]	**0.554** [a]	0.791 [a]	0.896 [a]
ASE						
ME	0.068	0.038	0.041	0.082	0.193	0.318
RMSE	0.560	0.487	0.477	0.874	1.785	2.577
ratio to AR	0.772 [a]	0.678 [a]	0.664 [a]	**0.688** [a]	0.849 [a]	0.930
BRRU						
ME	0.036	0.037	0.070	0.295	0.782	1.051
RMSE	0.814	0.586	0.546	1.245	3.398	4.633
ratio to AR	**0.692** [a]	*0.503* [a]	0.469 [a]	0.532 [a]	0.788 [a]	0.798 [a]

([1]) Ratios are reported in italic when GW is significant at 10%, in bold when it is significant at 5%; further, **a** means that BM parameter in FS equation is 5% significant while AR is not, **b** both parameters are significant. For GW test, we use the test function $h_t = (1, \Delta L_{t-\tau})$.

BM RMSE are not only better "numerically" than those of AR benchmarks, but – in the light of the GW test – they are very often significantly better than benchmark ones. Furthermore, according to the FS test, BM forecasts are significant explanations of actual GDP development, at least up to one-year, while the significance of benchmark models is often spurious, possibly a consequence of the sharp fall in GDP in 2008-9. For this reason, "b" cases in table 3 (where both the BM and AR parameters are significant in the FS regression) tend to be more frequent in *JEU* countries, where the recession was particularly severe.

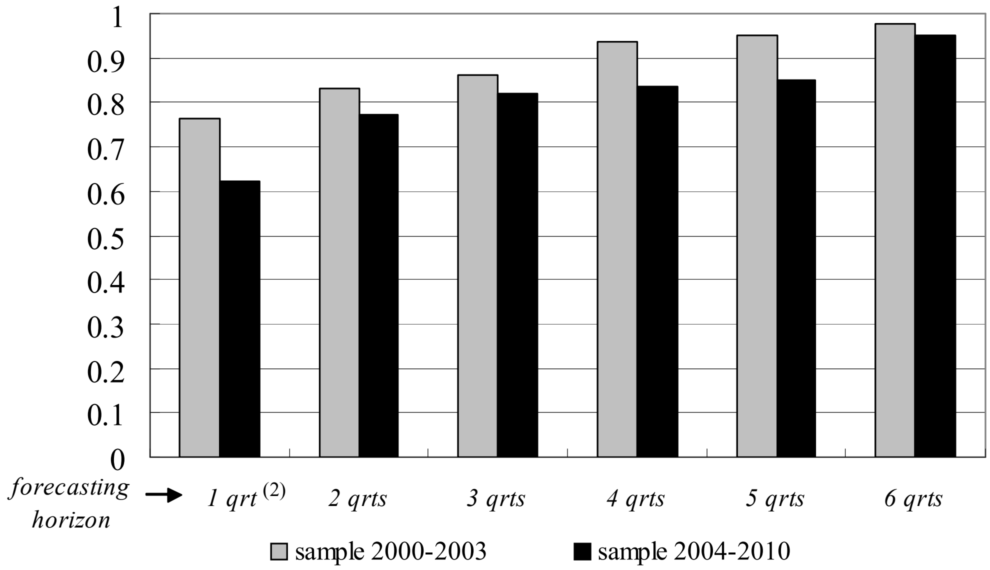
A direct way to assess the important contribution of emerging countries forecast to the prediction of the global outlook is obtained by comparing the WBM predictions of the world output

[20] BM forecasts of the Chinese GDP have a lower RMSE with respect to the other Asian economies and markedly improve with respect to the AR benchmark.

growth either including or excluding the groups of *ASE* and *BRRU* in the aggregator equation. In figure 3 we show the ratios between the RMSE obtained from the more comprehensive model (numerator) and from the model excluding the emerging countries (denominator). RMSE ratios for the different forecasting horizons are computed over two sample periods (2000-2003, histograms in grey, and 2004-2010 in black), to evaluate whether the relevance of emerging markets has increased in most recent years.

All the ratios are lower than one, meaning that the aggregator model which includes also the *ASE* and *BRRU* countries provides more accurate predictions for the world GDP growth. The gain in precision is greater for short term forecasts, attaining the maximum in the nowcast case, while it tends to disappear at longer horizons. The RMSE ratios computed over the second part of the sample (2004-2010) are generally lower than those of the first period (2000-2003). The limited number of observations prevents us from computing tests for the significance of these differences. However, these results confirm the evidence presented so far about the importance of the information content of emerging country dynamics.

Fig. 3 - RMSE ratios between WBM that include or exclude emerging countries(1)



(1) Bars represents the ratios of the RMSE incurred when predicting world GDP with a bridge model that includes emerging economies (*ASE* and *BRRU*) and the RMSE computed when the bridge model includes only advanced economies (*JEU*). Values below 1 prove that the more comprehensive model outperforms the latter. The comparison between grey and black bars, whenever black bars are shorter shows the rising importance of emerging economies. (2) Results refer to the case in which the conditioning IP is known for all three months of the quarter (nowcast).

4. The WBM, *Consensus* and the IMF's WEO forecasts of world GDP

A more stringent test of the usefulness of our simple BM is given by comparing their predictions with those based on much richer information sets, such as the forecasts published by IMF in April and October of each year in the *World Economic Outlook* (WEO), or those published monthly by *Consensus Forecast.* We must stress that our simple WBM is not designed to predict GDP at the horizons typical of the IMF's WEO and *Consensus Forecast*, nor it can compare with them in terms of model complexity and completeness of the information set. Nonetheless, BMs can be seen as a quick update of the bi-annual WEO's forecasts or as a tool to gauge the changes in the *Consensus* monthly predictions.

4.1 *Forecast comparison with the WEO*

Once we are equipped with our WBM[21], we might wonder whether, after the publication of the WEO, there is some use for the WBM as we wait for the next WEO release. More specifically, we perform two exercises:

a) an "*updating exercise*" to assess whether the WBM provides better predictions than what is currently available;

b) an "*anticipating exercise"* to assess the reliability of the WBM in anticipating the predictions that will be published in the next-nearby WEO.

In the *updating* exercise, from October of year *t* to March of *t+1* the WBM "*updates*" 6 times the world output growth forecasts for years *t+1* and *t+2* already published in October of year *t*; similarly, from April to September of year *t+1* it updates 6 times the forecasts published in April *t+1* (see Tab. B5).[22] Similarly, the *anticipating* exercise is structured as follows: from October of year *t* to March of *t+1* our WBM can "*anticipate*" 6 times the world output growth forecasts for years *t+1* and *t+2* that will be published in April of year *t+1*; similarly, from April to September *t+1* we anticipate 6 times the forecasts that will be published in October *t+1.*

Simulations start in October 1999 and end in September 2009. In both cases WBM and WEO forecasts are compared with the final estimates of world GDP growth, taken to be the estimates released for the years 2000-2009 in the most recent WEO (in this case April 2011).

Table 4a. Evaluation of WBM forecast: updating WEO

Month of forecast for WBM	***Month of WEO release used for comparison***	**TARGET YEAR "*t + 1*"**		**TARGET YEAR "*t + 2*"**	
		RMSE of last WEO predictions w.r.t."final" estimates	*RMSE of WBM predictions w.r.t."final" estimates*	*RMSE of last WEO predictions w.r.t."final" estimates*	*RMSE of WBM predictions w.r.t."final" estimates*
October (t)	October (t)	1.53	1.78	–	3.32
November(t)			1.59		3.17
December (t)			1.29		2.86
January (t+1)			1.08		2.92
February (t+1)			1.01		3.01
March (t+1)			0.88		2.91
April (t+1)	April (t+1)	0.56	0.93	2.18	3.26
May (t+1)			0.85		3.20
June (t+1)			0.69		2.78
July (t+1)			0.66		2.66
August (t+1)			0.63		2.53
September (t+1)			0.36		2.13

In the *updating* exercise reported in table 4a, the WBM 1-year ahead predictions (termed *t+1*) appear to be more accurate with respect to the October WEO release already in December of year *t* and through the first months of year *t+1*. On the other hand, the predictions of the April WEO, are

[21] Obviously, what is said here for the WBM can be replicated for the single BMs of countries and country groups.

[22] Hence from October *t* to March *t+1* we "anticipate" 6 times the world output growth forecasts that will be published in April for years *t+1* and *t+2*; similarly, from April to September of year *t+1* we "update" 6 times these forecasts and compare them with those published in October *t+1*. It is worth recalling that April WEO forecasts are based on data available up to March, while October WEO forecasts on data up to September.

outperformed only by the WBM in September of the same year, when sufficient new high frequency information (here IP) dramatically improves WBM accuracy. In the last 3 months of the year (not reported in the table) the WBM accuracy is always significantly superior to the October WEO release as to the prediction of "current" year growth.

Table 4b. Evaluation of WBM forecast: anticipating WEO

Month of forecast for WBM	Month of WEO release used for comparison	TARGET YEAR "t + 1": RMSE of WBM w.r.t. "next-nearby" WEO predictions	TARGET YEAR "t + 1": RMSE of "next-nearby" WEO predictions w.r.t. "final" estimates	TARGET YEAR "t + 1": RMSE of WBM predictions w.r.t. "final" estimates	TARGET YEAR "t + 2": RMSE of WBM w.r.t. "next-nearby" WEO predictions	TARGET YEAR "t + 2": RMSE of "next-nearby" WEO predictions w.r.t. "final" estimates	TARGET YEAR "t + 2": RMSE of WBM predictions w.r.t. "final" estimates
October (t)	April (t+1)	1.69	0.56	1.78	2.85	2.18	3.32
November(t)		1.48		1.59	2.57		3.17
December (t)		1.09		1.29	2.03		2.86
January (t+1)		0.79		1.08	1.73		2.92
February (t+1)		0.57		1.01	1.51		3.01
March (t+1)		0.46		0.88	1.12		2.91
April (t+1)	October (t+1)	0.59	0.40	0.93	1.73	1.84	3.26
May (t+1)		0.52		0.85	1.65		3.20
June (t+1)		0.41		0.69	1.30		2.78
July (t+1)		0.42		0.66	1.22		2.66
August (t+1)		0.46		0.63	1.34		2.53
September (t+1)		0.25		0.36	1.00		2.13

In the *anticipating* exercise, shown in table 4b, the accuracy of the WEO can be compared to two benchmarks: the final estimates of the annual growth (third column in each "target year" section of table 4b), or the next-nearby WEO forecast (first column). Results lend support to the conclusion that the accuracy of WBM forecasts increases as we approach the date of the WEO release, by exploiting more and more monthly information.

Table 5 focuses on what we termed "1-year ahead" prediction, i.e. WBM forecasts for year *t+1* produced in the last 3 months of the previous year and in the months from January till September of the year to be forecast. Monthly WBM forecast errors with respect to the "final" GDP are compared with the WEO ones. In particular, we made the same two different types of check termed above *updating* and *anticipating* the WEO.

In other terms, we compare with a statistical test what is descriptively reported in table 4a and 4b. In both cases, we assess the relative performance of the predictions using a simple forecast encompassing test (see Clements, 2005), which is quite close to that proposed in Fair and Shiller (1990) with the advantage of being based on a more parsimonious model, a particularly welcome characteristic in this context since we have only 10 observations for each variable. For the target-year *t+1* (*t+1* = 2000, 2001,... 2009), we estimate via OLS the following equation:

$$e_{m,t+1}^{WBM} = \lambda \, (e_{m,t+1}^{WBM} - e_{i,t+1}^{WEO}) + e_{m,t+1}^{C} \qquad \begin{array}{l} m = 1,2,3 \ldots 12 \\ i = October \text{ or } April \end{array} \qquad (4)$$

where $e_{m,t+1}^{WBM} = y_{t+1}^{final} - y_{m,t+1}^{WBM}$ is the forecast error of the WBM in month m and $e_{i,t+1}^{WEO} = y_{t+1}^{final} - y_{i,t+1}^{WEO}$ is the WEO forecast error based on predictions published in the issue of month

i (October or April) ; $e^C_{m,t+1}$ is the forecast combination error, to be minimized as a function of the estimated parameter (weight) λ. The hypothesis that WBM forecast encompasses the WEO ones can be tested imposing $\lambda = 0$ in eq. 4.[23] This test was repeated twelve times, for all the months of each year.

If the WBM forecast error is defined – as above – for m = October to December of year t and January to September of year $t+1$, while the WEO one is for i = October of year t and April of year $t+1$, eq. (5) can be used to test for WBM ability to update next WEO, i.e. the first of the two exercises above. Alternatively, if the WBM forecast error is defined for m = October to December of year t and January to September of year $t+1$ and the WEO one is for i = April and October of year $t+1$, eq. (5) can be used to test for WBM ability to predict next-nearby WEO, as stated the second of the two exercises above.

In short, given the same WBM forecast errors in eq. (5), the subject of the two encompassing tests depends on the competing WEO errors: if we use the last published issue errors, we refer to the *updating* exercise, if we use next published issue errors, we refer to the *anticipating* one.

Though we must be cautious because of the lack of data (each regression is run over a sample of only 10 observations), the results are sufficiently clear to detect the WBM ability of efficiently exploit information, when data on GDP are not yet released, while indicators are available (see table 5). WBM forecasts from October of year t to February or March of year $t+1$ encompass WEO ones published in the issue of October of year t.

Table 5 – Evaluating WBM: encompassing WEO [1]

Month of forecast for WBM	*Month of WEO release used for comparison*	TARGET YEAR "$t+1$"							
		World		JEU		ASE		BRRU	
		updating	anticipating	updating	anticipating	updating	anticipating	updating	anticipating
October (t)	*October (t)*	0.090	0.000	0.038	0.000	0.604	0.004	0.266	0.000
November(t)		0.328	0.000	0.103	0.000	0.841	0.009	0.577	0.000
December (t)		0.355	0.000	0.755	0.000	0.381	0.080	0.429	0.000
January (t+1)		0.589	0.000	0.985	0.000	0.002	0.001	0.067	0.130
February (t+1)		0.723	0.000	0.829	0.000	0.000	0.000	0.000	0.007
March (t+1)		0.119	0.000	0.222	0.001	0.000	0.023	0.001	0.039
April (t+1)	*April (t+1)*	0.000	0.000	0.000	0.000	0.047	0.002	0.056	0.000
May (t+1)		0.003	0.000	0.000	0.000	0.105	0.008	0.094	0.000
June (t+1)		0.083	0.000	0.055	0.015	0.201	0.197	0.056	0.001
July (t+1)		0.047	0.000	0.019	0.000	0.246	0.206	0.196	0.000
August (t+1)		0.046	0.003	0.044	0.012	0.235	0.693	0.205	0.002
September (t+1)		0.697	0.690	0.304	0.807	0.575	0.593	0.593	0.028

([1]) P-values of λ significance in equation (4). Under the null, WBM forecast encompasses the WEO ones; see also Clements (2005, p. 15) for details.

WEO forecasts are no more negligible in April, when new IMF predictions are released, but WBM forecasts start encompassing again WEO ones from June to the end of the forecasting exercise. Note that there are a few exceptions to this overall pattern, that repeats itself for world growth and for *JEU, ASE* and *BRRU's* ones, notably results for ASE are less favourable for BM. Given the paucity of data points on which the *p-values* are computed, we cannot deny that the presence of a single outlier might hide an otherwise robust pattern.

[23] See Clements and Hendry (2004). Estimation results in Table 6 are robust to the inclusion of an intercept in the test equation in order to allow for biased forecasts. Though the inference about the λ parameter is based on the Newey and West (1987) heteroskedasticity and autocorrelation-consistent standard error estimates, the reported results are robust to alternative estimates of parameters' variance-covariance matrix.

As to the *anticipating* test, from October of year *t* to March of *t+1*, WBM never encompasses WEO forecasts of world growth in *t +1* released in April of year *t+1*, while at the very end of the forecast round, i.e. since September *t+1*, WBM forecast encompasses the next-nearby WEO (October) forecasts. A similar pattern is detectable also for the *JEU* and *BRRU* aggregates, while for *ASE* BM forecasts encompass the predictions that will be released in the "future" WEO since June of year *t+1*.

Overall, we can conclude that, in order to predict the current year, WBM forecasts are generally better than previous WEO ones, with the exception of the months immediately after the April release. If we want to anticipate the world GDP forecast published in October WEO, then only the WBM predictions made since September (when two quarters of GDP and also one month of the third quarter of IP are known) appear to be more accurate. In the *anticipating* exercise, BM forecasts turn out to be a particularly effective tool, in comparison with the WEO benchmark, in predicting the GDP of emerging economies, in particular for the *ASE* group.

Table 6 – Comparison of BM and *Consensus Forecasts* RMSE[1]

Month of forecast	TARGET YEAR *"t + 1"*							
	World		JEU		ASE		BRRU	
	BM	*Consensus*	BM	*Consensus*	BM	*Consensus*	BM	*Consensus*
October (t)	1.78	1.76	1.89	1.50	1.68	1.97	3.52	3.20
November(t)	1.59	1.65	1.66	1.32	1.56	1.91	3.31	3.01
December (t)	1.29	1.54	1.25	1.10	1.38	1.83	2.78	2.79
January (t+1)	1.12	1.46	1.15	0.98	1.54	1.76	1.87	3.22
February (t+1)	1.04	1.41	0.98	0.73	1.65	1.69	1.55	3.27
March (t+1)	0.92	1.38	0.80	0.52	1.63	1.67	1.59	2.93
April (t+1)	0.97	1.38	0.99	0.46	1.47	1.67	1.59	2.70
May (t+1)	0.89	1.40	0.98	0.47	1.32	1.54	1.53	2.37
June (t+1)	0.72	1.38	0.59	0.51	0.85	1.48	1.20	2.10
July (t+1)	0.69	1.38	0.57	0.49	0.81	1.38	1.11	1.82
August (t+1)	0.66	1.35	0.49	0.46	0.74	1.22	1.09	1.72
September (t+1)	0.38	1.27	0.32	0.43	0.74	1.17	0.79	1.47

(1) Data taken from *Consensus Forecasts* various years. The comparison is made on the sample (1999-2010)

We extended the analysis to *Consensus* predictions. Each month we compared the RMSE of the BM estimates for GDP in year t+1 (along the lines seen above for the comparison with the WEO) with that of the monthly forecasts of *Consensus* (see Table 6). BM perform in line or better than Consensus in most cases (results for the "world" might be biased by the different set of countries considered by *Consensus Forecasts*), hence we find some comfort also here in our reliance on these simple tools to have a quick update of the conjunctural situation. What really matters here, however, is not establishing if one method is clearly superior to the other: the main advantage of the BM consists in the possibility of relating changes in the predictions to changes in the conditioning variable (in the simplest case, IP) rather than just deriving it from black box expert judgment.

It is worth observing that even though we not take into account data revisions, as it uses latest available GDP time series, this fact does not necessarily lead to an artificial improvement of our models forecasting ability. In fact, Croushore and Stark (2001 and 2002) modelling US GDP growth do not find a significant difference between the forecast errors generated using real-time data or latest-available data. The same result is broadly confirmed for other industrialised countries, (see e.g. Golinelli and Parigi, 2008, for the Italian case).[24]

4.2 Forecast performance during the recession: WBM, WEO and Consensus

During the recession of 2007-09 the main forecasting institutions performed particularly poorly, facing a sequence of unprecedented shocks not comparable with those included in the sample period normally used for forecasting (see Visco, 2009). It is therefore interesting to check if the bridge models proposed here, although very simple and not tailored for predicting next year growth, could have made a reasonably good job in tracking the evolution of the world economy during the crisis. The sharp slowdown in world GDP growth occurred in 2009 proved particularly hard to anticipate, as shown in table 7. We therefore select this year for our "recession tracking" exercise.

Table 7 – April's WEO forecast errors for next year annual growth

WEO's release	***Forecast for target year***	***Final estimate***	***Forecast error***
Apr. 2006 (*Target: 2007*)	4.7	5.2	0.5
Apr. 2007 (*Target: 2008*)	4.9	3.0	-1.9
Apr. 2008 (*Target: 2009*)	3.8	-0.6	**-4.4**

Source: IMF and authors computations

To monitor the forecasting performance of the WBM we plot in Figure 4 the monthly predictions of 2009 GDP growth computed over the January 2008 - December 2009 period. We compare BMs with the WEO, considering this time also the "updates" published between the main releases of IMF forecasts.[25] We also look at *Consensus Forecasts* published monthly for all the countries considered in this paper. The prediction of annual GDP growth for the world (and for *JEU, ASE* and *BRRU*, see appendix B) were obtained as a weighted sum of those of the countries involved, with weights given by 2000 GDP shares at PPP.[26]

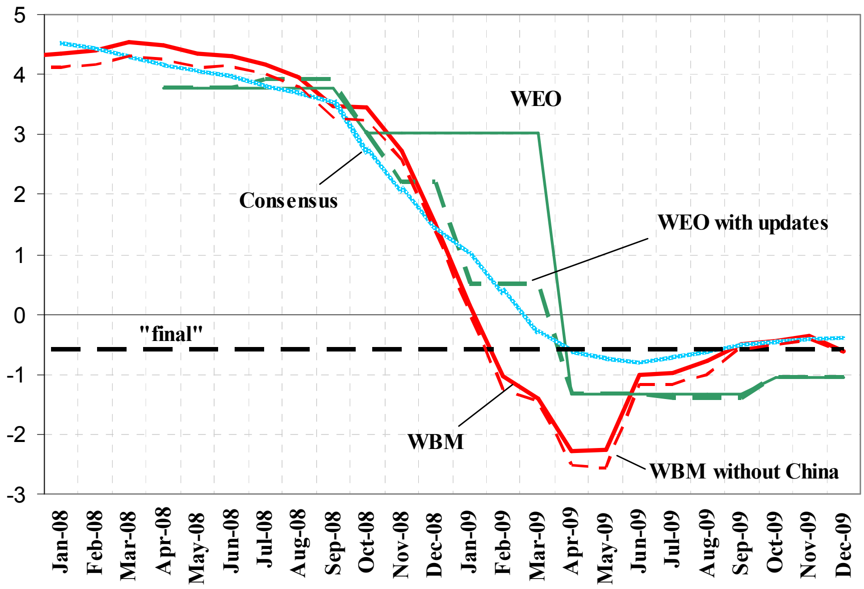
As shown in the graph (figure 4), only at the end of the summer of 2008 the models started signaling a deceleration in growth. By the end of that year it became clear that the economic slump was much harsher than previously envisaged. Quite surprisingly, our simple BMs did not perform visibly worse than *Consensus* or the *WEO* (considering the updates to the world outlook).

[24] This conclusion must be qualified. Since no direct evidence is available for emerging countries – at least as far as we know – it might well be that, though unlikely given the wealth of studies on industrial economies, the conclusion could be reversed for emerging countries.

[25] During this period the IMF published forecasts updates every other quarter, thus effectively providing a new scenario for the world outlook every 3 months. Since the IMF started only recently to issue Interim forecasts it was not possible to consider them when analyzing the BMs ability to *update* and *anticipate* the WEO.

[26] As *Consensus* does not publish world output growth, we computed it as the weighted sum of the following countries: USA, Japan, Germany, France, United Kingdom, Italy and Spain (for JEU), and the four single BRIC countries. Weights – constant over time – are derived from IMF (2010), World Economic Outlook, April, p. 148.

Fig. 4 - Comparison of WBM monthly forecasts patterns of World GDP growth for 2009 with WEO and *Consensus* predictions [1]



([1]) The horizontal axis measures the calendar dates in which the forecasts are made. WBM line measures the forecasts made with bridge models in rounds # 97-120 (see Appendix B). WEO plot measures the forecasts released by IMF. The latest available data are those published in WEO of April 2010.

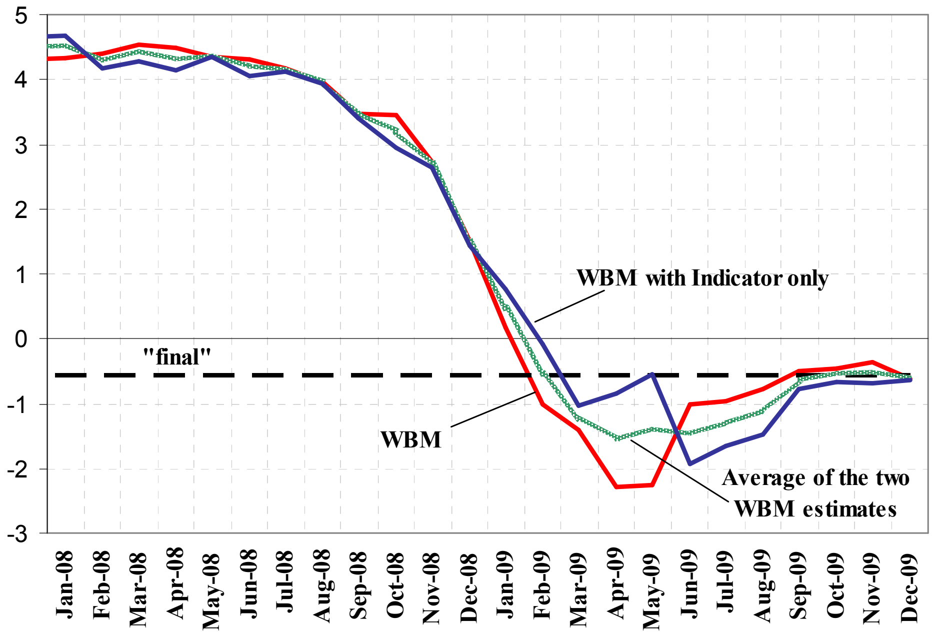
Nonetheless, a disturbing feature of the WBM behaviour is the considerable undershooting in the spring of 2009, when the US (and probably the world) economy reached a trough according to the NBER business cycle dating.[27] Our BMs – being based solely on industrial production that was hit much harder than the other sectors – are bound by design to produce a starker slump. We might suspect that a richer specification of the BMs would contribute to reduce the undershooting. It is interesting to look at countries and groupings (see figure B2 in appendix B) and observe that the underprediction was strong for advanced countries (both *JEU* and Asian *NIE*s), where services play a larger role in economic growth, while it was nil in the case of China, whose growth is largely determined by manufacturing output and exports.

To verify the soundness of our presumption, we introduce a new indicator in our BMs to account for economic developments over and above industrial production. For most countries we considered a PMI or similar statistics, to exploit information coming directly from firms and not confined to production activity (see table A3 for a complete list).[28] As expected, taking into account also the indicator, reduces the undershooting of the BMs. In particular the forecast combination of the original BM (based only on IP) and of the BM based only on the new indicator gives the best results by greatly reducing the undershooting of the predictions (Fig. 5). This is true not only for the world GDP, but also for the main countries and groupings considered here (see figure B2 in the appendix).

[27] The NBER dating committee has recently agreed to pinpoint June 2009 as the trough month in the US for the recession started in December 2007, according to the same institution (see http://www.nber.org/cycles/sept2010.html).

[28] Detailed results for the period 2006-2010 of the forecasting performance of our original BMs (based solely on IP) as well as the BM based on the indicator, on both IP and the indicator and on the forecast combination of the first two are available upon request. As a general conclusion, the BM that includes both indicators outperforms all the others over the period considered, even though, as a rule, BM_ip far outperforms BM_ind. However – focusing only on the time span used in our graphical analysis – the forecast combination is superior to all other three.

Fig. 5 - Comparison of monthly forecasts patterns of World GDP growth for 2009 among different WBM specifications [1]



(1) The horizontal axis measures the calendar dates in which the forecasts are made. WBM line measures the forecasts made with bridge models in rounds # 97-120 (see Appendix B).

5. Conclusions

Over the last fifteen years financial and economic globalization proceeded at high speed. New actors appeared on the scene of the world economy, moving rapidly to the center stage. China and the other East Asian emerging economies (together with Brazil and Russia), nowadays play a determinant role in all economic *fora*. The greater relevance acquired by the G20, that has *de facto* taken the place of the G8, is a product of this evolution and at the same time it confirms the deep changes occurred in the economic and political landscape.

The analysis of the global economic developments must not ignore these changes. This is true also for the assessment of its short run evolution. In the first part of this paper we showed that a break occurred in the relationship between world GDP and that of the main advanced countries (Japan, the EU and the US). We also showed that this break is due to the increased weight of the Asian emerging economies, characterized by a markedly different cyclical pattern (the *emerging Asia effect*). This implies that considering only the economic situation of the most advanced country (as in Golinelli and Parigi, 2007; and Arouba and Diebold, 2010) might give a biased picture of the main trends at global level.

Exploiting simple bridge models, we provide a natural and easy way to tackle this new environment. The models proposed have been deliberately kept very simple, in order to show the advantage of our approach without unavoidably incurring in criticisms of using *ex post* knowledge in the specification of the models ("data mining"). We also show how the inclusion of information on emerging markets improves the accuracy of world GDP forecasts.

A problem arises, though, when dealing with the world economy: the lack of a benchmark variable at higher frequencies (say, quarterly) with which to evaluate the reliability of the tools proposed for the assessment of the current situation. The solution given in this paper has been to compare our forecasts with those periodically published by international institutions, such as the

IMF's WEO or *Consensus*. Bridge models estimates fare well with respect to the WEO forecasts, both as an updating (the most recent WEO forecasts) and as an anticipating (the next WEO forecasts) device. They also stand a comparison with *Consensus Forecasts.* Forecasting accuracy, however, is not the whole story: the value of bridge model estimates lies also in the their real time availability and in the extreme simplicity of the computations.

The comparison with broad based forecasts stressed the importance of employing a set of indicators covering most economic sectors. Our simple models consider only industrial production, which clearly provides a partial view of the evolution of the economic activity at least in advanced countries. This is the main reason for the undershooting of bridge models estimates during the crisis of 2009. Introducing, in this latter case, an extra variable that takes into account the confidence effects (PMI), gives rise to better results.

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Appendix A – Data sources

We collected the longest available series of both quarterly GDP and monthly IP for: US, European Union, Japan, Brazil, Russia, China, India, Indonesia, Malaysia, Thailand, Philippines, Hong Kong, Singapore, Korea and Taiwan.

GDP quarterly data. Il *National Institute of Economic and Social Research* (NIESR) provides quarterly world GDP data which are coherent with annual WEO figures. Regarding the other 15 countries/areas we used the respective sources, listed in Table A1. In order to have comparable GDP national levels, we re-scaled all the "final" quarterly GDP time series to match the 2000 annual levels expressed in international Dollars (PPP), as they are reported by the IMF's WEO.

IP monthly data. The source of data for US, European Union, Japan, Brazil, India and Russia is the OECD Main Economic Indicators (MEI) database, the series selected is *production of total industry, seasonally adjusted (2005=100)*. Data for this series are available at least since 1975 with only two exceptions: India, whose series starts in 1994 and Russia, whose series starts in 1993. For India data from 1960 to 1993 are constructed using the growth rates of the corresponding series published by the IMF's International Financial Statistic (seasonally adjusted with X12 ARIMA). In the case of Russia data are backcasted to 1989 using the monthly interpolation (quadratic match sum) of Bessonov (2002, Tab. 4) annual growth rates. China IP data rely on a series built by the Bank of Italy, data prior to 1989 are constructed using the growth rate of electricity consumption. Other Asian countries' IP series (Indonesia, Malaysia, Thailand, Philippines, Singapore, Korea and Taiwan) we used the respective national sources, listed in Table A2.. Monthly data for Indonesia (prior to 1994) and Philippines (prior to 1995) are backcasted using the monthly interpolation (quadratic match sum) of the available quarterly growth rates. Monthly data for Malaysia (prior to 1990) are backcasted using the monthly growth rate of the nominal sales deflated by CPI. For Hong Kong, IP data are replaced by the series (available from 1983) of cement production (volume index).

Table A1 – GDP National sources [1]

country	seasonality [2]	from-to	source
US	sa	1947-2010	The Real-Time Data Research Center, Federal Reserve Bank of Philadelphia.
EU 15	sa	1960-2010	OECD Stats
Japan	sa	1960-2010	OECD Stats
Brazil	sa	1996-2010	OECD, National Accounts for Non-Member Economies
	sa	1980-1995	Institute of Applied Economic Research (IPEA), Presidencia da Republica, Brasil
	sa	1951-1979	quarterly interpolation (quadratic match sum) of Maddison's annual growth rates
Russia	sa	1995-2010	OECD, National Accounts for Non-Member Economies
	sa	1951-1994	quarterly interpolation (quadratic match sum) of Maddison's annual growth rates
China	nsa	1999-2010	NBS China, not seasonally-adjusted y-o-y growth rate
	nsa	1978-1998	Abeysinghe and Gulasekaran (2004), and updates on Tilak Abeysinghe's webpage
	sa	1952-1977	quarterly interpolation (quadratic match sum) of Maddison's annual growth rates
India	sa	1996-2010	OECD, National Accounts for Non-Member Economies
	sa	1983-1996	Vineet and Kapoor (2003)
	sa	1951-1982	quarterly interpolation (quadratic match sum) of Maddison's annual growth rates
Indonesia	nsa	2000-2010	Badan Pusat Statistik
	nsa	1975-1999	Abeysinghe and Gulasekaran (2004), and updates on Tilak Abeysinghe's webpage
Malaysia	nsa	2000-2010	Department of Statistics, Malaysia
	nsa	1975-1999	Abeysinghe and Gulasekaran (2004), and updates on Tilak Abeysinghe's webpage
Philippines	sa	1992-2010	National Statistics Coordination Board
	nsa	1975-1991	Abeysinghe and Gulasekaran (2004), and updates on Tilak Abeysinghe's webpage
Thailand	sa	1993-2010	Office of National Economic and Social Development
	nsa	1975-1992	Abeysinghe and Gulasekaran (2004), and updates on Tilak Abeysinghe's webpage
Hong Kong	nsa	1973-2010	Census and Statistics Departments
Singapore	sa	1975-2010	Department of Statistics, Singapore
Korea	sa	1970-2010	The Bank of Korea
Taiwan	nsa	1961-2010	Directorate General of Budget, Accounting and Statistics

([1]) When more sources are listed for the same country, the most recent source is "backcasted" by using the growth rates of the other available sources after comparability checks for the overlapping periods. ([2]) Not seasonally adjusted (nsa) data are filtered by using X12 ARIMA.

Table A2 – Industrial Production Indices of other Asian countries - National sources [1]

country	description	seasonality (2)	from-to	source
Indonesia	Industrial production index, volume	nsa	1994-2010	Badan Pustat Statistik
Malaysia	Industrial production index, volume	nsa	1990-2010	Department of Statistics, Malaysia
Philippines	Manufacturing industrial production index, volume	nsa	1995-2010	Philippines National Statistical Office
Singapore	Industrial production (excluding rubber) index, volume	nsa	1983-2010	Department of Statistics, Singapore
South Korea	Industrial production index, volume	sa	1980-2010	Kostat - Department of Statistics, Korea
Taiwan	Industrial production index, volume	nsa	1971-2010	MOEA, Ministry of Economic Affairs
Thailand	Manufacturing industrial production index, volume	nsa	1987-1999	Bank of Thailand
	Manufacturing industrial production index, volume	nsa	2000-2010	OIE, Ministry of Industry of Thailand
Hong Kong	Cement production	nsa	1983-2010	Census and Statistics Department, Hong Kong

([1]) When more sources are listed for the same country, the most recent source is "backcasted" by using the growth rates of the other available sources after comparability checks for the overlapping periods. ([2]) Not seasonally adjusted (nsa) data are filtered by using X12 ARIMA.

Table A3 – Additional Indicators - National sources [1]

country	description	seasonality	from-to	source
US	Manufacturing Purchasing Managers Index (PMI)	sa	1980-2010	Institute for Supply Management (ISM)
EU 15	Consumer Confidence Index	sa	1985-2010	The European Commission, OECD
Japan	Consumer Confidence Index	nsa	1980-2010	Cabinet Office, Government of Japan
Brazil	Units of automobiles sold	nsa	1980-2010	National Association of Automobile Manufacturers of Brazil
Russia	Crude Oil-Brent Price (FOB) U$/Barrel	nsa	1990-2010	ICIS Pricing
China	Consumer Expectation Index	nsa	1990-2010	National Bureau of Statistics of China
India	Real Bank Credit to the Commercial Sector (M3), in real terms (WPI deflated)	nsa	1994-2010	Reserve Bank of India
Indonesia	Commercial Banks' Outstanding Credits to Individuals, in real terms (CPI deflated)	nsa	1995-2010	Bank Indonesia
Malaysia	Commercial Banks' Loans, in real terms (CPI deflated)	nsa	1990-2010	Bank Negara Malaysia
Philippines	Net Domestic Credits to the Private Sector, in real terms (CPI deflated)	nsa	1990-2010	Central Bank of the Philippines
Thailand	Construction Area Permitted, Whole Kingdom	nsa	1990-2010	Bank of the Thailand
Hong Kong	Electricity Consumption of the Commercial Sector	nsa [1]	1990-2010	Hong Kong Census and Statistics Department
Singapore	Commercial Banks' Loans, in real terms (CPI deflated)	nsa	1990-2010	Monetary Authority of Singapore
Korea	Business Survey, Domestic Sales Index, all industries.	nsa [1]	1990-2010	Federation of Korean Industries (FKI)
Taiwan	Loans and Discounts at Domestic Banks	nsa	1990-2010	Central Bank of the Republic of China (Taiwan)

([1]) In these case, not seasonally adjusted (nsa) data are filtered by using X12 ARIMA.

Appendix B – Additional tables and graphs

Table B1 - China's weight in each country/group total
(values in current US dollars, percent shares)

	Import			
	1995	**2000**	**2005**	**2008**
EU	4.4	6.7	11.8	13.3
USA	6.3	8.6	15.0	16.5
Japan	10.8	14.5	21.1	18.8
NIES[(1)]	11.3	14.9	23.0	25.2
Other Developing Asia[(2)]	7.2	4.8	10.1	12.5
Russia	1.6	2.8	7.3	13.0
Brazil	0.8	2.2	7.3	11.6
	Export			
	1995	**2000**	**2005**	**2008**
EU	2.5	2.5	4.0	4.8
USA	2.0	2.1	4.7	5.6
Japan	5.0	6.3	13.5	16.1
NIES[(1)]	10.9	13.0	24.3	26.3
Other Developing Asia[(2)]	2.8	4.3	8.3	8.7
Russia	5.4	3.9	4.6	5.3
Brazil	2.6	2.0	5.8	8.3

source: UN Comtrade

(1) It includes Hong Kong, Rep. of Korea, Singapore, Taiwan.

(2) It includes India, Indonesia, Malaysia, Philippines, Thailand and Viet Nam.

Table B2 – Explaining the World GDP growth : estimation results[1]

dependent variable: **World GDP growth**

	(1)	(2)	(3)	(4)
Sample period	**1979 Q1-2010 Q1**	**1979 Q1-1993 Q4**	**1994 Q1-2010 Q1**	**(3)−(2)**
observations	125	60	65	
constant	0.0008	0.0019	-0.0016	-0.0035
	(0.0045)	(0.0017)	(0.002)	(0.0026)
JEU GDP growth	0.5188 ***	0.8214 ***	0.5376 ***	-0.2838 **
	(0.1291)	(0.0877)	(0.0866)	(0.1211)
ASE GDP growth	0.2150	-0.0001	0.4186 ***	0.4186 ***
	(0.2971)	(0.114)	(0.1213)	(0.1636)
BRRU GDP growth	0.1403 ***	0.0683 *	0.0649 *	-0.0035
	(0.0362)	(0.041)	(0.0416)	(0.0591)
sum of *w(i)*	0.8740	0.8896	1.0210	
	(0.1775)	(0.0923)	(0.1169)	
Godfrey AC (p-val):				
- 1st order	0.0851	0.7470	0.6772	
- 4th order	0.2781	0.8677	0.0773	
Andrews breakpoint:				
- Sup F-statistic ((p-val)	0.0000	0.1477	0.0952	
Hausman test:				
- weak exogeneity	0.0267			

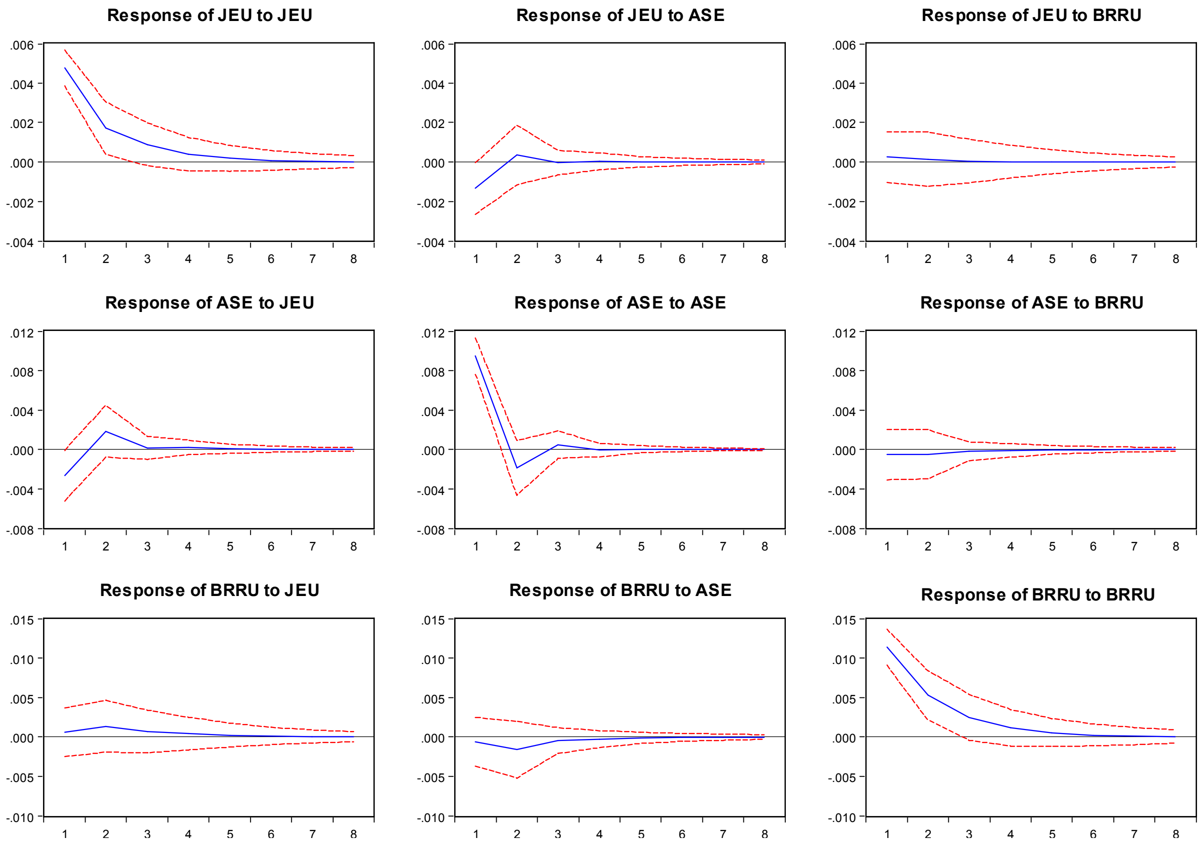
[1] HAC standard errors are reported in brackets.

Table B3 – The dynamic relationship among country groups: VAR estimation results

	(1)	(2)	(3)
Sample period	**1979 Q1-2010 Q1**	**1979 Q1-1993 Q4**	**1994 Q1-2010 Q1**
observations	125	60	65
Standard errors			
- JEU equation	0.004	0.005	0.004
- ASE equation	0.009	0.009	0.008
- BRRU equation	0.013	0.011	0.012
Godfrey AC (p-val):			
- 1st order	0.794	0.647	0.114
- 4th order	0.746	0.093	0.099
Non Granger causality NGC (p-values)			
- ASE NGC JEU	0.002	0.147	0.006
- BRRU NGC JEU	0.280	0.886	0.035
overall in JEU equation	0.005	0.347	0.006
- JEU NGC ASE	0.154	0.210	0.710
- BRRU NGC ASE	0.646	0.566	0.747
overall in ASE equation	0.360	0.409	0.818
- JEU NGC BRRU	0.141	0.574	0.194
- ASE NGC BRRU	0.151	0.459	0.001
overall in BRRU equation	0.113	0.584	0.001
Correlation between VAR shocks			
- JEU, ASE	-0.027	-0.280	0.296
- JEU, BRRU	0.191	0.053	0.294
- ASE, BRRU	0.101	-0.054	0.131

Figure B1 – Impulse-response from VAR(1) estimates: response to generalized one S.D. Innovations ± 2 S.E.

Sample period 1979q1 - 1993q4



Sample period 1994q1 - 2010q1

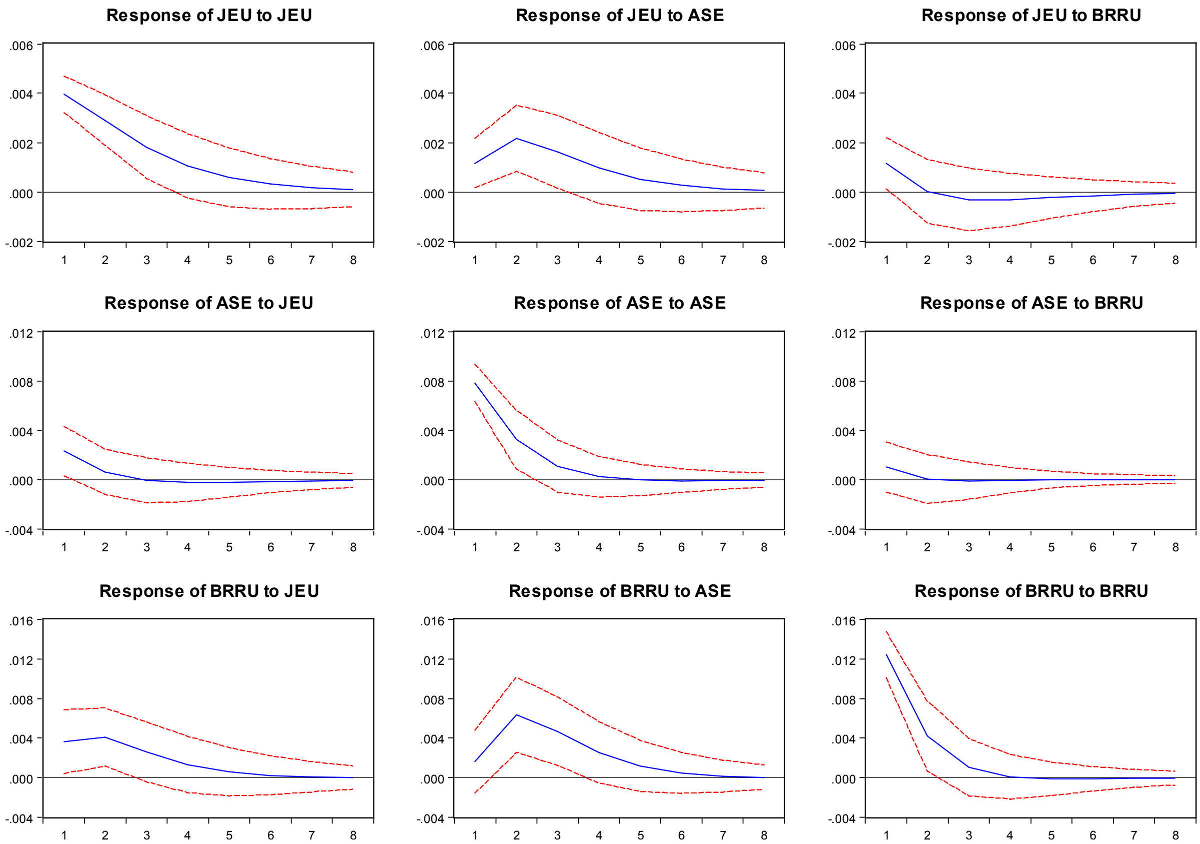


Table B4 – Assessment of the forecasting ability of the Bridge Models for selected countries[(1)]

	GDP forecast horizon					
	1 qrt			*2 qrts*	*4 qrts*	*6 qrts*
	with 1m	*with 2m*	*with 3m*			
USA						
ME	-0.481	-0.500	-0.500	-0.901	-1.750	-2.360
RMSE	0.688	0.691	0.675	1.236	2.889	4.657
ratio to AR	0.957 [a]	0.926 [a]	0.903 [a]	0.819 [a]	0.858 [b]	**0.930** [b]
EU						
ME	-0.243	-0.243	-0.238	-0.615	-1.686	-3.250
RMSE	0.645	0.619	0.612	1.282	3.041	4.972
ratio to AR	0.834 [a]	0.803 [b]	0.795 [b]	0.744 [b]	0.818 [b]	0.864 [b]
Japan						
ME	-0.011	-0.023	-0.027	-0.089	-0.310	-1.182
RMSE	1.490	1.504	1.512	2.047	3.488	5.393
ratio to AR	*0.675* [b]	*0.682* [b]	*0.685* [b]	0.589 [b]	0.524 [b]	0.583
China						
ME	0.209	0.168	0.167	0.372	0.543	0.503
RMSE	0.805	0.778	0.779	1.385	2.131	2.637
ratio to AR	0.864 [a]	0.841 [a]	0.842 [a]	0.841	0.845	**0.773** [b]
India						
ME	0.276	0.406	0.350	0.401	0.383	-0.086
RMSE	1.187	1.233	1.199	1.812	2.808	3.034
ratio to AR	1.031	1.043	1.014	0.991	*0.974*	**0.915**
Korea						
ME	-0.295	-0.250	-0.209	-0.410	-0.761	-0.813
RMSE	1.247	0.872	0.779	1.701	5.076	8.479
ratio to AR	0.774 [a]	0.542 [a]	0.484 [a]	*0.622* [b]	1.171 [b]	1.521
Brazil						
ME	0.321	0.340	0.291	0.591	1.047	0.785
RMSE	1.760	1.607	1.622	2.683	4.102	4.065
ratio to AR	0.983	0.918	0.926	**0.889**	**0.948**	0.918
Russia						
ME	-0.607	-0.519	-0.516	-1.286	-3.606	-7.607
RMSE	1.668	1.367	1.370	3.190	9.451	15.540
ratio to AR	0.964	0.814 [a]	0.816 [a]	0.843 [a]	1.261	1.631

(1) Ratios are reported in italic when GW is significant at 10%, in bold when it is significant at 5%; further, [a] means that BM parameter in FS equation is 5% significant while AR is not, [b] both parameters are significant. For GW test, we use the test function $h_t = (1, \Delta L_{t-\tau})$.

Tab. B5 – Timing of the monthly forecast activity and corresponding WEO forecasts

Month of forecast for WBM	*Month of WEO release used for comparison*		*IP*		*GDP*		*Years predicted*
	Updating	*Anticipating*	*Last available month*	*forecast horizon (in months)*	*data availability*	*Last available quarter*	
October (t)	***October (t)***	***April (t+1)***	**m8**	**28**	**q2**	**10**	**t+1, t+2**
November(t)			m9	27	q2	10	t+1, t+2
December (t)			m10	26	q3	9	t+1, t+2
January (t+1)			m11	25	q3	9	t+1, t+2
February (t+1)			m12	24	q3	9	t+1, t+2
March (t+1)			m1	23	q4	8	t+1, t+2
April (t+1)	***April (t+1)***	***October (t+1)***	**m2**	**22**	**q4**	**8**	t+1, t+2
May (t+1)			m3	21	q4	8	t+1, t+2
June (t+1)			m4	20	q1	7	t+1, t+2
July (t+1)			m5	19	q1	7	t+1, t+2
August (t+1)			m6	18	q1	7	t+1, t+2
September (t+1)			m7	17	q2	6	t+1, t+2

Table B6 – Evaluating WBM: encompassing WEO and tracking the crisis in 2008-09

JEU(1)

Month of forecast for WBM	*Month of WEO release used for comparison*	TARGET YEAR *"t + 1"*					
		USA		EU		JAPAN	
		updating	anticipating	updating	anticipating	updating	anticipating
October (t)	*October (t)*	0.003	0.000	0.162	0.000	0.004	0.000
November(t)		0.004	0.000	0.787	0.000	0.002	0.000
December (t)		0.071	0.000	0.000	0.000	0.050	0.000
January (t+1)		0.101	0.000	0.577	0.008	0.377	0.000
February (t+1)		0.253	0.000	0.542	0.004	0.829	0.001
March (t+1)		0.187	0.000	0.487	0.013	0.007	0.000
April (t+1)	*April (t+1)*	0.000	0.000	0.001	0.003	0.006	0.005
May (t+1)		0.000	0.000	0.002	0.004	0.000	0.001
June (t+1)		0.000	0.000	0.047	0.038	0.013	0.002
July (t+1)		0.000	0.001	0.401	0.000	0.117	0.036
August (t+1)		0.000	0.000	0.991	0.095	0.172	0.054
September (t+1)		0.005	0.251	0.906	0.147	0.582	0.201

ASE(1)

Month of forecast for WBM	*Month of WEO release used for comparison*	TARGET YEAR *"t + 1"*							
		INDIA		CHINA		KOREA		INDONESIA	
		updating	anticipating	updating	anticipating	updating	anticipating	updating	anticipating
October (t)	*October (t)*	0.322	0.015	0.006	0.002	0.345	0.003	0.016	0.000
November(t)		0.136	0.009	0.023	0.006	0.638	0.011	0.038	0.000
December (t)		0.004	0.516	0.110	0.002	0.870	0.007	0.350	0.010
January (t+1)		0.048	0.618	0.027	0.000	0.000	0.007	0.191	0.002
February (t+1)		0.057	0.969	0.016	0.001	0.000	0.009	0.081	0.010
March (t+1)		0.205	0.047	0.000	0.000	0.000	0.038	0.017	0.008
April (t+1)	*April (t+1)*	0.030	0.003	0.001	0.001	0.000	0.000	0.006	0.000
May (t+1)		0.023	0.002	0.007	0.005	0.065	0.000	0.007	0.000
June (t+1)		0.006	0.000	0.434	0.146	0.560	0.015	0.000	0.000
July (t+1)		0.016	0.002	0.524	0.351	0.202	0.003	0.000	0.000
August (t+1)		0.021	0.008	0.344	0.238	0.004	0.002	0.000	0.000
September (t+1)		0.408	0.342	0.038	0.028	0.150	0.129	0.079	0.000

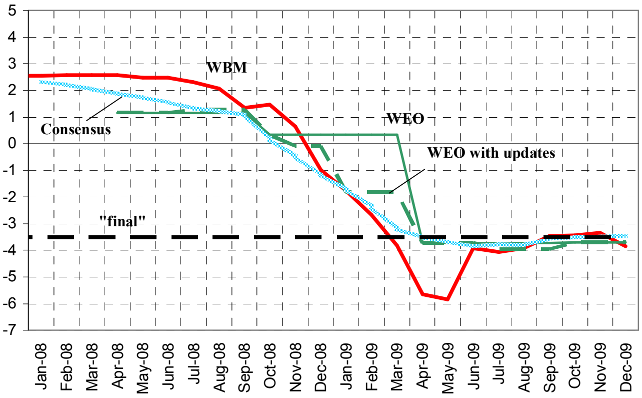
BRRU(1)

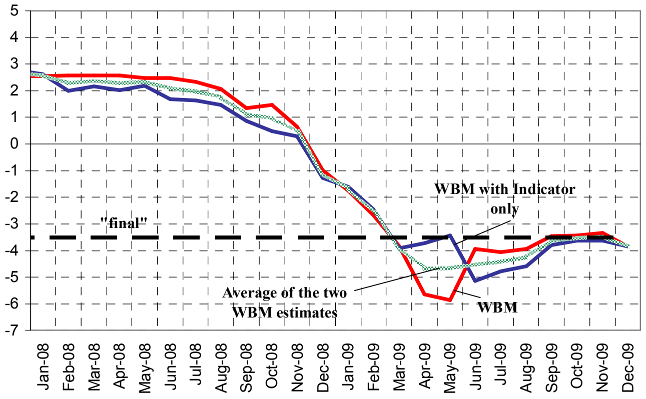
Month of forecast for WBM	*Month of WEO release used for comparison*	TARGET YEAR *"t + 1"*			
		BRAZIL		RUSSIA	
		updating	anticipating	updating	anticipating
October (t)	*October (t)*	0.298	0.000	0.128	0.000
November(t)		0.384	0.000	0.155	0.000
December (t)		0.087	0.000	0.979	0.000
January (t+1)		0.880	0.003	0.057	0.025
February (t+1)		0.019	0.024	0.935	0.001
March (t+1)		0.004	0.019	0.023	0.929
April (t+1)	*April (t+1)*	0.126	0.000	0.758	0.000
May (t+1)		0.965	0.014	0.448	0.000
June (t+1)		0.468	0.069	0.000	0.000
July (t+1)		0.260	0.652	0.206	0.004
August (t+1)		0.534	0.199	0.203	0.021
September (t+1)		0.829	0.082	0.489	0.994

(1) P-values of lambda significance in equation (4). Under the null, WBM forecast encompasses the WEO ones; see also Clements (2005, p. 15) for details.

Figure B2 - Comparison of monthly forecasts patterns of World GDP growth for 2009 among different WBM specifications, WEO and *Consensus* predictions.

JEU





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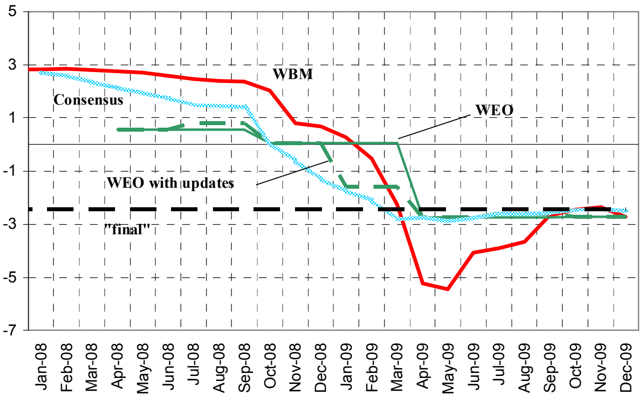

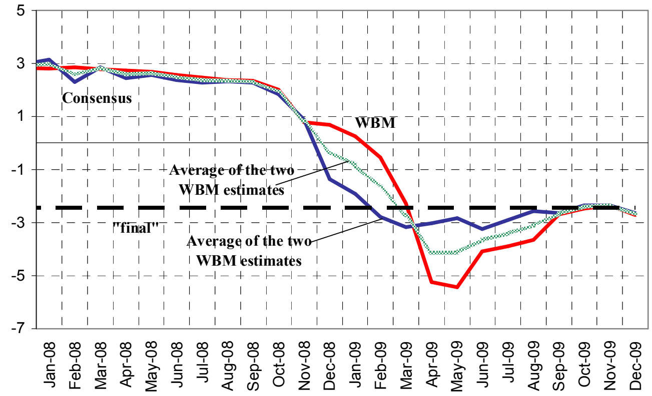

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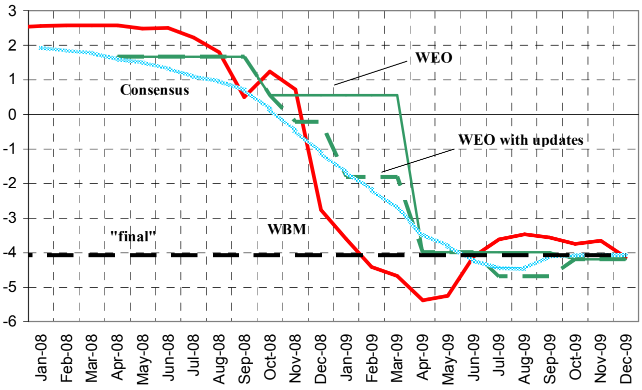


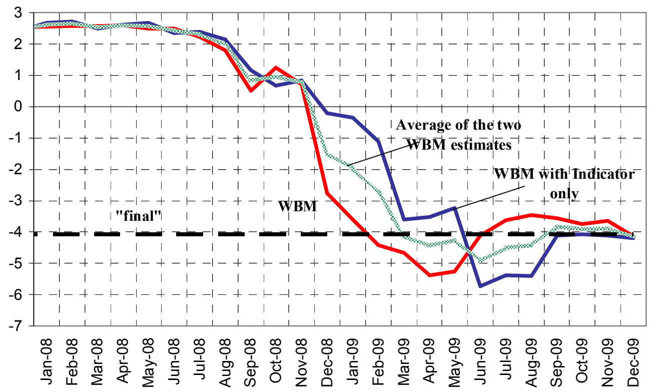
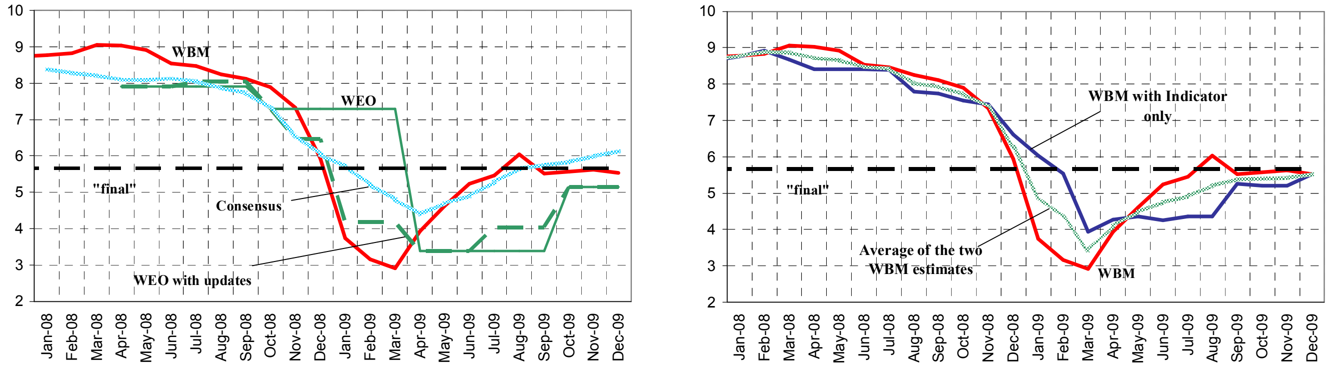


Figure B2 – *continued*

ASE



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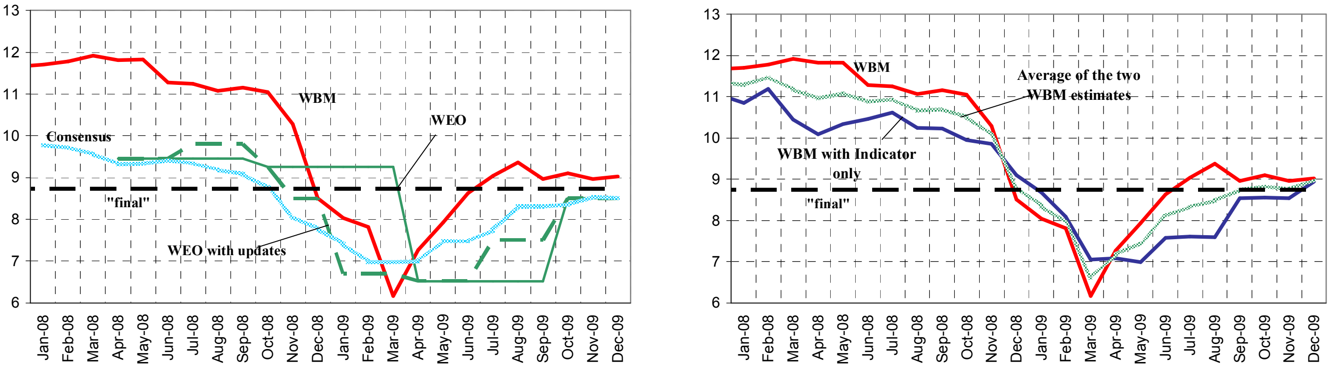

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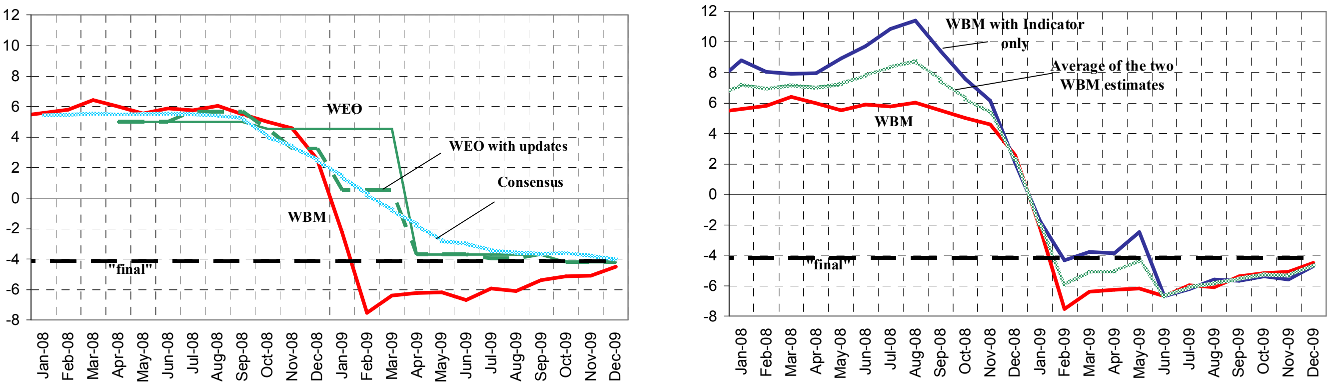

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