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Yannick LE PEN et Benoît SEVI

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Centre de Recherche en Economie et Droit de l'Energie
CREDEN – Equipe ART Dev – Université Montpellier 1
Faculté d'Economie, Av. Raymond Dugrand, C.S. 79606
34960 Montpellier Cedex 2, France
Tél. : 33 (0)4 34 43 25 04

Macro factors in oil futures returns*

Yannick Le Pen†

Université Paris Dauphine
yannick.le_pen@dauphine.fr

Benoît Sévi‡

Aix-Marseille School of Economics
benoit.sevi@univ-amu.fr

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Abstract

We investigate the macro factors that can explain the monthly oil futures return for the NYMEX WTI futures contract for the time period 1993:11 to 2010:03. We build a new database of 187 real and nominal macroeconomic variables from developed and emerging countries and resort to the large factor approximate model to extract 9 factors from this dataset. We then regress crude oil return on several combinations of these factors. Our best model explains around 38% of the variability of oil futures return. More interestingly, the factor which has the largest influence on crude oil price is related to real variables from emerging countries. This result confirms the latest finding in the literature that the recent evolution in oil price is attributable to change in supply and demand conditions and not to the large increase in trading activity from speculators.

JEL Classification: C22, C32, G15, E17.
Keywords: crude oil futures, large approximate factor models, macro determinants.

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†Université de Paris Dauphine, LEDa-CGEMP, Place du Maréchal de Lattre de Tassigny, 75775 Paris Cedex 16 and Chaire Economie du Climat.

‡Château La Farge, Route des Milles, 13290 Aix-en-Provence Les Milles, France.

Résumé

Nous évaluons l'importance des variables macroéconomiques des économies développées et émergentes dans la détermination des rendements du contrat futures WTI échangé sur le NYMEX pour la période allant de novembre 1993 à mars 2010. À cette fin, nous construisons une nouvelle base de données mensuelles de 187 variables macroéconomiques, réelles et nominales, de pays développés et émergents. Le modèle à facteurs approximés nous permet d'extraire 9 facteurs représentant un pourcentage significatif de l'information contenue dans cette base. Nous considérons un grand nombre de spécifications à partir de cet ensemble de facteurs. Notre meilleur modèle explique environ 38% de la variabilité des rendements du pétrole. De plus, le facteur ayant le pouvoir explicatif le plus élevé est lié aux variables réelles des pays émergents. Ce résultat confirme les dernières analyses académiques donnant aux modifications de l'offre et de la demande, dus notamment à la croissance des économies émergentes, une influence supérieure à celle des activités spéculatives dans la détermination du prix du pétrole.
Mots-clés: marché à terme du pétrole, modèles à facteurs approximés, déterminants macroéconomiques.

1 Introduction

Crude oil is by far the most traded commodity around the world and the evolution of its price is of utmost importance for almost all economies. The large increase in the trading activity of financial agents on the crude oil market has led the financial press to consider these speculators as responsible for the dramatic increase in price of the late 2000s.[1] Recent academic literature has examined the possible role for speculation in shaping the price of oil. In particular, Büyükşahin *et al.* (2008), Hamilton (2009), Kilian (2009), Büyükşahin and Harris (2011), Parsons (2010), Kaufmann (2011) and Tang and Xiong (2011) report empirical findings that lead to consider the dramatic increase of trading activity in the NYMEX WTI futures contract as a minor factor in the 2008 price peak formation. The authors show that among traders, the category of speculators has grown spectacularly but resorting to causality analysis, they do not identify any effect going from speculation to price. Further analysis in, for instance, Hamilton (2009) attributes the 2008 oil price increase to what is called a "demand shock" which may have its origin in Asia and more particularly in China.[2]

These results lead to a fundamental question: how is crude oil price determined if not by speculation?[3] Indeed, if the increasing presence of funds, bankers and swaps dealers, among others, in the futures market did not cause the crude oil price increase in 2008, one may wonder what are the determinants of the oil price which is a critical input in almost all our macroeconomic models. This question has been partially answered in Kilian and Vega (2011) who do not find evidence of an impact of macroeconomic announcements on daily price changes in the oil spot market. Because the authors only consider the spot market and U.S. macroeconomic news, their findings are doubtful or at least incomplete. Indeed, macroeconomic news may well have an impact on longer maturity futures contracts and U.S. news may well be only part of the story. We partly extend their analysis in searching for macroeconomic determinants of oil return.

This article tries to answer two empirical questions. First, how useful is a large set of international real and nominal variables in explaining crude oil return? To handle these variables, we resort to the large factor approximate model which allows to sum up the informational content of these variables by a reduced number of factors. Hence our second question: how can we interpret the factors that have the best explanatory power? To address these two questions, we gather an alternative database to the widely-used, but mainly focused on the U.S. economy, Stock and Watson (2002) dataset. Our aim is to take into account macroeconomic and financial variables that are more likely to influence the WTI futures prices which is a world reference (and the most traded futures contract for commodities around the world). More precisely, we include macro data from emerging countries. We then use factors extracted from this dataset as explanatory variables for oil return and show that a selection of 4 factors is able to explain almost 38% of the variability of our endogenous variable.

The present work may also be a first step in performing a forecasting exercise of crude oil price based on large factor models.[4] If our estimated factors are able to explain a significant part of the variability

[1] Zagaglia (2010) provides references of press articles supporting this view.

[2] A recent model exploiting the literature on limits-to-arbitrage (Acharya *et al.*, 2011) shows how the hedging component and the speculative behavior of agents can influence commodity prices. An empirical examination of their model using available stocks for oil and gas support their theoretical developments. In what follows, we also consider stocks in the analysis but do not retain the specification using this variable as it doesn't improve the explanatory power.

[3] The standard analysis of macro factors for crude oil returns is in, for instance, Brown and Yücel (2002) or Lescaroux and Mignon (2008). Discussion in these papers leads to consider variables such as those related to demand and supply, some real variables and other monetary aggregates.

[4] We develop this point further in the concluding section.

of oil return in-sample, they are also likely to have good properties out-of-sample, namely in forecasting the evolution of oil price. This may be of interest for exporter countries (see Borensztein *et al.*, 2009) which may hedge more efficiently their commodity exposure.

As noted in Borensztein and Reinhart (1994, p. 237): "The conventional analysis of commodity markets mimics the empirical strategy applied to other key macroeconomic variables-namely, to try to identify a stable and predictable relationship between commodity prices and two or three macroeconomic variables." To circumvent the weakness of considering a low number of macroeconomic variables *a priori*, Pindyck and Rotemberg (1993) rely on a latent factor model. More recently, Zagaglia (2010) uses the large dimensional approximate factor analysis to deal with the issue of preselecting variables. This strategy allows to incorporate a much larger quantity of information while keeping the number of parameters at a reasonable level. Nevertheless, Zagaglia (2010) has been criticized in Alquist *et al.* (2011) as he uses only variables related to the U.S. economy. While of crucial importance for the determination of the NYMEX WTI price, these variables are not likely to be the sole factor in the determination of the oil price. In particular, real and nominal variables (production indices, exportations and importations, exchange rates, stock indices, etc.) from developing economies may well play a major role in shaping the evolution of crude oil price. In spirit, the criticism of considering only U.S. variables is already considered, but in a different setting from ours, in the early contribution of Borensztein and Reinhart (1994) where the authors extend their demand-supply variables to variables of Eastern Europe and the former Soviet Union. We follow the same path in including in our factor analysis variables from several important economies around the world.

As a consequence, in this paper, we follow the recommendation in Alquist *et al.* (2011) to construct a worldwide database to include information from a large number of countries whose economies are likely to have a significant impact on crude oil demand side.[5] As such, we will be able to investigate whether international variables have, through our estimated factors, an explanatory power for oil return. Just to give a sketch of our results, we will show that variables of emerging countries indeed play a major role in explaining oil return. Differentiating between real and nominal variables, we further show that the former play a major role in influencing the price of oil.

Our methodology closely follows Ludvigson and Ng (2009). We give our preference to a static factor model which is easier to estimate and has shown to have comparable performance with dynamic factor models (Forni *et al.*, 2005) even when the dynamic structure of the data is known. In addition, Boivin and Ng (2005) showed that the Stock and Watson (2002) static factor model has superior forecasting properties compared to dynamic factor model when the dynamic properties of data are unknown. In this case, static factors are less vulnerable to specification issues and thus deliver better forecasts.

The idea behind using factors is that they may represent latent variables that are likely to drive oil price but are not observable. Using factor models, we avoid to choose *a priori* a set of existing variables which is a difficult task particularly when the number of potential variables is large and when most of

[5]Alquist *et al.* (2011, p. 67) note: "The more important problem from an economic point of view, in any case, is forecasting the real price of oil. It seems unlikely that approximate factor models could be used to forecast the real price of oil. The variables that matter most for the determination of the real price of oil are global. Short of developing a comprehensive worldwide data set of real aggregates at monthly frequency, it is not clear whether there are enough predictors available for reliable real-time estimation of the factors. For example, drawing excessively on U.S. real aggregates as in Zagaglia (2010) is unlikely to be useful for forecasting the global price of oil for the reasons discussed in section 4. Using a cross-section of data on energy prices, quantities, and other oil-market related indicators may be more promising, but almost half of the series used by Zagaglia are specific to the United States and unlikely to be representative of global markets."

them only contribute marginally to the evolution of the endogenous variable. In addition, as noted in Zagaglia (2010, p. 410) about the error-in-variables (EIV) problem, the interest of using factor models is that "[...] the use of sparse information in the form of factors extracted from a large dataset mitigates this [EIV] problem."[6]

The present work is the first to consider factors that are likely to affect oil price using international macroeconomic and financial variables. We extend the recent analysis in Zagaglia (2010) to deal with a larger number of variables but also, and equally importantly, to include real and nominal variables from emerging countries that are likely to drive oil prices in light of the energy-intensity of these economies. In addition, in contrast with Zagaglia (2010), we give a much larger place to variables that are not oil or derivatives of oil time series thereby enlarging greatly the scope of the analysis.

Our analysis is not only useful for economic analysis but also for investment purpose. Gorton and Rouwenhorst (2006) establish interesting properties of commodities for diversifying a portfolio of financial assets. In particular they emphasize the counter-cyclical aspect of commodity returns. In periods of recession, when the diversifying feature of assets is the most desired, the excess return of commodities is positive and thus compensate the bad performance of standard financial assets. As such, our analysis provides a better understanding of the variables that are able to explain crude oil return and also documents the factors that are possibly behind the counter-cyclical effect.

The paper is set out as follows. The next section presents the approximate factor model methodology. Section 3 is devoted to a brief presentation of the data and in particular, the newly constructed international database. In Section 4, we develop the empirical analysis with two distinct steps: first, the formal determination of the number of factors using statistical tools and second, the interpretation of the chosen factors using a simple procedure that will be described below. The last section provides concluding remarks with an emphasis on the potential of approximate large factors models for the purpose of forecasting oil prices, which is a very challenging issue.

2 Approximate factor model

Factor models allow to deal with a large number of series while avoiding the number of degrees-of-freedom problem.[7] This method is relevant to the estimation of latent common factors likely to affect changes in crude oil price. Each variable depends on a small number of common factors and its idiosyncratic error, the purpose being to estimate these common factors. Classical factor analysis is a rather well known method in statistics but its basic assumptions are too restrictive for economic time series[8]. Stock and Watson's (2002a,b) "large dimensional approximate factor model" alleviates these assumptions: the sample size tends to infinity in both directions in asymptotic theory and idiosyncratic errors are allowed to be cross-sectionally or serially "weakly correlated" . We do not present factors further and refer the interested reader to the excellent surveys of Stock and Watson (2006) or Bai and Ng (2008) which emphasize on economic applications.

[6] See also Bernanke *et al.* (2005) on this issue.

[7] The critics addressed by Wheatley (1989) to latent variables models (interpretability, etc.) could well be translated to factor models, but we believe that when the point is to aggregate information from a series of economic and financial variables, factors do a reasonable job and the fact that they could not be identified is of minor importance. Latent-factors models have been used in Bekaert and Hodrick (1992), Pindyck and Rotemberg (1993) and more recently in Ludvigson and Ng (2007), among many others.

[8] In the classical factor analysis, factors and idiosyncratic errors are assumed to be serially and cross-sectionally uncorrelated and the number of units of observations N is supposed to be fixed.

We dispose of a sample of $\{x_{it}\}$ variables where $i = 1, ..., N$ denotes cross-section units and $t = 1, ..., T$ time series observations. Each x_{it} can be modelled as:

$$x_{it} = \lambda_i^{'} F_t + e_{it}$$

F_t is the vector of the *r* common static factors and λ_i is the factor loadings for cross sectional unit ***i***. e_{it} is referred to as the idiosyncratic error. Note that factors and loading matrix are not identified unless we impose enough constraints.

Let $X_t = (x_{1t}, ..., x_{Nt})'$, $e_t = (e_{1t}, ..., e_{Nt})'$ and $\Lambda = (\lambda_1, ..., \lambda_N)'$, we have the vector form notation :

$$X_t = \Lambda F_t + e_t$$

If we assume that F_t and e_t are uncorrelated and have zero mean and make the normalisation $E(F_t F_t') = I_d$, we have:

$$\Sigma = \Lambda\Lambda' + \Omega$$

where Σ and Ω respectively denote the population covariance matrices of X_t and e_t.

Under the assumption of *k* factors, the $T \times k$ matrix F^k of factors and the corresponding $N \times T$ loading matrix Λ^k are estimated through the principal component method. These estimates solve the following optimization problem :

$$\min S(k) = (NT)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \lambda_i^{k'} F_t^k)^2$$

subject to the normalization $\Lambda^{k'} \Lambda^k / N = I_k$.

If we define X as the $T \times N$ matrix with t^{th} row $X_t^{'}$, this classical principal component problem is solved by setting $\hat{\Lambda}^k$ equal to the eigenvectors of the largest *k* eigenvalues of $X'X$. The principal components estimator of F^k is given by:

$$\hat{F}^k = N^{-1} X' \hat{\Lambda}^k$$

Computation of $\hat{F}^k$ requires the eigenvectors of the $N \times N$ matrix X'X. When $N > T$, a computationally simpler approach uses the $T \times T$ matrix XX'.

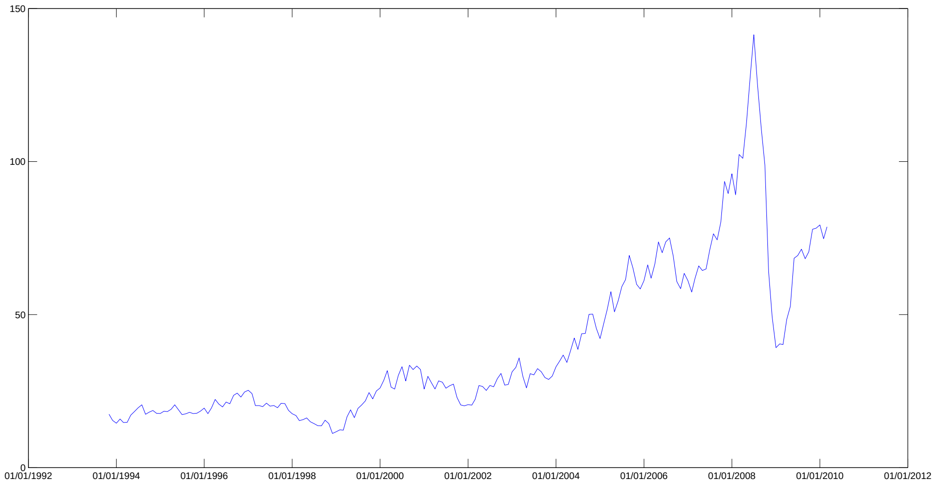
Consistency of the principal component estimator as $N, T \to \infty$ has been demonstrated by Stock and Watson (2002a) and Bai and Ng (2002). Bai (2003) gives the asymptotic distribution of the principal component estimator.

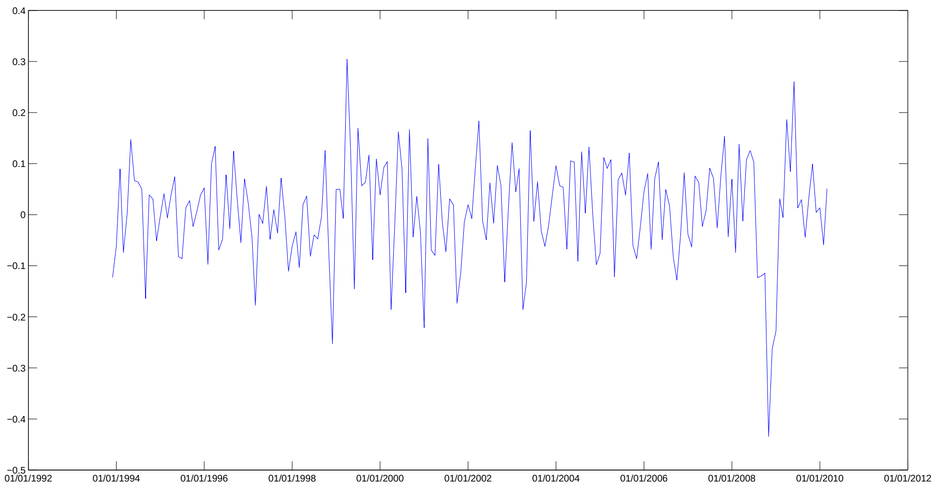
3 Data

In this section, we discuss the oil price data and the set of macroeconomic variables to be used in the empirical work to model crude oil return. A continuous series of monthly futures prices for the NYMEX WTI is extracted from DataStream. To achieve continuity, a rollover procedure is implemented so as to consider the most active contract at all time. Our time period runs from 1993:11 to 2010:03, which gives 197 monthly observations. As many of our macroeconomic variables are only observed at a monthly frequency, we use monthly oil price. As is common, return is computed as the price log difference. Price and return are displayed on Figure 1. The price figure displays the 2008 peak.

Figure 1

NYMEX WTI crude oil monthly prices (upper graph) and returns (lower graph) over the period 1993:12-2010:03. Source: DataStream.





Standard descriptive statistics for return are reported in Table 1. They show evidence of excess kurtosis and negative skewness. Not surprisingly, the Jarque-Bera test rejects the hypothesis of a Gaussian distribution. Some heteroscedasticity in the data may explain this non-normality as well as the presence of extremes (outliers). We do not explore the issue of heteroscedasticity here as it is not our primary interest which is to model crude oil return conditional expectation and not higher moments.

Table 1
Descriptive statistics for monthly crude oil returns (1993:12-2010:3).

	$r_{oil,t}$
Mean	0.0077
Maximum	0.3045
Minimum	-0.4340
Std. Dev.	0.0991
Skewness	-0.5770
Kurtosis	4.6766
Jarque-Bera	33.83*
Nb of Obs	196

Note:(i) $r_{oil,t}$ denotes crude oil return. It is computed as the price log differences. (ii) "*" denotes a rejection of the null hypothesis of a Gaussian distribution at the 5% level.

In the empirical analysis presented in the next section, factors are extracted from a large panel of 187 macroeconomic and financial variables from developed and emerging countries. Our data set differs in its composition and time period from the widely known data set of Stock and Watson (2005) and its extension by Ludvigson and Ng (2009).[9] These two datasets mainly consist in U.S. data. As our aim is to include variables that are likely to influence crude oil return, we have included data from the main developed economies (128 variables) and also from emerging countries (59 variables). Therefore our dataset is representative of the world economy and high-level demand from emerging countries will be included in the information conveyed by estimated factors. These variables can also be classified into 103 real variables (73 for developed countries, 30 for emerging countries) and 84 nominal variables (55 for developed countries and 29 for emerging). For obvious reasons, we are constrained in our search of data for emerging countries but we try to make as much as possible a balanced panel. All data are extracted from DataStream. The list of these data is given in the appendix where a coding system indicates how the data were transformed so as to ensure stationarity. All of the raw data are standardized prior to estimation.

Following the analysis in Boivin and Ng (2006), we do not include as many variables as possible. Indeed, including too many variables may be particularly detrimental to the forecasting performance of the model. While we do not make any forecast in the present paper, we nevertheless pursue the logic of including a limited number of variables so as to render our study useful for future forecasting work. In addition, it is found in the empirical literature that including too many variables rarely lead to a better explanatory power. In a recent paper by Caggiano *et al.* (2011), the authors give a strong empirical support for the Euro area to the findings in Boivin and Ng (2006). Thinking that similar findings may be obtained for our world dataset, we limit the number of variables to be included in the computation of our static factors.

[9] The original data set in Stock and Watson (2005) covers the period 1959:01 to 2003:12. It is slightly shortened in Ludvigson and Ng (2009) to cover the period 1964:01 to 2007:12.

4 Empirical implementation

4.1 Estimating the number of factors

We use Bai and Ng (2002) information criteria and Kapetanios (2009) sequential test to determine the number of factors. We briefly describe these two approaches and then present our results.

Bai and Ng (2002) information criteria are an extension to factor model of usual information criteria. If we note $\hat{S}(k) = (NT)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \hat{\lambda}_i^{k\prime} \hat{F}_t^k)^2$ the sum of squared residuals (divided by *NT*) when *k* factors are considered, the information criteria have the following general expressions:

$$\begin{aligned} PCP_i(k) &= \hat{S}(k) + k\bar{\sigma}^2 g_i(N,T) \\ IC_i(k) &= \ln(\hat{S}(k)) + k g_i(N,T) \end{aligned}$$

where $\bar{\sigma}^2$ is equal to $\hat{S}(k_{max})$ for a pre-specified value k_{max} and $g_i(N,T)$ is a penalty function. We allow a maximum of $k_{max} = 20$ factors and apply the four penalty functions $g_i(N,T), i = 1,..,4$ proposed by Bai and Ng (2002). The estimated number of factors is chosen to minimize the aforementioned information criteria.

We also apply Kapetanios (2009) sequential test for determining the number of factors. This test is based on the property that if the true number of factors is k_0, then, under some regularity conditions, the first k_0 eigenvalues of the population covariance matrix Σ will increase at rate *N* while the others will remain bounded. If we denote by $\hat{\lambda}_k, k = 1,...,N$ the *N* eigenvalues of the sample covariance matrix Σ, the difference $\hat{\lambda}_k - \hat{\lambda}_{k^{max}+1}$ will tend to infinity for $k = 1,...,k_0$ but remain bounded for $k = k_0+1,...,k_{max}$ where k_{max} is some finite number such that $k_0 < k_{max}$. The null hypothesis that the true number of factors k_0 is equal to k ($H_{0,k} : k_0 = k$) against the alternative hypothesis ($H_{1,k} : k_0 > k$) is therefore tested with the test statistics $\hat{\lambda}_k - \hat{\lambda}_{k^{max}+1}$. If there is no factor structure, $\hat{\lambda}_k - \hat{\lambda}_{k^{max}+1}$ properly normalized by a sequence of constant $\tau_{N,T}$ should converge to a law limit. In the presence of factors, it should tend to infinity. The law limit as the rate of convergence $\tau_{N,T}$ have to be estimated by resampling technique. The test procedure is sequential. In a first step, we test ($H_{0,k} : k_0 = k = 0$) against ($H_{1,k} : k_0 > 0$). If we reject the null hypothesis, then we consider the null ($H_{0,k} : k_0 = k+1 = 1$). We stop once we cannot reject the null hypothesis. Kapetanios names this algorithm the MED (maximal eigenvalue distribution) algorithm.

The estimated numbers of factors are displayed in Table 2. There is clearly no agreement on the optimal number of factors. This result is similar to previous empirical works which show that there is a great instability in determining the correct number of factors. According to Bai and Ng (2002) information criteria, the optimal number of factors runs from the 2 to 9. The Kapetanios test gives a number of 2 factors. Some information on the autocorrelation and the explanatory power of estimated factors $\widehat{F}_t$ are displayed in Table 3. We can note that the first 3 factors only explain 20 % of the variance of the 187 data while we reach 36% with 9 factors. We decide to consider the set of the first 9 factors as potential set of regressors. Factors autocorrelations up to 3 lags also provided in Table 3 show that most factors appear to be persistent.

Table 2
Static factors selection results

Method	No of static factors
MED	2
IC_1	3
IC_2	2
IC_3	20
IC_4	20
PCP_1	9
PCP_2	7
PCP_3	20
PCP_4	20

Notes: MED denotes the number of factors given by the Maximum eigenvalue algorithm. IC_i and PCP_i respectively denote the number of factors given by the information criteria IC and PCP estimated with penalty function $g_i(N, T)$.

Table 3
Summary statistics for $\widehat{F}_{t,i}$ for $i = 1, ..., 9$

factor *i*	ρ_1	ρ_2	ρ_3	R_i^2
1	0.1614	0.1256	0.3176	0.0975
2	0.1357	0.0805	0.3110	0.1619
3	-0.0748	0.0145	-0.0294	0.2030
4	-0.0765	-0.0910	0.1508	0.2355
5	-0.2180	-0.0763	0.1213	0.2654
6	0.1801	0.0388	0.0267	0.2927
7	0.0721	0.2765	0.2744	0.3185
8	0.4086	0.5013	0.3332	0.3418
9	-0.0066	-0.0305	-0.0379	0.3636

Note: For *i* = 1,..,9, $\hat{F}_{it}$ is estimated by the method of principal components using a panel of data with 187 indicators of economic activity from 1993:12 to 2010:03 (196 time-series observations). The data are transformed (taking logs and differenced where appropriate) and standardized prior to estimation. ρ_i denotes the i^{th} autocorrelation. The relative importance of the common component,R_i^2, is calculated as the fraction of total variance in the data explained by factors 1 to *i*.

4.2 Specification search

We now describe our specification search procedure. As a preliminary analysis, we regress crude oil return on each of the 9 factors and consider each R^2 and $\bar{R}^2$ as a measure of the explanatory power of each individual factor. Results show that factor $\hat{F}_t^1$ has the largest explanatory power[10] while factors 3 and 9 have almost none, so we exclude these latter from our potential regressors. We consider all combinations of the 7 remaining factors and select the subset which minimizes the BIC criterion, as in Stock and Watson (2002) and Ludvigson and Ng (2009). According to this criterion, we choose the set of 4 factors $\hat{F}_t = (\hat{F}_t^1, \hat{F}_t^2, \hat{F}_t^4, \hat{F}_t^7)'$ and estimate by OLS the following regression:

$$r_{oil,t} = \alpha + \beta \hat{F}_t + u_t = \alpha_1 + \beta_1 \hat{F}_t^1 + \beta_2 \hat{F}_t^2 + \beta_4 \hat{F}_t^4 + \beta_7 \hat{F}_t^7 + u_t$$

Our estimates are reported in Table 4.[11] We explore a number of specifications where power transfor-

[10] $\hat{F}_t^1$ alone explains 14.3 % of the variation of crude oil return.
[11] We add other possible extra explanatory variables (see Brown and Yücel (2008) for a justification for the case of natural gas).

mations of estimated factors are used as in Ludvigson and Ng (2009) to consider potential nonlinear effects. We do not report results here as nonlinear specifications have not a better explanatory power than linear ones.

Table 4
OLS results for regression of the oil futures returns on selected factors (1993:12 to 2010:03).

	$r_{oil,t}$
Intercept	0.0077
	(1.38)
$\widehat{F}_1$	-0.1217*
	(-7.49)
$\widehat{F}_2$	-0.1489*
	(-7.95)
$\widehat{F}_4$	0.0957*
	(3.07)
$\widehat{F}_7$	0.1454*
	(4.13)
R^2	0.3787
$\overline{R}^2$	0.3657

Notes: (i) t-statistics are reported in parenthesis under the estimates. A constant whose estimate is reported in the second row is always included in the regressions. (ii) For each test *, **, and *** respectively denotes rejection of the null hypothesis at the 1%, 5% and 10% levels.

Each factor is significant and the R^2 of the regression equals 37.87 % (the adjusted R^2 is 36.57%) which is quite satisfying in light of the noisy nature of monthly returns. In addition, recall that we do not use oil price series which would increase the R^2 as in Zagaglia (2010) as they do not represent macro factors. However, it is not possible to interpret the sign of the estimated coefficients for the factors as the latter cannot be identified. In the next section, we present a simple method which could be used to give an interpretation of these factors.

4.3 Interpreting the estimated factors

Ludvigson and Ng (2009) suggest a simple method to interpret the estimated factors. In practice, we regress each original variable on a single factor to measure the correlation between the former and the latter. Then, after sorting the variables along the horizontal axis say beginning with real variables and then with nominal variables, it is graphically possible to show the variables for which the highest R^2 are obtained. The factor can then be considered as representative of this set of variables. We classify our 187 series into four categories according to the characteristics real variable/nominal variable and developed countries/emerging countries. A finer classification would be difficult to illustrate and is relevant, in our opinion, only when a single country is at play.[12] The R^2 from the regressions of each of the 187 variables on each of the four factors $\hat{F}_t^1, \hat{F}_t^2, \hat{F}_t^4$ and $\hat{F}_t^7$ considered separately are displayed on Figure 2.

Factor $\hat{F}_t^1$ can easily be interpreted as a real factor as it has its highest explanatory power for real vari-

We add monthly stock/inventories changes computed as $\Delta s_{it} = log(S_{i,t}/S_{i,t-1})$ where $S_{i,t}$ stands for the stock level at date t (these data are extracted from the US Department of Energy website) and a dummy variable for the disruption in oil caused by Hurricanes Ivan in September 2004 and Katrina in August 2005. However these variables are not significant.

[12] Ludvigson and Ng (2009) indeed rely on a finer classification but only use U.S. variables. We do not think that this methodology is applicable when several economies are considered if we want to preserve some interpretability.

ables. To be more precise, $\hat{F}_t^1$ is mostly correlated with real variables from emerging countries[13]. The correlation of $\hat{F}_t^1$ with crude oil return can be interpreted as an evidence of the growing weight of emerging countries in oil imports during the time period considered. This finding is the most important result of the paper and it is new in the economic literature, to our best knowledge. Importantly, it may explain the rather weak support of previous studies to the common thinking that oil prices are mainly driven by speculative activity and not by real supply and demand variables.

Factor $\hat{F}_t^4$ reaches its highest explanatory power for nominal variables, especially for developed countries. It can therefore be interpreted as a "nominal" factor. Factors $\hat{F}_t^7$ and $\hat{F}_t^2$ are more difficult to characterize as their explanatory power do not clearly cluster around a set of variables. $\hat{F}_t^7$ reaches its highest explanatory power for a limited set of real variables from developed countries but no obvious interpretation can be given to $\hat{F}_t^2$.

Our results thus give a strong support to the theories in Hamilton (2009) and Kilian (2009) that emerging economies through an increasing demand for oil are responsible for the evolution of oil price in recent years. In particular, because we include in our database a number of Asian variables, it seems that their explanatory power is rather large and support the view in the literature of a demand-shock-based-dynamics.

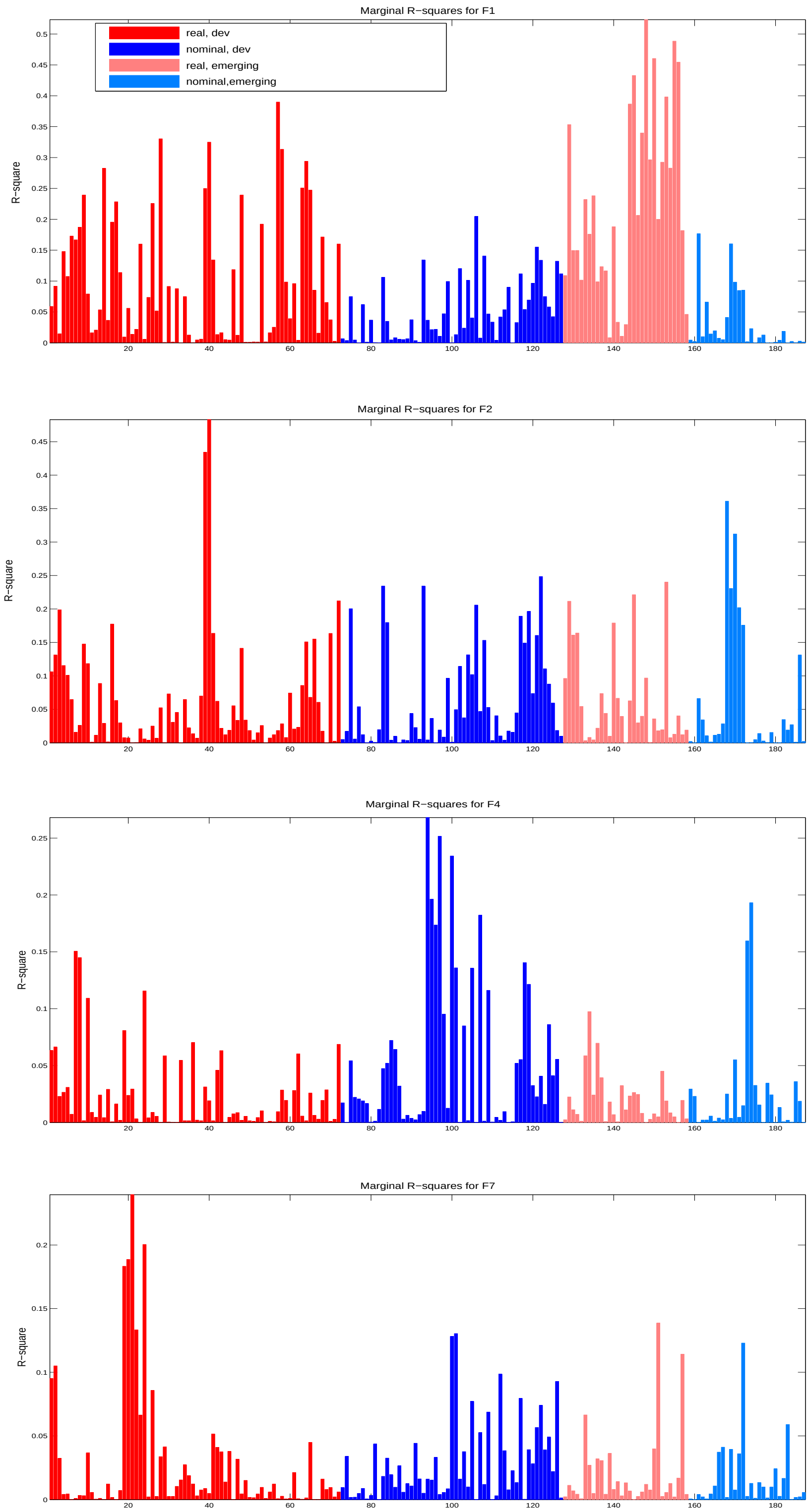
5 Conclusion

This paper deals with the macroeconomic determinants of crude oil futures return taken at a monthly frequency. For such a purpose, we use the approximate factor model methodology along with a newly constructed database of macroeconomic and financial variables representative of developed and emerging countries. After investigating the optimal number of factors with several recent criteria from the econometric literature, we introduce the chosen estimated factors to explain the oil returns. Our results indicate that around 38% of the variability of oil futures return can be explained by a simple combination of 4 factors. These factors can be interpreted in light of their explanatory power of the variables included in the dataset. Importantly, we find that the first factor explaining oil price is strongly related to real variables from emerging countries. Hence, our first conclusion is that the analysis in Zagaglia (2010) is, as mentioned in Alquist *et al.* (2011), incomplete because the author only considers variables from the United-States of America. Our second, and more general conclusion is that, as commonly said in the financial press, emerging economies do influence oil price. While intuitive, this statement has not been supported in the literature so far. An exception is Faria *et al.* (2009, p. 793) where the authors show that "[...] Chinese growth can lead to an increase in oil prices that has a stronger impact on its export competitors.". Their results as well as ours provide a first step to the investigation of the relative share of emerging economies in driving oil prices.

The methodology used in the paper may be extended in a number of ways. In particular, as in Ludvigson and Ng (2010), it is possible to consider fully the fact that factors are estimated quantities that can be bootstrapped to make the analysis more robust. Ludvigson and Ng (2010) suggest a bootstrap procedure to deal with the issue of estimated factors. We do not think that the high explanatory power (and its related economic significance) of our main regression would be significantly modified but the robustness of the analysis would be enhanced. Dynamic factor models may also be used despite the

[13] Remind that factors are not identified, unless we impose some constraint to estimate them. Therefore the sign of the coefficient of $\hat{F}_t^1$ in the crude oil return equation has no meaning *per se*.

Figure 2
Marginal R^2 of macroeconomic and financial variables regressed on the estimated factors no. 1, 2, 4 and 7.



Note: Each chart shows the R^2 from regressing the series number given on the x-axis onto each individual factor $\hat{F}_i$. See the appendix for a description of the series. Series in the appendix are sorted as they appear in the Figure (real variables for developed countries, nominal variables for developed countries, real variables for emerging countries, nominal variables for emerging countries).

mis-specification issue discussed in the introduction. Indeed, if our interest is only in forecasting, as discussed below, the only barometer to choose among models will be the forecasting performance which may be better even with a misspecified model.

A natural extension of the present paper would be to investigate the forecasting power of time-series models based on large factors as those presented here. Forecasting crude oil price is of utmost importance for all international institutions, governments and multinationals. Nevertheless, as for exchange rates, the forecasting power of various methodologies that have been proposed in the literature is rather poor. Alquist *et al.* (2011) provide a very exhaustive survey of this challenging issue. The authors conclude that the random walk is not statistically beaten by any other method. To reach this conclusion, they compare the random walk forecasting accuracy with forecasts from futures prices (Wu and McCallum (2005), Alquist and Kilian (2010)), from exchange rates (Gilbert (1988), Chen *et al.* (2011)), from convenience yield predictions (Knetsch, 2007)[14] and a number of time-series models based on crude oil prices and other explanatory variables.

[14] See also Gospodinov and Ng (2010) on the related issue of using the convenience yield to enhance inflation prediction.

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Appendix: list of variables considered in the computation of the common factors.

Developed countries				
Series Number	Short name	Mnemonic	Trans	Description
Industrial production				
1	IP: US	USIPTOT_G	$\Delta \ln$	US INDUSTRIAL PRODUCTION - TOTAL INDEX VOLA (2002=100)
2	IP: US	USIPMFGSG	$\Delta \ln$	US INDUSTRIAL PRODUCTION - MANUFACTURING (SIC) VOLA (1997=100)
3	IP: Canada	CNIPTOT.C	$\Delta \ln$	CN GDP - INDUSTRIAL PRODUCTION CONN
4	IP: France	FRIPMAN.G	$\Delta \ln$	FR INDUSTRIAL PRODUCTION - MANUFACTURING VOLA
5	IP: France	FRIPTOT_G	$\Delta \ln$	FR INDUSTRIAL PRODUCTION EXCLUDING CONSTRUCTION VOLA INDEX (2005=100)
6	IP: Germany	BDIPTOT_G	$\Delta \ln$	BD INDUSTRIAL PRODUCTION INCLUDING CONSTRUCTION VOLA (2005=100)
7	IP: UK	UKIPTOT.G	$\Delta \ln$	UK INDEX OF PRODUCTION - ALL PRODUCTION INDUSTRIES VOLA (2003=100)
8	IP: UK	UKIPMAN.G	$\Delta \ln$	UK INDUSTRIAL PRODUCTION INDEX - MANUFACTURING VOLA (2003=100)
9	IP: Japan	JPIPTOT_G	$\Delta \ln$	JP INDUSTRIAL PRODUCTION - MINING & MANUFACTURING VOLA (2005=100)
Orders and capacity utilization				
10	Capacity utilization: US	USCUMANUG	Δlv	US CAPACITY UTILIZATION - MANUFACTURING VOLA
11	Manufct. new ord.: US	USNOCOGMC	$\Delta^2 \ln$	US MANUFACTURERS NEW ORDERS - CONSUMER GOODS AND MATERIALS CONN (base 1982)
12	Manufct. new ord.: US	USBNKRTEQ	$\Delta \ln$	US MANUFACTURERS NEW ORDERS,NONDEFENSE CAPITAL GOODS SADJ (base 1982)
13	New orders: Canada	CNNEWORDB	$\Delta \ln$	CN NEW ORDERS: ALL MANUFACTURING INDUSTRIES (SA) CURA
14	Manufct. ord.: Germany	BDNEWORDE	$\Delta \ln$	BD MANUFACTURING ORDERS SADJ (2000=100)
15	Manufct. ord.: Japan	JPNEWORDB	$\Delta \ln$	JP MACHINERY ORDERS: DOM.DEMAND-PRIVATE DEMAND (EXCL. SHIP) CURA
16	Operating ratio: Japan	JPCAPUTLQ	Δlv	JP OPERATING RATIO - MANUFACTURING SADJ (2005=100)
17	Business failures: Japan	JPBNKRPTP	$\Delta \ln$	JP BUSINESS FAILURES VOLN
Housing start				
18	Housing permits: US	USHOUSETOT	$\ln$	US HOUSING AUTHORIZED VOLN
19	Housing permits: Canada	CNHOUSE.O	$\ln$	CN HOUSING STARTS: ALL AREAS (SA, AR) VOLA
20	Housing permits: Germany	BDHOUSINP	$\ln$	BD HOUSING PERMITS ISSUED FOR BLDG.CNSTR.: BLDG.S-RESL, NEW VOLN
21	Housing permits: Australia	AUHOUSE_A	$\ln$	AU BUILDING APPROVALS: NEW HOUSES CURN
22	Housing permits: Japan	JPHOUSSTF	$\ln$	JP NEW HOUSING CONSTRUCTION STARTED VOLN
Car sales				
23	Car registration: US	USCAR_P	$\ln$	US NEW PASSENGER CARS - TOTAL REGISTRATIONS VOLN
24	Car registration: Canada	CNCARSLSE	$\ln$	CN PASSENGER CAR SALES:TOTAL SADJ
25	Car registration: France	FRCARREGP	$\ln$	FR NEW CAR REGISTRATIONS VOLN
26	Car registration: Germany	BDRVNCARP	$\ln$	BD NEW REGISTRATIONS - CARS VOLN
27	Car registration: UK	UKCARTOTF	$\ln$	UK CAR REGISTRATIONS VOLN
28	Car registration : Japan	JPCARREGF	$\ln$	JP MOTOR VEHICLE NEW REGISTRATIONS: PASSENGER CARS EXCL.BELOW 66
Consumption				
29	Consumer sentiment: US	USUMCONEH	$\Delta \ln$	US UNIV OF MICHIGAN CONSUMER SENTIMENT - EXPECTATIONS VOLN (base 1966=100)
30	Pers. cons. exp.: US	USPERCONB	$\Delta \ln$	US PERSONAL CONSUMPTION EXPENDITURES (AR) CURA
31	Pers. saving: US	USPERSAVE	Δlv	US PERSONAL SAVING AS % OF DISPOSABLE PERSONAL INCOME SADJ
32	Retail sale: Canada	CNRETTOTB	$\Delta \ln$	CN RETAIL SALES: TOTAL (ADJUSTED) CURA
33	Household confidence: France	FRCNFCONQ	Δlv	FR SURVEY - HOUSEHOLD CONFIDENCE INDICATOR SADJ
34	Household confidence: Germany	BDCNFCONQ	Δlv	BD CONSUMER CONFIDENCE INDICATOR - GERMANY SADJ
35	Retail sales: UK	UKRETTOTB	$\Delta \ln$	UK RETAIL SALES (MONTHLY ESTIMATE, DS CALCULATED) CURA
36	Household confidence: UK	UKCNFCONQ	Δlv	UK CONSUMER CONFIDENCE INDICATOR - UK SADJ
37	Retail sales: Australia	AURETTOTT	$\Delta \ln$	AU RETAIL SALES (TREND) VOLA
38	Household confidence: Australia	AUCNFCONR	Δlv	AU MELBOURNE/WESTPAC CONSUMER SENTIMENT INDEX NADJ
39	Household expenditure: Japan	JPHLEXPWA	$\Delta \ln$	JP WORKERS HOUSEHOLD LIVING EXPENDITURE (INCL. AFF) CURN
40	Retail sales: Japan	JPRETTOTA	$\Delta \ln$	JP RETAIL SALES CURN

Note: In the Trans column, we report the transformation used to make each variable stationary. ln denotes logarithm, $\Delta \ln$ and $\Delta^2 ln$ denote the first and second difference of the logarithm, lv denotes the level of the series, and Δlv denotes the first difference of the series.

Series Number	Short name	Mnemonic	Trans	Description
Wages and labor				
41	Av. hourly real earnings: US	USWRIM_D	Δ ln	US AVG HOURLY REAL EARNINGS - MANUFACTURING CONA (base 82-84)
42	Av. overtime hours: US	USOOL024Q	Δ ln	US OVERTIME HOURS - MANUFACTURING, WEEKLY VOLA
43	Av. wkly hours : US	USHKIM_O	Δ ln	US AVG WKLY HOURS - MANUFACTURING VOLA
44	Purchasing manager index: US	USPMCUE	Δ ln	US CHICAGO PURCHASING MANAGER DIFFUSION INDEX - EMPLOYMENT NADJ
45	Av. hourly real earnings: Canada	CNWAGES.A	Δ ln	CN AVG.HOURLY EARN- INDUSTRIAL AGGREGATE EXCL. UNCLASSIFIED CURN
46	Labor productivity: Germany	BDPRODVTQ	Δ ln	BD PRODUCTIVITY: OUTPUT PER MAN-HOUR WORKED IN INDUSTRY SADJ (2005=100)
47	wages: Germany	BDWAGES.F	Δ ln	BD WAGE & SALARY,OVERALL ECONOMY-ON A MTHLY BASIS(PAN BD M0191)
48	Labor productivity: Japan	JPPRODVTE	Δ ln	JP LABOR PRODUCTIVITY INDEX -ALL INDUSTRIES SADJ
49	wages index: Japan	JPWAGES_E	Δ ln	JP WAGE INDEX: CASH EARNINGS - ALL INDUSTRIES SADJ
Unemployment				
50	U rate: US	USUNEM15Q	Δ^2 ln	US UNEMPLOYMENT RATE - 15 WEEKS & OVER SADJ
51	U rate: US	USUNTOTQ_pc	Δ^2 ln	US UNEMPLOYMENT RATE SADJ
52	Employment: Canada	CNEMPTOTO	Δ^2 ln	CN EMPLOYMENT - CANADA (15 YRS & OVER, SA) VOLA
53	U all: Germany	BDUNPTOTP	Δ ln	BD UNEMPLOYMENT LEVEL (PAN BDFROM SEPT 1990) VOLN
54	U rate: UK	UKUNTOTQ_pc	Δ^2 ln	UK UNEMPLOYMENT RATE SADJ
55	Emp: Australia	AUEMPTOTO	Δ ln	AU EMPLOYED: PERSONS VOLA
56	U all: Australia	AUUNPTOTO	Δ ln	AU UNEMPLOYMENT LEVEL VOLA
57	U rate: Japan	JPUNTOTQ_pc	Δlv	JP UNEMPLOYMENT RATE SADJ
International trade				
58	Exports: US	USI70_A	Δ ln	US EXPORTS CURN
59	Exports: EU	EKEXPGDSA	Δ ln	EK EXPORTS TO EXTRA-EA17 CURN
60	Exports: France	FREXPGDSB	Δ ln	FR EXPORTS FOB CURA
61	Exports: Germany	BDEXPBOPB	Δ ln	BD EXPORTS FOB CURA
62	Exports: UK	UKI70_A	Δ ln	UK EXPORTS CURN
63	Exports: Australia	AUEXPG&SB	Δ ln	AU EXPORTS OF GOODS & SERVICES (BOP BASIS) CURA
64	Exports: Japan	JPEXPGDSB	Δ ln	JP EXPORTS OF GOODS - CUSTOMSBASIS CURA
65	Imports: US	USIMPGDSB	Δ ln	US IMPORTS F.A.S. CURA
66	Imports: EU	EUOXT_09B	Δ ln	EU IMPORTS CURA
67	Imports: France	FRIMPGDSB	Δ ln	FR IMPORTS FOB CURA
68	Imports: Germany	BDIMPGDSB	Δ ln	BD IMPORTS CIF (PAN BD M0790) CURA
69	Imports: UK	UKIMPBOPB	Δ ln	UK IMPORTS - BALANCE OF PAYMENTS BASIS CURA
70	Imports: Australia	AUIMPG&SB	Δ ln	AU IMPORTS OF GOODS & SERVICES (BOP BASIS) CURA
71	Imports: Japan	JPOXT009B	Δ ln	JP IMPORTS CURA
72	Terms of trade: UK	UKTOTPRCF	Δ ln	UK TERMS OF TRADE - EXPORT/IMPORT PRICES (BOP BASIS) NADJ
73	Terms of trade: Japan	JPTOTPRCF	Δ ln	JP TERMS OF TRADE INDEX NADJ
Money and credit				
74	Money supply: US	USM0_B	Δ^2 ln	US MONETARY BASE CURA
75	Money supply: US	USM2_B	Δ^2 ln	US MONEY SUPPLY M2 CURA
76	Money supply: France	FRM2_A	Δ ln	FR MONEY SUPPLY - M2 (NATIONAL CONTRIBUTION TO M2) CURN
77	Money supply: France	FRM3_A	Δ ln	FR MONEY SUPPLY - M3 (NATIONAL CONTRIBUTION TO M3) CURN
78	Money supply: Germany	BDM1_A	Δ ln	BD MONEY SUPPLY-GERMAN CONTRIBUTION TO EURO M1(PAN BD M0790)
79	Money supply: Germany	BDM3_B	Δ ln	BD MONEY SUPPLY-M3 (CONTRIBUTION TO EURO BASIS FROM M0195) CURA
80	Money supply: UK	UKM1_B	Δ ln	UK MONEY SUPPLY M1 (ESTIMATE OF EMU AGGREGATE FOR THE UK) CURA
81	Money supply: UK	UKM3_B	Δ ln	UK UK MONEY SUPPLY M3(ESTIMATE OF EMU AGGREGATE FORTHE UK) CURA
82	Money supply: Australia	AUM1_B	Δ ln	AU MONEY SUPPLY - M1 CURA
83	Money supply: Australia	AUM3_B	Δ^2 ln	AU MONEY SUPPLY - M3 (SEE AUM3...OB) CURA
84	Money supply: Japan	JPM1_A	Δ ln	JP MONEY SUPPLY: M1 (METHO-BREAK, APR. 2003) CURN
85	Money supply: Japan	JPM2_A	Δ ln	JP MONEY SUPPLY: M2 (METHO-BREAK, APR. 2003) CURN

Money and credit - continuation				
Series Number	Short name	Mnemonic	Tran	Description
86	Credit: US	USCOMILND	$\Delta^2 \ln$	US COMMERCIAL & INDUSTRIAL LOANS OUTSTANDING (BCI 101) CONA (base 2005)
87	Credit: US	USCILNNCB	Δlv	US COMMERCIAL & INDL LOANS, NET CHANGE (AR) (BCI 112) CURA
88	Credit: US	USCRDNRVB	$\Delta^2 \ln$	US NONREVOLVING CONSUMER CREDIT OUTSTANDING CURA
89	Credit: US	USCSCRE_Q	$\Delta^2 \ln$	US CONSUMER INSTALLMENT CREDIT TO PERSONAL INCOME (RATIO) SADJ
90	Credit: France	FRBANKLPA	$\Delta^2 \ln$	FR MFI LOANS TO RESIDENT PRIVATE SECTOR CURN
91	Credit: Germany	BDBANKLPA	$\Delta^2 \ln$	BD LENDING TO ENTERPRISES & INDIVIDUALS CURN
92	Credit: UK	UKCRDCONB	$\Delta^2 \ln$	UK TOTAL CONSUMER CREDIT: AMOUNT OUTSTANDING CURA
93	Credit: Australia	AUCRDCONB	$\Delta^2 \ln$	AU FINANCIAL INTERMEDIARIES: NARROW CREDIT - PRIVATE SECTOR CURA
94	Credit: Japan	JPBANKLPA	$\Delta^2 \ln$	JP AGGREGATE BANK LENDING (EXCL. SHINKIN BANKS) CURN
Stock index				
95	Stock index: US	USSHRPRCF	$\Delta \ln$	US DOW JONES INDUSTRIALS SHARE PRICE INDEX (EP) NADJ
96	Stock index: France	FRSHRPRCF	$\Delta \ln$	FR SHARE PRICE INDEX - SBF 250 NADJ
97	Stock index: Germany	BDSHRPRCF	$\Delta \ln$	BD DAX SHARE PRICE INDEX, EP NADJ
98	Stock index: UK	UKOSP001F	$\Delta \ln$	UK FTSE 100 SHARE PRICE INDEXNADJ (2005=100)
99	Stock index: Japan	JPSHRPRCF	$\Delta \ln$	JP TOKYO STOCK EXCHANGE - TOPIX (EP) NADJ (1968=100)
Interest rate				
100	Interest rate: US	USFEDFUN	Δlv	US FEDERAL FUNDS RATE (AVG.)
101	Interest rate: US	USCRBBAA	Δlv	US CORPORATE BOND YIELD - MOODY'S BAA, SEASONED ISSUES
102	Interest rate: US	USGBOND	Δlv	US TREASURY YIELD ADJUSTED TO CONSTANT MATURITY - 20 YEAR
103	Interest rate: France	FRPRATE	Δlv	FR AVERAGE COST OF FUNDS FOR BANKS / EURO REPO RATE
104	Interest rate: France	FRGBOND	Δlv	FR GOVERNMENT GUARANTEED BOND YIELD (EP) NADJ
105	Interest rate: Germany	BDPRATE	Δlv	BD DISCOUNT RATE / SHORT TERM EURO REPO RATE
106	Interest rate: Germany	BDGBOND	Δlv	BD LONG TERM GOVERNMENT BOND YIELD - 9-10 YEARS
107	Interest rate: UK	UKPRATE	Δlv	UK BANK OF ENGLAND BASE RATE (EP)
108	Interest rate: UK	UKGBOND	Δlv	UK GROSS REDEMPTION YIELD ON 20 YEAR GILTS (PERIOD AVERAGE) NADJ
109	Interest rate: Australia	AUPRATE	Δlv	AU RBA CASH RATE TARGET
110	Interest rate: Australia	AUBOND	Δlv	AU COMMONWEALTH GOVERNMENT BOND YIELD 10 YEAR (EP)
111	Interest rate: Japan	JPPRATE	Δlv	JP OVERNIGHT CALL MONEY RATE, UNCOLLATERALISED (EP)
112	Interest rate: Japan	JPGBOND	Δlv	JP INTEREST-BEARING GOVERNMENT BONDS - 10-YEAR (EP)
Exchange rate				
113	Exchange rate: DM to US $	BBDEMSP	$\Delta \ln$	GERMAN MARK TO US $ (BBI) - EXCHANGE RATE
114	Exchange rate: SK to US $	SDXRUSD	$\Delta \ln$	SD SWEDISH KRONOR TO US $ (BBI, EP)
115	Exchange rate: £ to $	UKDOLLR	$\Delta \ln$	UK £ TO US $ (WMR) - EXCHANGE RATE
116	Exchange rate: Yen to $	JPXRUSD	$\Delta \ln$	JP JAPANESE YEN TO US $
117	Exchange rate: Aus.$ to US $	AUXRUSD	$\Delta \ln$	AU AUSTRALIAN $ TO US $ (MTH.AVG.)
Producer price index				
118	PPI: US	USPROPRCE	$\Delta \ln$	US PPI - FINISHED GOODS SADJ
119	PPI: Canada	CNPROPRCF	$\Delta \ln$	CN INDUSTRIAL PRICE INDEX: ALL COMMODITIES NADJ
120	PPI: Germany	BDPROPRCF	$\Delta \ln$	BD PPI: INDL. PRODUCTS, TOTAL, SOLD ON THE DOMESTIC MARKET NADJ (2005=100)
121	PPI: UK	UKPROPRCF	$\Delta \ln$	UK PPI - OUTPUT OF MANUFACTURED PRODUCTS (HOME SALES) NADJ
122	PPI: Japan	JPPROPRCF	$\Delta \ln$	JP CORPORATE GOODS PRICE INDEX: DOMESTIC - ALL COMMODITIES NADJ
Consumer price index				
123	CPI: US	USCONPRCE	$\Delta \ln$	US CPI - ALL URBAN: ALL ITEMS SADJ
124	CPI: Canada	CNCONPRCF	$\Delta \ln$	CN CPI NADJ
125	CPI: France	FRCONPRCE	$\Delta \ln$	FR CPI SADJ
126	CPI: Germany	BDCONPRCE	$\Delta \ln$	BD CPI SADJ
127	CPI: UK	UKD7BT_F	$\Delta \ln$	UK CPI INDEX 00 : ALL ITEMS- ESTIMATED PRE-97 2005=100 NADJ
128	CPI: Japan	JPCONPRCF	$\Delta \ln$	JP CPI: NATIONAL MEASURE NADJ

Emerging countries				
Series Number	Short name	Mnemonic	Trans	Description
Industrial production				
129	IP: Brasil	BRIPTOT_G	$\Delta \ln$	BR INDUSTRIAL PRODUCTION VOLA index 2002=base
130	IP: China (cement)	CHVALCEMH	$\Delta \ln$	CH OUTPUT OF INDUSTRIAL PRODUCTS - CEMENT VOLN
131	IP: India	INIPTOT_H	$\Delta \ln$	IN INDUSTRIAL PRODN. (EXCLUDING CONSTRUCTION & GAS UTILITY) VOLN index
132	IP: India	INIPMAN_H	$\Delta \ln$	IN INDUSTRIAL PRODUCTION: MANUFACTURING VOLN index
133	IP: Korea	KOIPTOT.G	$\Delta \ln$	KO INDUSTRIAL PRODUCTION VOLA (2005=100)
134	IP: Mexico	MXIPTOT_H	$\Delta \ln$	MX INDUSTRIAL PRODUCTION INDEX VOLN
135	IP: Mexico	MXIPMAN_H	$\Delta \ln$	MX INDUSTRIAL PRODUCTION INDEX: MANUFACTURING VOLN
136	IP: Philippines	PHIPMAN_F	$\Delta \ln$	PH MANUFACTURING PRODUCTION NADJ 2000 prices
137	IP: South Africa	SAIPMAN.G	$\Delta \ln$	SA INDUSTRIAL PRODUCTION (MANUFACTURING SECTOR) VOLA
Orders and capacity utilization				
138	Operating ratio: Brazil	BRCAPUTLR	Δlv	BR CAPACITY UTILIZATION - MANUFACTURING NADJ
139	Mach. ord.: Korea	KONEWORDA	$\Delta \ln$	KO MACHINERY ORDERS RECEIVEDCURN
140	Manufct. prod capa.: Korea	KOCAPUTLF	Δlv	KO MANUFACTURING PRODUCTION CAPACITY NADJ (2005=100)
Consumption				
141	Retail sales: Korea	KORETTOTF	$\Delta \ln$	KO RETAIL SALES NADJ (2005=100)
Wages and labor				
142	Labor cost: Brazil	BRLCOST.F	$\Delta \ln$	BR UNIT LABOR COST NADJ
Unemployment				
143	U rate: Korea	KOUNTOTQ_pc	Δlv	KO UNEMPLOYMENT RATE SADJ
International trade				
144	Exports: Brazil	BREXPBOPA	$\Delta \ln$	BR EXPORTS (BOP BASIS) CURN
145	Exports: China	CHEXPGDSA	$\Delta \ln$	CH EXPORTS CURN
146	Exports: India	INI70_A	$\Delta \ln$	IN EXPORTS CURN
147	Exports: Indonesia	IDEXPGDSA	$\Delta \ln$	ID EXPORTS FOB CURN
148	Exports: Korea	KOEXPGDSA	$\Delta \ln$	KO EXPORTS FOB (CUSTOMS CLEARANCE BASIS) CURN
149	Exports: Philippines	PHEXPGDSA	$\Delta \ln$	PH EXPORTS CURN
150	Exports: Singapore	SPEXPGDSA	$\Delta \ln$	SP EXPORTS CURN
151	Exports: Taïwan	TWEXPGDSA	$\Delta \ln$	TW EXPORTS CURN
152	Imports: Brazil	BRIMPBOPA	$\Delta \ln$	BR IMPORTS (BOP BASIS) CURN
153	Imports: China	CHIMPGDSA	$\Delta \ln$	CH IMPORTS CURN
154	Imports: Indonesia	IDIMPGDSA	$\Delta \ln$	ID IMPORTS CIF CURN
155	Imports: Korea	KOIMPGDSA	$\Delta \ln$	KO IMPORTS CIF (CUSTOMS CLEARANCE BASIS) CURN
156	Imports: Singapore	SPIMPGDSA	$\Delta \ln$	SP IMPORTS CURN
157	Imports: Taïwan	TWIMPGDSA	$\Delta \ln$	TW IMPORTS CURN
158	Terms of trade: Brazil	BRTOTPRCF	$\Delta \ln$	BR TERMS OF TRADE NADJ (2006=100)

Series Number	Short name	Mnemonic	Tran	Description
Money and credit				
159	Money supply: Brazil	BRM1_A	$\Delta \ln$	BR MONEY SUPPLY - M1 (EP) CURN
160	Money supply: Brazil	BRM3_A	$\Delta \ln$	BR MONEY SUPPLY - M3 (EP) CURN
161	Money supply: China	CHM0_A	$\Delta \ln$	CH MONEY SUPPLY - CURRENCY IN CIRCULATION CURN
162	Money supply: China	CHM1_A	$\Delta \ln$	CH MONEY SUPPLY - M1 CURN
163	Money supply: India	INM1_A	$\Delta \ln$	IN MONEY SUPPLY: M1 (EP) CURN
164	Money supply: India	INM3_A	$\Delta \ln$	IN MONEY SUPPLY: M3 (EP) CURN
165	Money supply: Indonesia	IDM1_A	$\Delta \ln$	ID MONEY SUPPLY: M1 CURN
166	Money supply: Indonesia	IDM2_A	$\Delta^2 \ln$	ID MONEY SUPPLY- M2 CURN
167	Money supply: Korea	KOM2_B	$\Delta^2 \ln$	KO MONEY SUPPLY - M2 (EP) CURA
168	Money supply: Mexico	MXM1_A	$\Delta \ln$	MX MONEY SUPPLY: M1 (EP) CURN base=end of period
169	Money supply: Mexico	MXM3_A	$\Delta^2 \ln$	MX MONEY SUPPLY: M3 (EP) CURN
170	Money supply: Philippines	PHM1_A	$\Delta \ln$	PH MONEY SUPPLY - M1 (METHO BREAK AT 12/03) CURN
171	Money supply: Philippines	PHM3_A	$\Delta^2 \ln$	PH MONEY SUPPLY - M3 (METHO BREAK AT 12/03) CURN
172	Money supply: Russia	RSM2_A	$\Delta^2 \ln$	RS MONEY SUPPLY- M2 CURN
Stock index				
173	Stock index: Brazil	BRSHRPRCF	$\Delta^2 \ln$	BR BOVESPA SHARE PRICE INDEX (EP) NADJ
174	Stock index: Hong-Kong	HKSHRPRCF	$\Delta \ln$	HK HANG SENG SHARE PRICE INDEX (EP) NADJ (31 july 1964 =100)
Exchange rate				
175	Exchange rate: Br.R. to US $	BRXRUSD	$\Delta^2 \ln$	BR BRAZILIAN REAIS TO US DOLLAR (AVG)
176	Exchange rate: Ch.Y. to US $	CHXRUSD	$\Delta^2 \ln$	CH CHINESE YUAN TO US DOLLAR (AVERAGE AMOUNT)
177	Exchange rate: In.R. to US $	INXRUSD	$\Delta^2 \ln$	IN INDIAN RUPEES PER US DOLLAR (RBI)
178	Exchange rate: Id.R. to US $	IDXRUSD	$\Delta^2 \ln$	ID INDONESIAN RUPIAHS TO US DOLLAR
179	Exchange rate: Mx.P. to US $	MXXRUSD	$\Delta^2 \ln$	MX MEXICAN PESOS TO US $-CENTRAL BANK SETTLEMENT RATE (AVG)
180	Exchange rate: RS.R. to US $	RSXRUSD	$\Delta^2 \ln$	RS RUSSIAN ROUBLES TO US $ NADJ
Consumer price index				
181	CPI: Brazil	BRCPIGENF	$\Delta^2 \ln$	BR CPI - GENERAL NADJ
182	CPI: China	CHCONPRCF	$\Delta \ln$	CH CPI NADJ
183	CPI: India	INCONPRCF	$\Delta \ln$	IN CPI: INDUSTRIAL LABOURERS(DS CALCULATED) NADJ (2001=100)
184	CPI: Korea	KOCONPRCF	$\Delta \ln$	KO CPI NADJ (2005=100)
185	CPI: Mexico	MXCONPRCF	$\Delta^2 \ln$	MX CPI NADJ (JUN 2002=100)
186	CPI: Philippines	PHCONPRCF	$\Delta \ln$	PH CPI NADJ
187	CPI: Russia	RSCONPRCF	$\Delta^2 \ln$	RS CPI NADJ

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