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Derek BUNN
Julien CHEVALLIER
Yannick LE PEN
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

Fundamental and Financial Influences on the Co-movement of Oil and Gas Prices

Derek Bunn* **Julien Chevallier†** **Yannick Le Pen‡** **Benoît Sévi§**

London Business School *Université Paris 8* *Université Paris Dauphine* *Aix-Marseille School of Economics*

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Abstract

As both speculative and hedging financial flows into commodity futures are expected to link commodity price formation more strongly to equity indices, we investigate whether these processes also create increased correlation amongst the commodities themselves. Considering U.S. oil and gas futures, using the large approximate factor models methodology we investigate whether common factors derived from a large international dataset of real and nominal macro variables are able to explain both returns and whether, beyond these fundamental common factors, the residuals remain correlated. We further investigate a possible explanation for this residual correlation by using some proxies for hedging and speculative activity, showing that speculation increases and hedging reduces the inter-commodity correlations.

JEL Classification: C22, C32, G15, E17

Keywords: Oil Futures, Gas Futures, Common Factors, Approximate Factor Models, Excess Comovement

*London Business School, Sussex Place, Regent's Park, London NW1 4SA, United Kingdom. Email: dbunn@london.edu

†Université Paris 8, LED. 2 rue de la Liberté, 93526 Saint-Denis Cedex, France. Email: julien.chevallier04@univ-paris8.fr

‡Université Paris-Dauphine, LEDa-CGEMP, Place du Maréchal de Lattre de Tassigny, 75775 Paris Cedex 16, France. Email: yannick.le_pen@dauphine.fr

§GREQAM, Development and International Finance Department, Aix-Marseille Université, Château La Farge - Route des Milles, 13290 Les Milles Aix-en-Provence, France. Email: benoit.sevi@gmail.com

1 Introduction

Whilst the evolution and volatility of commodity prices have always presented hedging and risk management concerns to producers and consumers, the so-called "financialization" of commodities through the active involvement of investors and speculators adds a new ingredient to the complexity of their price formations. This theme of increased investment and speculative activity in commodities became especially topical in relation to oil price behavior in the first decade of this century, with a view emerging that the financial effects may be substantial in linking commodity price indices to speculative volumes and to equity indices, but only alongside the changes in global economic fundamentals (Hamilton, 2009; Kilian, 2009; Tang and Xiong, 2012). For the individual commodities, however, whilst questions still remain on the relative effects of fundamental drivers and financial market activity, there is, in addition, a more subtle aspect relating to the changes in the relationships amongst the commodities themselves. If two or more commodities are part of the same asset class, traded perhaps as part of a commodity index, then it is plausible to expect that extra financial activity will further increase their correlation beyond that already attributable to their product fundamentals. This expectation now appears to follow as a conjecture from various strands of theoretical and empirical research. Thus, as a result of information frictions and adaptive learning from prices, more financial trading may increase the link between commodities and equity market indices, inducing a pro-cyclical tendency (e.g. Singleton, 2013), which would plausibly also manifest a greater co-movement amongst the commodities involved. Furthermore, capital frictions have been shown to influence risk premia in commodity futures (e.g. Acharya et al, 2013) and the consequent limits to arbitrage may again influence the correlations amongst commodities in the same asset class. More directly, it has been shown in general that as the objective function of investors becomes compromised by a need to outperform benchmark indices, index-focussed trading increases the correlations between asset prices comprising the indices (e.g. Basak and Pavlova, 2013).

In order to test whether co-movement amongst heavily traded commodities is being significantly influenced by financial factors, it is therefore clearly necessary to do so in the context of a comprehensive representation of the underlying fundamental factors which may link their price behavior. With commodities being primary goods, global economic factors must therefore be fully specified in the modeling. We approach this methodological challenge by means of a filtration of commodity returns through a large approximate factor model, to explore common fundamental factors, followed by analysis of the effects of hedging and speculative trading proxies on the residual co-movements. As an application area, energy commodities are particularly amenable to this research question and we analyse an important pair of energy products, crude oil and natural gas, which are of substantial economic impact and predominate within the commodity indices (e.g. GSCI).

As a topical area, the fundamental aspects of the link between oil and gas prices have engaged substantial commentary and analysis. In general, the conventional view was one of strong linkage, as in Serletis and Herbert (1999), mainly because of the history of product substitution between gas and fuel oil (e.g. for power generation, industrial boilers). Furthermore, especially within Continental Europe and South-East Asia, as well as elsewhere, the development of gas pipelines by the upstream oil producers had generally been associated with long-term gas contracts, index-linked to crude oil prices. Against this, there are some different market features. Oil markets are part of broader international markets, while natural gas markets are essentially regional. Surplus production of natural gas may arise since it is a co-product of oil. Gas supply is more inelastic than oil in the short-term, partly because of production and delivery logistics (Villar and Joutz (2006)); likewise gas demand is less elastic because of its substantial component of residential heating (Ewing et al. (2002)) compared to the high transportation component for oil. Finally, more recent data suggests that linkages may have weakened with the advent of shale gas and, looking beyond the US, with the continuing deregulation of energy markets worldwide (Ramberg and Parsons (2012)).

In such a changing and multifaceted context of fundamental influences, empirical analysis has unsurprisingly revealed mixed results concerning the existence of a long-term relationship between gas and oil. From a cointegration framework, Serletis and Herbert (1999) identified shared trends among the U.S. Henry Hub natural gas price and the fuel oil price during 1996-1997, as did Villar and Joutz (2006) for the Henry Hub natural gas price and the West Texas Intermediate (WTI) crude oil price during 1989-2005. They identified a stable relationship between oil and gas prices, despite periods where they may have appeared to 'decouple'. By using error correction models, Bachmeier and Griffin (2006) also found evidence of market integration among primary energy fuels in the U.S. during 1990-2004. Their analysis confirmed that oil and natural gas prices were cointegrated in the long run and exhibited strong evidence of market integration. Furthermore, Brown and Yücel (2008) showed that movements in crude oil prices had a prominent role in shaping natural gas prices in the U.S., once other drivers such as weather, seasonality, storage, and production disruptions have been taken into account. Yet, also based on vector error-correction models and common cycle tests, Serletis and Rangel-Ruiz (2004) claimed that Henry Hub and WTI did not have common price cycles, and that progressive decoupling of US energy prices was a result of deregulation. Furthermore, Hartley et al. (2008) found evidence that the link between natural gas and crude oil prices in the U.S. was indirect, acting through competition at the margin between natural gas and residual fuel oil (being the price of the main competitive oil product). More precisely, the residual fuel oil price caused movements in the natural gas price, while the converse was not true.[1]

Despite this large body of work on market integration between gas and oil, the cointegration approach appears too restrictive for our purposes. In seeking to go beyond tests for linkage and dynamic error correction, we a looking to identify what may be the common underlying factors of co-movement in these two commodities, amongst an extensive set of global macro variables, as well as with regard to financial hedging and speculative proxies. To find the common factors, we use the large approximate factor model methodology following Stock and Watson (1999, 2002a,b, 2006); Bai and Ng (2008). Large approximate factor models have been used in a number of financial applications, with, in particular, Ludvigson and Ng (2007, 2009, 2010) investigating the risk-return trade-off and the bond premium. Thus, in our study, we extract from a large dataset of macroeconomic and financial variables the factors that are able to explain oil and gas returns in the U.S. futures markets. We show that a few factors can explain a significant proportion of both returns, which is an indication of similar fundamentals for oil and gas dynamics. This appears to be the first study aiming at explaining oil and gas returns with factors extracted from a large dataset. Furthermore, compared to the well-known dataset by Stock and Watson (2002a,b), ours also includes variables from emerging economies known to contribute to the price formation of market for energy commodities. Indeed, we find that the factor with the highest explanatory power for oil is mostly connected with real macroeconomic variables from emerging countries. Furthermore, we show that the correlation between the unexplained parts of the returns (residuals after filtration by the factors) can be explained by trading activity proxies, which would be consistent with the

[1] Several cointegration studies have also investigated the relationship between oil and gas prices in the UK, where a fully liberalized, actively traded, gas market has existed since the early 1990s. Panagiotidis and Rutledge (2007) found a linear relationship between UK gas prices and Brent oil price during 1996-2003.

financialization conjecture for related energy commodities. In particular, we find that the speculative activities increase the correlations, whereas the hedging activities reduce it.

The remainder of the paper is structured as follows. Section 2 presents the dataset and Section 3 reviews the approximate factor modeling methodology. Section 4 reports the empirical analysis of oil and gas returns using this methodology and Section 5 contains the analysis of residual autocorrelation. Section 6 focuses on the trading activity proxies and Section 7 concludes.

2 Data

We look at the main global oil and natural gas prices from the U.S. The natural gas futures are the Henry Hub price in \$/MMBTU, whilst the crude oil futures are the WTI prices in \$/BBL. The dataset is composed of 196 monthly observations from 01/11/1993 to 01/03/2010. Raw prices and returns are respectively displayed in Figures 1 and 2.

Descriptive statistics for returns are reported in Table 1. These statistics show evidence of excess kurtosis for each return series. Returns also record a negative skewness for crude oil but not natural gas. The Jarque-Bera test rejects the hypothesis of a Gaussian distribution for each return. Heteroskedasticity is present in the data, which may explain the non-normality. Oil and gas prices have unit roots and are cointegrated. The raw correlation between U.S. crude oil and natural gas returns is positive and significant (as judged by the p-value).

Whilst the cointegration tests established the linkages, to understand the common macro drivers more explicitly, factors are extracted from 187 macroeconomic and financial variables representative of developed and emerging countries. Our dataset differs in its composition from the widely known large factor datasets of Stock and Watson (2005) and Ludvigson and

Ng (2009) which consist mainly of U.S. national data.[2] Since we aim at explaining crude oil and natural gas returns, we include 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 the 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 countries). Following the analysis in Boivin and Ng (2006), we do not include as many variables as could be possible. Indeed, those authors demonstrate that including too many variables rarely leads to a better estimation of factors. In a recent contribution, Caggiano et al. (2011) provide strong empirical support to the findings of Boivin and Ng (2006) in the Euro area.

Thus, inclusion in our dataset followed two principles: (i) to gather, as far as possible, a balanced panel between developed and developing countries, and (ii) to limit the dimensionality of the dataset so as to avoid measurement error problems in the factor analysis. All data are extracted from Thomson Financial DataStream. The list of the 187 time series is given in the Appendix, where a coding system indicates how the data are transformed to ensure stationarity. All of the raw data are standardized prior to estimation.

3 The large approximate factor methodology

With a sample of $i = \{1, \ldots, N\}$ cross-section units and $t = \{1, \ldots, T\}$ time series observations, we formulate:

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

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

where F_t is the vector of the r common factors. e_{it} is referred to as the idiosyncratic error, and λ_i as the factor loadings of the (static[3]) common factors. F_t, $\{\lambda_i\}_{i=1,\dots,N}$, $\{e_{it}\}_{i=1,\dots,N \quad t=1,\dots,T}$ are unknown and have to be estimated from $\{x_{it}\}$. With $X_t = (x_{1t}, \dots, x_{Nt})'$, $e_t = (e_{1t}, \dots, e_{Nt})'$ and $\Lambda = (\lambda_1, \dots, \lambda_N)'$, we have the vector form notation :

$$X_t = \Lambda F_t + e_t$$

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

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

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

In classical factor analysis, F_t and e_t are assumed to be serially and cross-sectionally uncorrelated. Moreover the number of observations N is fixed. The 'large dimensional approximate factor model' initiated by Stock and Watson (2002a,b) differs from previous factor models in two ways (at least): (i) the sample size tends to infinity in both directions, and (ii) the idiosyncratic errors are allowed to be 'weakly correlated'[4] across i and t.

We assume k factors, and use the principal components method to estimate the $T \times k$ matrix of factors F^k and the corresponding $N \times T$ loadings matrix Λ^k. These estimates solve the following optimization problem :

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

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

[3] We adopt the static approach following D'Agostino and Giannone (2012) who show that there is no clear advantage of using dynamic factor models.

[4] Although Forni and al. (1999) and Stock and Watson (2002) use different sets of assumptions to characterize 'weak correlations', the main idea is that cross-correlations and serial correlations have an upper bound.

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:

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

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 $N \, \text{and} \, T \to \infty$ is demonstrated by Stock and Watson (2002a) and Bai and Ng (2002). Bai (2003) gives the asymptotic distribution of the principal component estimator.

We use the information criteria by Bai and Ng (2002) and the sequential test by Kapetanios (2010) to determine the number of factors. The information criteria by Bai and Ng (2002) can be seen as an extension to factor models of usual information criteria. If we note $\hat{S}(k) = (NT)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \hat{\lambda}_i^{k'} \hat{F}_t^k)^2$ 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 minimizes the aforementioned information criteria.

We also apply the sequential test by Kapetanios (2010) to determine 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 k_0 eigenvalues (in decreasing order) 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 and the rate of convergence $\tau_{N,T} \to \infty$ 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 (2010) refers to this algorithm as MED (maximal eigenvalue distribution).

The estimated numbers of factors are displayed in Table 2, where it is evident that there is clearly no agreement on the optimal number of factors. This result is similar to previous empirical studies, which also show substantial variations in determining the number of factors. According to the information criteria by Bai and Ng (2002), the optimal number of factors runs from the 2 to 9. The sequential test by Kapetanios (2009) selects 2 factors.

Additional information on the autocorrelation and the explanatory power of the estimated factors $\widehat{F}_t$ is displayed in Table 3. We notice that the first 3 factors only explain 20% of the variance of the 187 time series, while we reach 36% with 9 factors. Hence, we choose to consider the set of the first 9 factors as potential set of regressors. The factor autocorrelations (up to 3 lags) provided in Table 3 show that most factors are persistent.

4 Factor analysis of oil and gas returns

We consider the first 9 factors to comprise the set of potential regressors. Since a preliminary analysis factor-by-factor shows that factors 3 and 9 have low explanatory powers (compared to the others), we choose to exclude them from our set of regressors. We then consider all combinations of the 7 remaining factors, and select the subset which minimizes the multivariate BIC criterion (as in Stock and Watson (2002) and Ludvigson and Ng (2009)). All results are reported in Table 4.

Following this process, we choose the set $\tilde{F}_t = (\hat{F}_t^1, \hat{F}_t^2, \hat{F}_t^7)'$ and estimate the following SUR regression:

$$\begin{cases} r_{1,t} = \alpha_1 + \beta_1' \tilde{F}_t + u_{1,t} = \alpha_1 + \beta_{1,1}\hat{F}_t^1 + \beta_{1,2}\hat{F}_t^2 + \beta_{1,7}\hat{F}_t^7 + u_{1,t} \\ r_{2,t} = \alpha_2 + \beta_2' \tilde{F}_t + u_{2,t} = \alpha_2 + \beta_{2,1}\hat{F}_t^1 + \beta_{2,2}\hat{F}_t^2 + \beta_{2,7}\hat{F}_t^7 + u_{2,t} \end{cases}$$

We consider extra explanatory variables by adding for each energy market 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 (see Brown and Yücel (2008)).[5] In addition, we include the dummy variable Du, which captures the disruption in oil and gas supply caused by the Hurricanes Ivan in September 2004 and Katrina in August 2005.

The minimization of the BIC criterion leads us to select the same set of factors as previously, and to estimate:

$$\begin{cases} r_{1,t} = \alpha_1 + \beta_1' \hat{F}_t + \gamma_1 \Delta s_{1,t} + \theta_1 Du + v_{1,t} = \alpha_1 + \beta_{1,1}\hat{F}_t^1 + \beta_{1,2}\hat{F}_t^2 + \beta_{1,7}\hat{F}_t^7 + \gamma_1 \Delta s_{1,t} + \theta_1 Du + v_{1,t} \\ r_{2,t} = \alpha_2 + \beta_2' \hat{F}_t + \gamma_2 \Delta s_{2,t} + \theta_2 Du + v_{2,t} = \alpha_2 + \beta_{2,1}\hat{F}_t^1 + \beta_{2,2}\hat{F}_t^2 + \beta_{2,7}\hat{F}_t^7 + \gamma_2 \Delta s_{2,t} + \theta_2 Du + v_{2,t} \end{cases}$$

[5] These data are extracted from the US Department of Energy website.

The results of these estimations are reported in Table 4. Firstly, we find a higher explanatory power for crude oil than for natural gas. The R^2 associated with regression (1.a) is equal to 0.34 for oil, and to 0.07 for gas in regression (1.b). This distinction applies across all regressions (1.a) to (3.b). This result may be explained by the fact that gas markets are more regional and hence international factors are less likely to have a good explanatory power for these series (compared to oil).

Regarding the estimated coefficients, the first factor $\widehat{F}_1$ appears to be statistically significant only for oil returns. This finding is stable across the regressions (1.a), (2.a) and (3.a). Concerning the factors $\widehat{F}_2$ and $\widehat{F}_7$, we notice the remarkable stability of the signs obtained across all regressions, as well as their statistical significance (except $\widehat{F}_7$ in regression (3.a)). The coefficient estimates for the extra explanatory variables are not significant, except for changes in stock/inventories. With the significant negative sign for stocks, as in other studies (e.g. Brown and Yücel (2008)), this is intuitively consistent with conventional fundamental expectations for the effect of stocks on price movements.

In order to interpret the factors, we follow Ludvigson and Ng (2009), by regressing each original variable on each single factor and then, for graphical convenience, as in Figure 3, sorting the variables along the horizontal axis (in our case, beginning with real variables and then with nominal variables), to show the variables for which high marginal R^2 are obtained. Thus, we classify our 187 series into four categories according to the characteristics real/nominal variables and developed/emerging countries. A finer classification would be difficult to illustrate and is relevant, in our opinion, only when a single country is under consideration.[6]

[6] Ludvigson and Ng (2009) rely indeed on a finer classification, but they 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.

Factor $\widehat{F}_1$ can easily be interpreted as a real factor, since it records its highest explanatory power for real variables. More particularly, $\widehat{F}_1$ is mostly associated with real variables from emerging countries.[7] It is significant for oil market returns, but does not indicate any effect on gas returns. The association of $\widehat{F}_1$ with crude oil returns can be interpreted as an evidence of the growing weight of emerging countries in oil imports during the time period considered. This finding is consistent with the rather weak support of previous studies to the popular view that oil prices have been driven more by financial activities, rather than real supply and demand variables, and in this respect supports the findings by Hamilton (2009) and Kilian (2009) that real demand from emerging economies has been partly responsible for the rise in oil prices over the recent period. More importantly, because we include in our database a number of Asian variables, it seems that their explanatory power is rather large and supports the view of the demand-shock-based dynamics.

Unlike $\widehat{F}_1$, the other factors indicate common macro effects on both gas an oil returns. $\widehat{F}_7$ has its highest factor loadings for a small set of real economic activity variable from developed countries (most notably western housing starts and car registrations) and is significant across all variables, including both oil and gas. Factor $\widehat{F}_2$ is a significant, more broadly loaded factor for both oil and gas (with relatively higher loadings on Asia-Pacific economies than $\widehat{F}_7$). Evidently there is a substantial basis from factors 2 and 7 for asserting that gas has a linkage with oil due to common economic and other global drivers, but, from the first factor, oil also has its own distinct global economic driver linked to the growth of the emerging economies.

[7] Recall that factors are not identified, unless we impose some constraints to estimate them. Therefore, the sign of the coefficient of $\widehat{F}_1$ in the crude oil return equation has no meaning *per se*.

5 Correcting residual correlation for heteroscedasticity

In this section, we proceed, as in Kallberg and Pasquariello (2008), to correct the residual correlations for the heteroscedasticity. The main idea is to compute the sample correlation, and then to correct it for the effect of change in volatility by using Forbes and Rigobon (2002)'s methodology to obtain an unbiased estimate of correlation. When applied on a rolling basis, this estimation technique is able to track the true conditional correlation. Note that the resulting estimate is nonparametric. As mentioned by Kallberg and Pasquariello (2008), the financial literature contains various empirical applications where rolling filters are found to perform quite well in comparison with parametric specifications. This correction for heteroscedasticity has been used in the context of financial contagion where time-varying volatility is unambiguously present in the data.

Having estimated the commodities returns' conditional mean equation, we use the residuals $\hat{u}_{i,t}$ to compute the residuals correlation coefficient:

$$\hat{\rho}_t^{ij} = \frac{\text{cov}(\hat{u}_{i,t}, \hat{u}_{j,t})}{[\text{var}(\hat{u}_{i,t})\text{var}(\hat{u}_{j,t})]^{1/2}}$$

Boyer et al. (1999), Loretan and English (2000) and Forbes and Rigobon (2002) show that the correlation coefficient is conditional on returns volatility. Hence, in the presence of heteroscedasticity, the usual sample correlation may be biased upward or downward. These authors propose a correction for this bias, and define an unconditional correlation measure under the assumption of no omitted variables or endogeneity. The unconditional correlation is defined as:

$$\hat{\rho}_{ij,t}^{*} = \frac{\hat{\rho}_{ij,t}}{[1 + \hat{\delta}_{i,t}(1 - (\hat{\rho}_{ij,t}^{2})]^{1/2}}$$

where the ratio $\hat{\delta}_{i,t} = \frac{\mathrm{var}(\hat{u}_{i,t})}{\mathrm{var}(\hat{u}_{i,t})_{LT}} - 1$ corrects the conditional correlation $\hat{\rho}_{ij,t}$ by the relative difference between short-term volatility $\mathrm{var}(\hat{u}_{i,t})$ and the long-term volatility $\mathrm{var}(\hat{u}_{i,t})_{LT}$ of the i^{ith} return. As we do not make any *ex ante* assumption on the direction of propagation of shocks from one commodity to another, we alternatively assume that the source of these shocks is commodity i (in $\hat{\rho}^*_{ij,t}$) or commodity j (in $\hat{\rho}^*_{ji,t}$). Therefore, $\hat{\rho}^*_{ij,t}$ and $\hat{\rho}^*_{ji,t}$ may be different.

As we have only two returns, we compute the two unbiased measures of correlation, by using the change in volatility in oil and gas residuals that is to say, if the source of shock is 1:

$$\hat{\rho}^*_{12,t} = \frac{\hat{\rho}_{12,t}}{[1 + \hat{\delta}_{1,t}(1 - (\hat{\rho}^2_{12,t}))]^{1/2}}$$

and, if the source of shock is 2:

$$\hat{\rho}^{**}_{12,t} = \frac{\hat{\rho}_{12,t}}{[1 + \hat{\delta}_{2,t}(1 - (\hat{\rho}^2_{12,t}))]^{1/2}}$$

Besides, we compute the mean of excess squared correlation coefficients:

$$\hat{\rho}^*_t = \frac{1}{2}(\hat{\rho}^*_{12,t} + \hat{\rho}^{**}_{12,t})$$

In this analysis, we treat the covariance matrix of returns residuals as observable, and construct time series of rolling excess squared correlations for each commodity i. We consider a time-varying model:

$$\begin{cases} r_{1,t} = \alpha_{1,t} + \beta'_{1,t}\hat{F}_t + u_{1,t} \\ r_{2,t} = \alpha_{2,t} + \beta'_{2,t}\hat{F}_t + u_{2,t} \end{cases}$$

where $\hat{\rho}^*_{ij,t}$ is estimated over a short-time window of fixed length N $[t - N + 1, t]$. We also consider long-term intervals of length gN (with $g > 1$) $[t - gN + 1, t]$, which gives us $\hat{\delta}_{1,t}$

and $\hat{\delta}_{2,t}$. We are therefore able to compute $\hat{\rho}^{*}_{12,t}$ and $\hat{\rho}^{**}_{12,t}$. We finally obtain the aggregate measure of excess co-movement $\hat{\rho}^{*}_{t}$. Thus, we have corrected the sample correlations for changes in conditional volatilities with a rolling windows of $N = 30$ observations for short-term volatilities, and $N = 60$ observations for long-term volatilities. With the corrected correlations, we compute the average excess squared correlations.

Some descriptive statistics are given in Table 5. We notice that the average squared correlation μ for raw returns $\hat{\rho}^{*2ret}_{t}$ is significant (at the 5% level). Reassuringly, the percentage rate of significant squared correlations $F\rho^{*2}$ is lower for the estimated OLS residuals $\hat{\rho}^{*2OLS}_{t}$ than for the raw returns $\hat{\rho}^{*2ret}_{t}$, indicating the value of the filtration in removing some, but not all of the sources of co-movement.

More specifically, looking at Figure 4, showing the mean excess squared correlation for raw returns and OLS residuals, where the dotted line represents the minimal value above which the squared correlation is significant at the 5% level, we can broadly distinguish two periods[8] during which oil and gas returns are characterized by an episode of 'excess co-movement', namely year 1999 and years 2004 and 2005. During these periods, the red line representing the 'unconditional average square residual correlation' (i.e. the $\hat{\rho}^{*2}_{t}$ computed from OLS residuals) lies below the green line capturing the 'unconditional average square gross returns correlation'(i.e. the $\hat{\rho}^{*2}_{t}$ computed from raw returns). Hence, we verify that our factor analysis has eliminated most (but not all) of the mean excess squared correlation.

[8]Even if these periods correspond to lagged values with our rolling analysis, they fall into the corresponding data points in 1999, 2004 and 2005 when these changes were captured.

6 Financial Impacts on the US oil-gas residual correlation

We now seek to test the financialization conjecture as an explanation for the remaining residual correlation in the filtered oil and gas returns for the U.S. More particularly, we investigate the potential impact of trading activity variables in the oil and gas futures markets on the relationship between oil and gas futures returns. Trading and speculative activities has indeed been established as one influence in the rise of energy prices during the 2000-2008 period (Büyüksahin and Harris (2011), Singleton, 2013), and we also expect this to be manifest in excess co-movement of our commodities.

One instrument for trading activity is inspired by Han (2008), who computed the net position of large speculators in S&P 500 futures based on data from the U.S. Commodity Futures Trading Commission (CFTC). Indeed, the CFTC requires large traders holding positions above a specified level to report their positions on a daily basis. Then, the CFTC aggregates the reported data, and releases the breakdown of each Tuesday's open interest in its Commitments of Traders Report (CoT). This report contains the number of long positions and the number of short positions for both 'commercial' traders and 'non-commercial' traders. Commercial traders are required to register with the CFTC by showing a related cash business for which futures are used as a hedge. The non-commercials are large speculators. Hence, it is possible to calculate a trading activity proxy as the number of long non-commercial contracts minus the number of short non-commercial contracts, scaled by the total open interest in S&P 500 futures. We apply this methodology to the case of the U.S. crude oil and natural gas futures data, which provides us with two regressors denoted *Han* oil and *Han* gas.

We use another measure of trading activity based on the work by de Roon et al. (2000), which proxies the hedging pressure in futures markets. The variable corresponds to the difference between the number of short hedge positions and the number of long hedge positions, divided by the total number of hedge positions. The idea behind this proxy is to focus on the positions of traders who are hedgers, only thereby estimating the pressure of hedging in the futures market. The application of this methodology in our setting returns the regressors *DeRonnetal* oil and *DeRonnetal* gas.

By regressing the unconditional average squared residual correlation (i.e. the $\hat{\rho}_t^{*2}$) on the four exogenous regressors *Han* oil, *Han* gas, *DeRonnetal* oil and *DeRonnetal* gas, we obtain the estimation results reported in Table 6.

Whilst columns (5.a) and (5.b), show the separate regressions for the two proxies with little significance, in column (5.c), the four regressors are considered jointly in the same regression and the results are more satisfactory in the sense that all coefficients are significant. It seems that Han (2008)'s proxy for the speculative activity in the U.S. oil and gas futures market is positively related to the unconditional average squared residual correlation. Conversely, de Roon et al. (2000)'s proxy for hedging pressure appears negatively related to the residual correlation. Thus, it appears that a higher hedging activity, which is by nature more specifically related to one market or another, is associated with a lower residual correlation. Conversely, when the speculative activity is strong, the impact on residual correlation is detected on both oil and gas markets, as agents in this case tend to invest in energy futures markets through commodity indices (Tang and Xiong (2012)), and the consequent explanation of residual returns co-movement is consistent with the financialization conjecture. Finally, as judged by the R^2 of 19%, this analysis of financial trading has explained a substantial part of the remaining residual correlation present in our filtered series for the U.S.

7 Conclusion

A consequence of the streams of research that have suggested that increased financial engagement in commodity futures will link commodity returns more closely to equity indices (Tang and Xiong, 2012; Büyüksahin and Harris, 2011; Singleton, 2013) and that index-focused investment by itself may increase the correlations amongst the assets within the index (Basak and Pavlova, 2013), is the expectation that financial flows into commodities may also manifest increased correlations between actively traded commodities. We tested this on U.S. oil and gas futures and find support for the conjecture. Moreover we find significant evidence that speculation, with its focus on index trading, increases the correlation between oil and gas, whilst hedging, which is based more on individual forward contracts, actually decreases this correlation. Both of these are plausible effects and consistent with the "financialization" observations. Expanding the set of commodities to include coal futures is an obvious extension.

The methodological challenge in obtaining these results is substantial. Since commodities are global products, they generally have a complex set of fundamental drivers, and this is certainly the case for oil and gas. Oil itself requires careful structural modeling (Hamilton, 2009; Kilian, 2009) and the theme of oil-gas linkage has been a lengthy and on-going debate amongst energy economists (Ramberg and Parsons, 2012). We therefore undertook a comprehensive fundamental filtration of oil and gas returns before seeking to associate financial activity with the residual correlations. From a large dataset of macroeconomic and financial variables we found that two factors can explain a significant proportion of both returns, which is an indication of similar economic fundamentals for oil and gas dynamics. This appears to be the first study explaining oil and gas returns with factors extracted from a large dataset in the Stock and Watson (2002a,b) tradition, but ours also includes more international variables from emerging economies. Indeed, we find that the factor with the highest explanatory power for oil is mostly connected with real macroeconomic variables from emerging countries, and this was the one key factor that was not shared in common with gas. Given that gas markets tend to be more local with lower gas penetration in developing countries, this is a consistent result.

Whilst the large dataset factor filtration was effective, it is an area for further methodological refinement, as it is crucial for the subsequent residual estimations. Thus, we considered, as in most of the factor-models literature, the factors as if they were observed, whilst they are actually estimated. Despite this, the assumption should only have a limited impact on our results. However it could be relevant to investigate the small sample case using some simulation techniques as in Ludvigson and Ng (2007, 2009 and 2010) and Gospodinov and Ng (2013). The evolving nature of these fundamentals is more challenging, as dynamic representations may become necessary. Overall, however, the analysis undertaken here appears to give robust and consistent results to the subtle question of estimating the financial effects on commodity inter-correlations in the context of complex global fundamentals.

References

Acharya, V., Lochstoer, J.A., Ramadorai, T., 2013. Limits to arbitrage and hedging: evidence from commodity markets. *Journal of Financial Economics*, forthcoming.

d'Agostino, A., Giannone, D., 2012. Comparing alternative predictors based on large-panel factor models. *Oxford Bulletin of Economics and Statistics* 74, 306-326.

Bachmeier, L.J., Griffin, J.M., 2006. Testing for market integration, crude oil, coal and natural gas. *Energy Journal* 27, 55-71.

Bai, J., 2003. Inferential theory for factor models of large dimensions. *Econometrica* 71, 135-172.

Bai, J., Ng, S., 2002. Determining the number of factors in approximate factor models. *Econometrica* 70, 191-221.

Bai, J., Ng, S., 2008. Large dimensional factor analysis. *Foundations and Trends in Econometrics* 3, 89-163.

Basak, S., Pavlova, A., 2013 Asset prices and institutional investors. *American Economic Review*, forthcoming.

Boivin, J., Ng, S., 2006. Are more data always better for factor analysis. *Journal of Econometrics* 132, 169-194.

Boyer, B., Gibson, M., Loretan, M., 1999. Pitfalls in tests for changes in correlations. Working Paper, vol. 597R. Federal Reserve Board.

Brown, S.P.A., Yücel, M.K., 2008. What drives natural gas prices? *Energy Journal* 29, 45-60.

Caggiano, G., Kapetanios, G., Labhard, V., 2011. Are more data always better for factor analysis? Results for the euro area, the six largest euro area countries and the UK. *Journal of Forecasting* 30, 736-752.

Forbes, K., Rigobon, R., 2002. No contagion, only interdependence: measuring stock market co-movements. *Journal of Finance* 57, 2223-2261.

Forni, M., Hallin, M., Lippi, M., Reichlin, L., 2005. The generalized dynamic factor model, one sided estimation and forecasting. *Journal of the American Statistical Association* 100, 830-840.

Gospodinov, N., Ng, S., 2013. Commodity prices, convenience yields, and inflation. *Review of Economics and Statistics* 95, 206-219.

Hamilton, J.D., 2009. Causes and consequences of the oil shock of 2007-08. *Brookings Papers on Economic Activity* 1 (Spring), 215-261.

Han, B., 2008. Investor sentiment and option prices. *Review of Financial Studies* 21, 387-414.

Hartley, P.R., Medlock, K.B., Rosthal, J.E., 2008. The relationship of natural gas to oil prices. *Energy Journal* 29, 47-65.

Kallberg, J., Pasquariello, P., 2008. Time-series and cross-sectional excess comovement in stock indexes. *Journal of Empirical Finance* 15, 481-502.

Kapetanios, G., 2010. A testing procedure for determining the number of factors in approximate factor models with large datasets. *Journal of Business and Economic Statistics* 28, 397-409.

Kilian, L., 2009. Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review* 99, 1053-1069.

Loretan, M., English, W., 2000. Evaluation "correlation breakdowns" during periods of market volatility. In: Bank of International Settlements (BIS), International Financial Markets and the Implications for Monetary and Financial Stability. BIS, Switzerland.

Ludvigson, S.C., Ng, S., 2007. The empirical risk return relation: A factor analysis approach. *Journal of Financial Economics* 83, 171-222.

Ludvigson, S.C., Ng, S., 2009. Macro factors in bond risk premia. *Review of Financial Studies* 22, 5027-5067.

Ludvigson, S.C., Ng, S., 2010. A factor analysis of bond risk premia. *Handbook of Empirical Economics and Finance*, e.d. by A. Uhla and D.E.A. Giles, pp. 313-372. Chapman and Hall, Boca Raton, FL.

Panagiotidis, T., Rutledge, E., 2007. Oil and gas markets in the UK: Evidence from a cointegrating approach. *Energy Economics* 29, 329-347.

Ramberg, D.J., Parsons, J.E., 2012. The weak tie between natural gas and oil prices. *Energy Journal* 33, 13-35.

de Roon, F.A., Nijman, T.E., Veld, C., 2000. Hedging pressure effects in futures markets. *Journal of Finance* 55, 1437-1456.

Serletis, A., Herbert, J., 1999. The message in North American energy prices. *Energy Economics* 21, 471-483.

Serletis, A., Rangel-Ruiz, R., 2004. Testing for common features in North American energy markets. *Energy Economics* 26, 401-414.

Singleton, K.J., 2013. Investor flows and the 2008 boom/bust in oil prices. *Management Science*, forthcoming.

Stock, J.H., Watson, M.W., 2002a. Forecasting using principal components from a large number of predictors. *Journal of the American Statistical Association* 97, 1167-1179.

Stock, J.H., Watson, M.W., 2002b. Macroeconomic forecasting using diffusion indexes. *Journal of Business and Economic Statistics* 20, 147-62.

Stock, J.H., Watson, M.W., 2005, Implications of dynamic factor models for VAR analysis, *NBER WP*, 11467.

Stock, J.H., Watson, M.W., 2006. Forecasting with many predictors. In: G. Elliott, C.W.J. Granger, A. Timmermann (Eds.), *Handbook of Economic Forecasting*, vol. 1, Elsevier.

Tang, K., Xiong, W., 2012. Index investment and financialization of commodities. *Financial Analysts Journal* 68, 54-74.

Villar, J.A., Joutz, F.L., 2006. The relationship between crude oil and natural gas prices. *Report of the Energy Information Administration*, Office of Oil and Gas, Washington D.C.

Tables

Table 1: Descriptive statistics for U.S. monthly returns.

	Oil (US)	Gas (US)
Mean	0.0077	0.0040
Maximum	0.3045	0.9694
Minimum	-0.4340	-0.8496
Std. Dev.	0.0991	0.2176
Skewness	-0.5770	0.0555
Kurtosis	4.6766	5.5875
Jarque-Bera	33.83*	33.83*
Nb. of Obs.	196	196
correlation	0.2095	
p-value	0.0032	

Note:(i) monthly returns are computed as log difference of raw prices. Commodity prices are cash prices except crude oil where the current month contract price is taken as a proxy for the cash price. (ii) '*' denotes a rejection of the null hypothesis of a Gaussian distribution at the 5% level. (iii) The p-value is computed by transforming the residual correlation to create a t-statistic having $(N-2)$ degrees of freedom, with N the number of observations.

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

Note: MED denotes the number of factors given by the Maximum Eigenvalue Distribution algorithm. IC_i and PCP_i denote, respectively, the number of factors given by the information criteria IC and PCP estimated with the 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 during 1993:12-2010:3. The data are transformed (taking logs and first difference 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.

Table 4: Fitting U.S. crude oil and natural gas returns. Data from 01/12/1993 to 01/03/2010.

	US market					
	Crude oil (1.a)	*Natural gas* (1.b)	*Crude oil* (2.a)	*Natural gas* (2.b)	*Crude oil* (3.a)	*Natural gas* (3.b)
Intercept	0.0077	0.0040	0.0085	0.0038	0.0089	0.0053
	(1.34)	(0.27)	(1.49)	(0.25)	(1.53)	(0.34)
$\widehat{F}_1$	-0.1217***	-0.0355	-0.1195***	-0.0458	-0.1199***	-0.0471
	(-6.95)	(-0.77)	(-6.58)	(-0.94)	(-6.59)	(-0.96)
$\widehat{F}_2$	-0.1489***	-0.1583***	-0.1503***	-0.1553***	-0.1507***	-0.1565***
	(-7.63)	(-2.71)	(-6.73)	(-2.63)	(-6.73)	(-2.65)
$\widehat{F}_7$	0.1454***	0.2574***	0.1322***	0.2487***	0.1335***	0.2517***
	(3.99)	(2.85)	(3.67)	(2.66)	(3.68)	(2.69)
Δs_{oil}			-0.9966*		-0.9742*	
			(-1.90)		(-1.83)	
Δs_{gas}				-0.3017		-0.3113
				(-1.16)		(-1.19)
Du					-0.0072	-0.0227
					(-0.31)	(-0.3744)
R^2	0.3481	0.0728	0.3597	0.0777	0.3600	0.0783
$\overline{R}^2$	0.3381	0.0583	0.3462	0.0584	0.3431	0.0541
Arch-LM (2)	3.26	27.59**	0.73	26.99**	0.69	26.99**
Residual correl.	0.0961		0.1081		0.1077	
p-value	0.1802		0.1315		0.1328	

Note: (i) Columns (1.a) and (1.b) report the OLS estimates of the regression of monthly US crude oil and natural gas returns on the contemporaneous variables named in the left column. (ii) Columns (2.a), (2.b), (3.a) and (3.b) report the FGLS estimates for the oil and gas returns. (iii) The dependent variable is the nominal log return for each commodity listed in row 1. $\widehat{F}_i$ denotes the i^{th} factor estimated using principal component methods. 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. (v) The p-value is computed by transforming the residual correlation to create a t-statistic having $(N-2)$ degrees of freedom. (vi) For each test ***, **, and * denote rejection of the null hypothesis at, respectively, the 1%, 5% and 10% levels. (vii) *Arch-LM (2)* stands for Engle's ARCH Lagrange Multiplier test with a lag order equal to 2.

Table 5: Descriptive statistics on squared correlations

	$\hat{\rho}_t^{*2ret}$	$\hat{\rho}_t^{*2OLS}$
μ	0.1793*	0.1048
σ	0.1413	0.1065
$F\rho^{*2}$	51%	22%
C_ρ	0.8306	

Notes: This table reports summary statistics for the excess squared unconditional correlation of OLS residuals $\hat{\rho}_t^{*2OLS}$, and the benchmark squared unconditional correlation of raw returns $\hat{\rho}_t^{*2ret}$. $F\rho^{*2}$ is the mean percentage of squared unconditional correlation significant at the 5% level using the t-square ratio test $\hat{t}_{ijt}^2 = (\hat{\rho}_{ijt}^*)^2[1-\hat{\rho}_{ijt}^*]^{-1}(N-2) \sim F(1, N-2)$. * denotes significance at the 5% level. C_ρ is the correlation between each pair $\hat{\rho}_t^{*2OLS}$ and $\hat{\rho}_t^{*2ret}$. μ stands for the mean, and σ for the standard deviation.

Table 6: Regression of average excess correlation on trading activity proxies for US oil and gas returns - time period 1998:02 to 2010:03.

		$\hat{\rho}_t^{*2}$	
	(5.a)	(5.b)	(5.c)
Intercept	0.0783*	0.0844*	0.0832*
	(4.39)	(5.16)	(5.06)
DeRonnetal oil	0.0511		-0.2015*
	(1.22)		(-2.21)
DeRonnetal gas	-0.0562*		-0.1143*
	(-2.05)		(-3.01)
Han oil		0.5014	2.2669*
		(1.76)	(3.49)
Han gas		0.1260	0.8370*
		(0.72)	(3.54)
N		137	
R^2	0.0307	0.0287	0.1914
$\overline{R}^2$	0.0162	0.0142	0.1669

Note: $\hat{\rho}_t^{*2}$ is the unconditional average squared residual correlation. *Han oil* and *Han gas* are the speculative trading activity proxies computed from CFTC futures data for oil and gas, respectively. *DeRonnetal oil* and *DeRonnetal gas* are the proxy for hedging pressure in futures markets for oil and gas, respectively. N is the number of observations. * denotes significance at the 5% level.

Figures

Figure 1: Prices of crude oil (upper graph) and natural gas (lower graph) - USA - 01/11/1993 to 01/03/2010

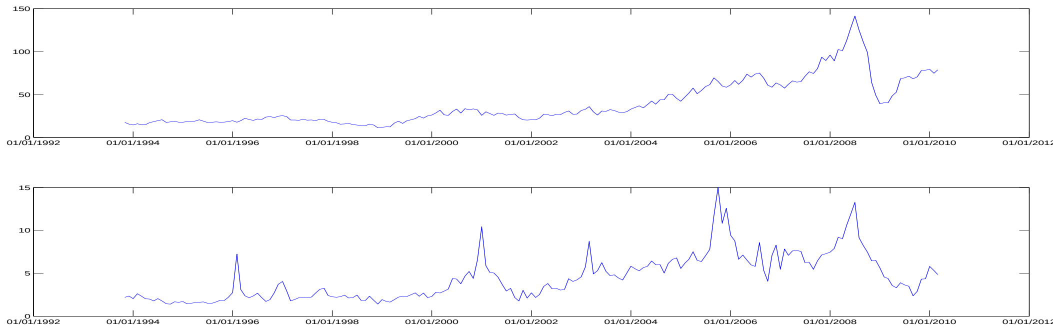


Figure 2: Returns of crude (upper graph) oil and natural gas (lower graph) - USA- 01/12/1993 to 01/03/2010

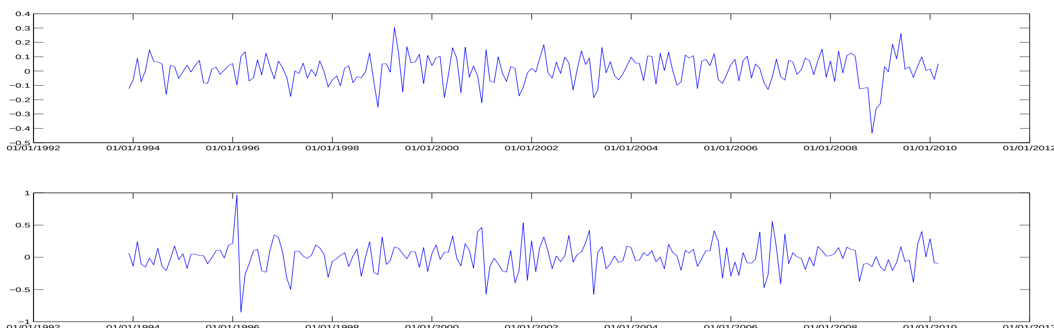
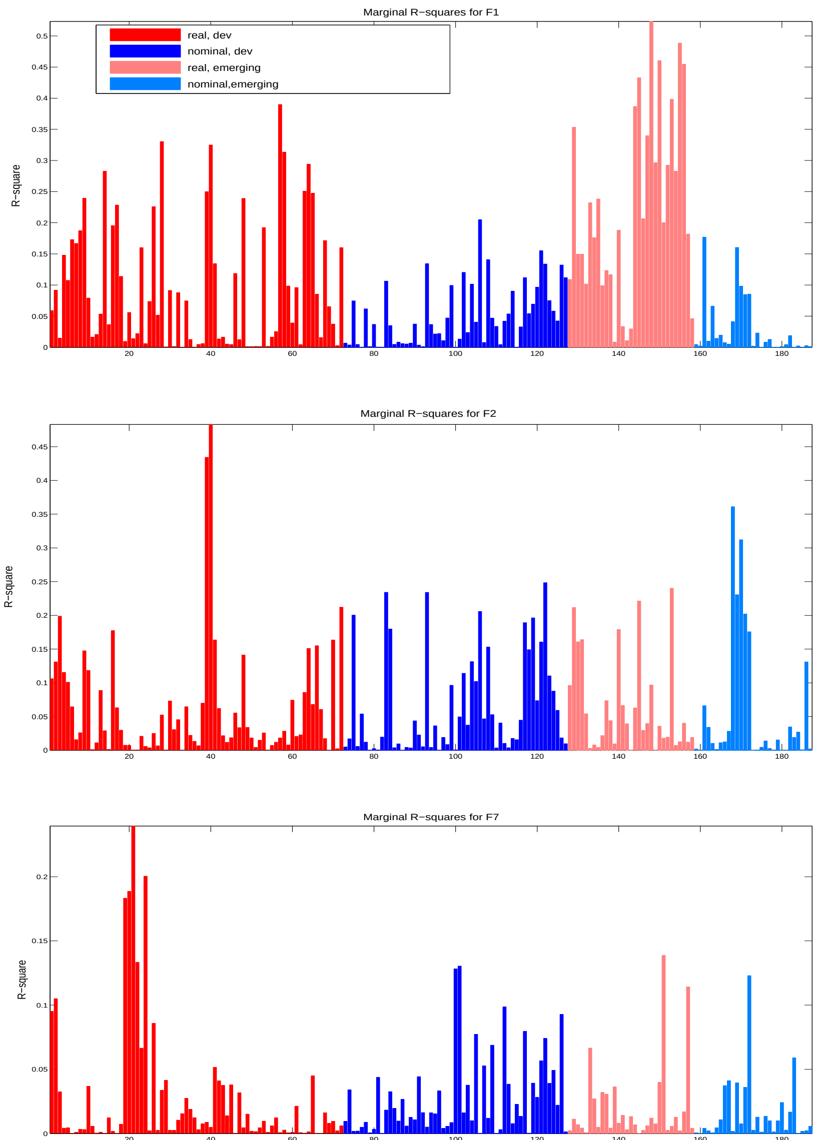
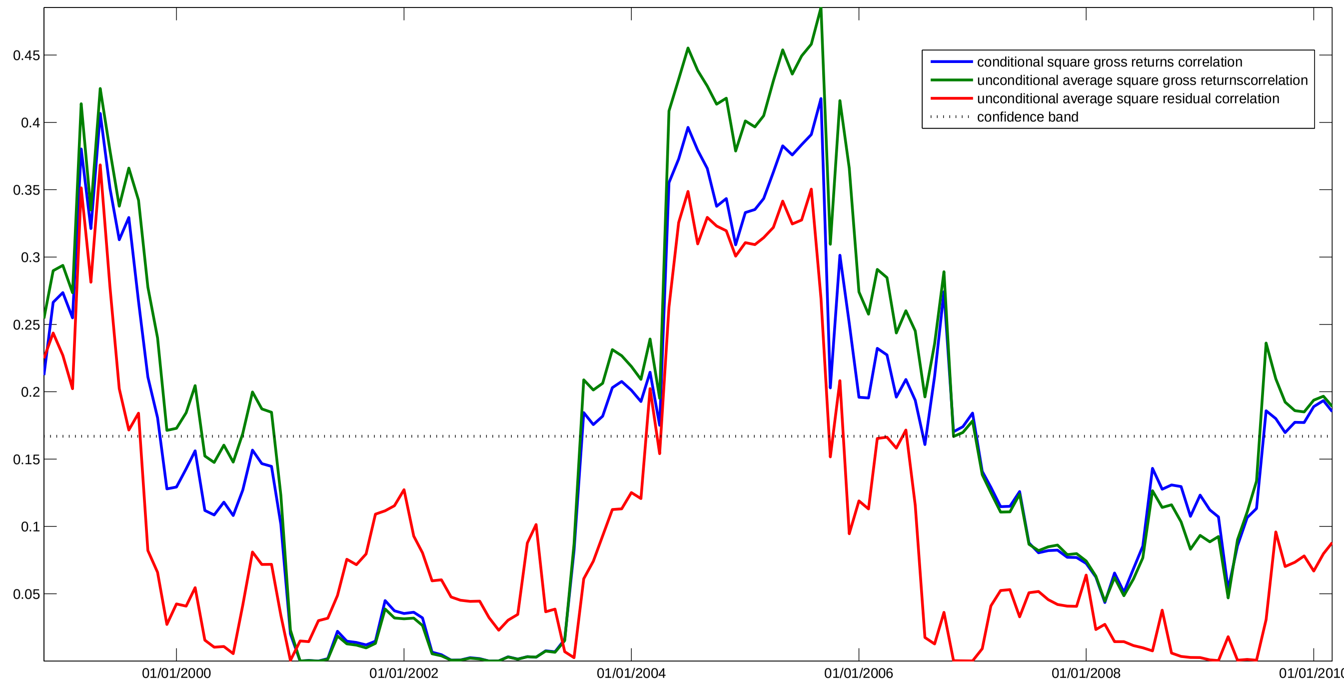


Figure 3: Marginal R^2 of macroeconomic and financial variables regressed on the estimated factors no. 1, 2 and 7.



Note: Each panel shows the R^2 from regressing the series number given on the x-axis onto each individual factor $\hat{F}_i$. The series are detailed in the Appendix, and 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).

Figure 4: Mean excess squared correlation for raw returns and OLS residuals



Note: 'conditional squared gross returns correlation' is the squared correlation of raw returns not corrected for heteroskedasticity. 'unconditional average square gross returns correlation' is the ρ_t^{*2} computed from raw returns. 'unconditional average square residual correlation' is ρ_t^{*2} computed from OLS residuals. The confidence band represents the minimal value above which squared correlation is significant at the 5% level. It is computed from the t-squared ratio test $\hat{t}_{ijt}^2 = (\hat{\rho}_{ijt}^*)^2[1-\hat{\rho}_{ijt}^*]^{-1}(N-2) \sim F(1, N-2)$.

Appendix: list of the 187 variables considered in the computation of the common factors

Note: In the Trans column, we report the transformation used to ensure the stationarity of each variable. ln denotes the 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.

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

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

Series Number	Short name	Mnemonic	Tran	Description
Money and credit - continuation				
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

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