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The oil price-macroeconomy relationship since the mid-1980s: A global perspective

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We investigate the oil price-macroeconomy relationship from a global perspective, by means of a large scale macro-financial-econometric model. In addition to real activity, we consider fiscal and monetary policy responses and labor and financial markets conditions, in order to provide a comprehensive account of the macro-financial effects of oil price shocks. We find that oil market supply side, speculative, preferences, and volatility shocks exercised recessionary effects during the first and second Persian Gulf War and 2008 oil price episodes. As long as oil supply will keep expanding at a slower pace than required by demand conditions, and in so far as the recently passed regulatory provisions aimed at controlling financial speculation in the oil (and other commodities) futures market will prove unsuccessful, a recessionary bias, determined by higher and more uncertain real oil prices, may then be expected to persist also in the near future.

1. INTRODUCTION

Since the 1990s, the literature has focused on different features of the oil price-macroeconomy relationship, concerning its relevance, the presence of asymmetric responses, the sources of shocks and the role of the Great Moderation: to date, 10 out 11 postwar US recessions were preceded by sharp increases in oil prices (Hamilton, 2011).

Theoretically, an oil price shock may *directly* affect real activity through different demand and supply side channels. For instance, private consumption may contract due to discretionary income and precautionary savings effects, as households dispose of lower real income after paying energy bills and face a higher likelihood of future unemployment or longer unemployment duration (Edelstein and Kilian, 2009). Moreover, as higher and more volatile energy prices may lead consumers and firms postponing the purchase of durables and irreversible investment decisions, respectively (Bernanke, 1983; Pindyck, 1991), uncertainty effects may also be relevant; similarly through an operating costs

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channel, as consumers may postpone the purchase of durables (complement in use of energy) and firms save on capital usage, due to rising marginal costs and decreasing labor and capital productivity (Pindyck and Rotemberg, 1984; Rotenberg and Woodford, 1996). [2]

Indirect effects, due to changes in consumption patterns and technologies, inducing capital/labor reallocation across sectors, may also be posited: if production factors are sector or product specific, an oil price shock, by shifting preferences in favor of more efficient durables and technologies, may then lead to labor and capital unemployment (Hamilton, 1988). Moreover, as the implementation of preemptive restrictive monetary policies might lead to stronger negative responses of real activity to oil price shocks than otherwise would occur (Bernanke et al., 1997), the monetary policy transmission mechanism may yield an additional source of asymmetry, relatively to the reallocation and uncertainty effects.[3]

The empirical evidence on the above channels is not clear-cut. For instance support to the asymmetry feature of the oil price-macroeconomy relationship (Mork, 1989) is provided by Lee et al. (1995) and Hamilton (1996, 2003), showing that oil shocks are more likely to affect real activity when they occur in an environment of low oil price volatility or when they are not compensating previous price decreases. Moreover, consistent with the relevance of the reallocation effect, oil price shocks are found to affect differently and more strongly job destruction than job creation, and energy intensive sectors (automobile, chemicals, rubber and plastic) than other sectors (generating supply rather than demand shortages) by Engeman et al. (2011), Davis and Haltinwanger (1999), Lee and Ni (2002), Herrera et al. (2010), Ramey and Vine (2012). See also Ferder (1996), Elder and Serletis (2010), Lee et al. (2010) and Miller and Ni (2011) for supporting evidence concerning the uncertainty channel.

Yet, by comparing dynamic multipliers, measuring the response of US consumption, investment, and GDP to positive and negative energy price shocks, in support to the (symmetric) discretionary income, precautionary savings and operating costs mechanisms, no evidence of asymmetric responses is found by Edelstein and Kilian (2007, 2009) and Kilian and Vigfusson (2011a,b). Moreover, despite the evidence provided by Bernanke et al. (1997), Hamilton and Herrera (2004), Herrera and Pesavento (2009) and Kilian and Lewis (2011) dismiss any deepening effect of systematic monetary policy on US recessions since the 1970s.

Different explanations for the resilience of the global (world) economy to the recent oil price episode have also been provided, i.e. a declining oil share (Nakov and Pescatori, 2010), lower real wage rigidity (Blanchard and Galí, 2010; Blanchard and Riggi, 2009), lower volatility of oil demand and supply shocks (Baumeister and Peersman, 2009), and better anchoring of inflation expectations, in the face of demand driven oil price shocks (Kilian, 2010).

In the light of the contrasting empirical evidence and the different

[2] Oil price drag and real balances/interest rate channels, in the case of a stagflationary oil price shock, may also be posited.

[3] Similarly for the real money balances effect, in so far as real wages are only downward rigid (Mork, 1994).

explanations provided in the literature for the economic effects of the 2008 oil price episode, the paper then assesses the recessionary effects of oil price shocks since the mid-1980s, by means of a large-scale factor vector autoregressive (F-VAR) model and a detailed description of global oil market-macro-finance interactions. The original contributions to the literature are as follows.

Firstly, in terms of model specification, the modeling approach allows for unobserved factors, related to global macro-financial conditions, estimated using data for fifty countries, including OECD and emerging countries; following the lead of Morana (2012a), proxy variables for expectations about future global fundamentals and economic/financial fragility conditions, i.e., risk aversion, size, value, momentum, stock's liquidity, and leverage factors, are also directly included in the information set; global oil reserves, production, consumption, (OECD) inventories, refineries margins, and proxies for oil price uncertainty and excess speculation in the oil futures market, are finally employed to account for physical and financial oil market conditions. To our knowledge this is the first paper in the oil price-macroeconomy literature to directly modeling market expectations about future fundamentals and to seek understanding of the global macro-financial effects of oil price shocks from a broad empirical perspective, involving real activity and fiscal/monetary policy responses, as well as labor and financial markets developments, within a joint assessment.

Secondly, the proposed modeling strategy grants the benefits of a richer description of oil market-macroeconomy interactions than achieved in previous small scale VAR investigations (Kilian, 2009; Baumeister and Peersman, 2008, 2009), still attained using the same tools of econometric policy analysis, and the multi-country/global perspective yield by dynamic panel data analysis, yet improving upon the latter in terms of empirical reliability: different from the fixed effect estimator for panel-VAR model, the PC-VAR approach implemented in the paper (Morana, 2012b) neither shows downward bias nor is inconsistent when the coefficients on the lagged endogenous variables differ across countries (Pesaran and Smith, 1995; Holtz-Eakin et al., 1988).

Ten oil market structural shocks, related to both supply and demand side conditions, are then identified and their macro-financial consequences studied in details. New evidences on the oil market-macroeconomy relationship are shed, as we are unaware, for instance of previous results concerning the macro-financial effects of oil market non fundamental financial speculation shocks, as well as oil reserves and refineries margins shocks.

Thirdly, by controlling for the macro-financial factors driving flow and financial oil demand, more accurate identification of purely oil market supply side shocks should be achieved within the proposed framework; this feature is particularly desirable in the light of recent results, suggesting that recessionary effects should stem from supply driven oil price shocks only (Kilian, 2009).

The main results are as follows. Firstly, oil market shocks exercise stronger effects on macro-financial variables in the long- than in the short-term; for instance, figures for real activity are 20% and 10%, respectively. In particular, supply side disturbances yield the largest contribution to macro-financial fluctuations, i.e., 12% and 9% for real activity and (core) inflation, 30% to 35%

for real stock and housing prices; consistent with their macro-financial effects, the latter shocks also sizably account for fluctuations in the policy variables, i.e. public expenditure (13%), liquidity (40%), and the real interest rate (7%).

Secondly, symmetric transmission mechanisms, as described by the discretionary income, precautionary savings and operating costs channels, are supported by the empirical evidence; similarly for the uncertainty channel, which, within the framework considered, is not necessarily asymmetric. Indeed, by comparing the effects of positive and negative net production shocks, weak evidence of asymmetric impacts on real activity can be found, the latter responding more strongly to negative than positive shocks in the very short-term only. Real effects of oil market speculative and consumption/inventories preferences shocks are also found.

Thirdly, the above mechanisms might account for the recessionary effects associated with some recent oil price shock episodes. In particular, during the first Persian Gulf War, oil market supply side shocks contributed to the 1990:2-1993:3 recession (-1.2%), and, at a lower extent, during the second Persian Gulf War, to the 2000:4-2003:2 recession (-0.24%). Oil market supply side conditions also exacerbated the recessionary effects of the subprime financial crisis in 2008 (-1.19%). Oil market speculative, preferences and volatility shocks also sizably contributed to slowing down real activity over the three episodes investigated.

Finally, we find that the resilience of the global economy to the 2008 oil price shock may be related to both an endogenous contraction in real wages and the implementation of expansionary stabilization policies, in the face of a mostly demand (macro)-driven oil price shock.

After this introduction, the paper is organized as follows. In Section 2 the econometric methodology is introduced, while in Section 3 the data are presented. Then, in Section 4 specification and estimation issues are discussed, while in Sections 5 and 6 the empirical results are presented. Finally, conclusions are drawn in Section 7.

2. THE ECONOMETRIC MODEL

The econometric model is described by two blocks of equations. The first block refers to the observed ($\mathbf{F}_{2,t}$) and unobserved ($\mathbf{F}_{1,t}$) global macro-financial factors and oil market demand and supply side variables ($\mathbf{O}_t$), collected in a $r \times 1$ vector $\mathbf{F}_t = \left[\mathbf{F}_{1,t}' \quad \mathbf{F}_{2,t}' \quad \mathbf{O}_t' \right]'$, while the second block to q macro-financial variables for m countries ($n = m \times q$ equations in total). Global and local economic dynamics are then modeled by means of the following reduced form dynamic factor model

$$\begin{aligned}&\left(\mathbf{I}-\mathbf{P}(L)\right)\left(\mathbf{F}_t-\boldsymbol{\kappa}_t\right)=\ \boldsymbol{\eta}_t\\&\boldsymbol{\eta}_t\sim i.i.d.(\mathbf{0},\boldsymbol{\Sigma}_\eta)\end{aligned}\tag{1}$$

$$\begin{aligned}&\left(\mathbf{I}-\mathbf{C}(L)\right)\left(\left(\mathbf{Z}_t-\boldsymbol{\mu}_t\right)-\boldsymbol{\Lambda}\left(\mathbf{F}_t-\boldsymbol{\kappa}_t\right)\right)\ =\ \mathbf{v}_t\\&\mathbf{v}_t\sim i.i.d.(\mathbf{0},\boldsymbol{\Sigma}_v)\end{aligned}\tag{2}$$

where $\left(\mathbf{F}_t-\boldsymbol{\kappa}_t\right),\left(\mathbf{Z}_t-\boldsymbol{\mu}_t\right)\sim I(0)$, $\boldsymbol{\mu}_t$ and $\boldsymbol{\kappa}_t$ are $n\times 1$ and $r\times 1$ vectors of deterministic components, respectively, with $r<n$, including an intercept term, and, possibly, linear or non-linear trends components.

Global dynamics are described by the stationary finite order polynomial matrix in the lag operator $\mathbf{P}(L)$, $\mathbf{P}(L)\equiv\mathbf{P}_1L+\mathbf{P}_2L^2+...+\mathbf{P}_pL^p$, where $\mathbf{P}_j$, $j=1,..,p$, is a square matrix of coefficients of order *r*, and $\boldsymbol{\eta}_t$ is a $r\times 1$ vector of *i.i.d.* reduced form shocks driving the $\mathbf{F}_t$ factors.

Local dynamics are modeled through the stationary finite order polynomial matrix in the lag operator $\mathbf{C}(L)$, $\mathbf{C}(L)\equiv\mathbf{C}_1L+\mathbf{C}_2L^2+...+\mathbf{C}_cL^c$, where $\mathbf{C}_j$, $j=1,..,c$, is a square block (own country) diagonal matrix of coefficients of order *n*, partitioned as $\underset{n\times n}{\mathbf{C}_j}=diag\left\{\underset{q\times q}{\mathbf{C}_{j,11}}\quad\underset{q\times q}{\mathbf{C}_{j,22}}\quad ...\quad\underset{q\times q}{\mathbf{C}_{j,mm}}\right\}$.

The contemporaneous effects of the global factors on each country variables in $\mathbf{Z}_t$ are measured by the loading coefficients collected in the $n\times r$ matrix $\boldsymbol{\Lambda}=\left[\boldsymbol{\Lambda}_{F_1}'\quad\boldsymbol{\Lambda}_{F_2}'\quad\boldsymbol{\Lambda}_O'\right]'$. Finally, $\mathbf{v}_t$ a $n\times 1$ vector of *i.i.d.* reduced form idiosyncratic (i.e. country-specific) disturbances, with $E\left[\eta_{j,t}v_{i,s}\right]=0$ for all *i*, *j*, *t*, *s*.

The specification of the model in (1)-(2) embeds a set of important assumptions on the structure of global and local linkages: (i) global shocks ($\boldsymbol{\eta}_t$) affect both the global and local economy through the polynomial matrix $\mathbf{P}(L)$ and the factor loading matrix $\boldsymbol{\Lambda}$; (ii) country-specific disturbances ($\mathbf{v}_t$) do not affect global factor dynamics, exercising their impact on the country of origin only, as $\mathbf{C}(L)$ is assumed to be block (own-country) diagonal.

Consistent and asymptotically normal estimation of the two-block specification in (1) and (2) is obtained by means of the procedures proposed in Morana (2011, 2012b), also shown to yield accurate estimation in small samples (see the Monte Carlo results therein reported).

The reduced form vector autoregressive (VAR) representation of the dynamic factor model can be written as

$$\left(\mathbf{I}-\mathbf{A}(L)\right)(\mathbf{Y}_t-\boldsymbol{\gamma}_t)=\boldsymbol{\varepsilon}_t\,, \tag{3}$$

where $\mathbf{Y}_t=\left[\mathbf{F}_t' \quad \mathbf{Z}_t'\right]'$, $\boldsymbol{\gamma}_t=\left[\boldsymbol{\kappa}_t' \; \boldsymbol{\mu}_t'\right]'$,

$$\mathbf{A}(L)=\begin{pmatrix} \mathbf{P}(L) & \mathbf{0} \\ \left[\boldsymbol{\Lambda}\mathbf{P}(L)-\mathbf{C}(L)\boldsymbol{\Lambda}\right] & \mathbf{C}(L) \end{pmatrix},$$

$$\boldsymbol{\varepsilon}_t\equiv\begin{bmatrix}\boldsymbol{\varepsilon}_{1,t}\\ \boldsymbol{\varepsilon}_{2,t}\end{bmatrix}=\begin{bmatrix}\mathbf{I}\\ \boldsymbol{\Lambda}\end{bmatrix}\left[\boldsymbol{\eta}_t\right]+\begin{bmatrix}\mathbf{0}\\ \mathbf{v}_t\end{bmatrix},$$

with variance-covariance matrix

$$E\left[\boldsymbol{\varepsilon}_t\boldsymbol{\varepsilon}_t'\right]=\boldsymbol{\Sigma}_{\varepsilon}=\begin{pmatrix}\boldsymbol{\Sigma}_{\eta} & \boldsymbol{\Sigma}_{\eta}\boldsymbol{\Lambda}'\\ \boldsymbol{\Lambda}\boldsymbol{\Sigma}_{\eta}' & \boldsymbol{\Lambda}\boldsymbol{\Sigma}_{\eta}\boldsymbol{\Lambda}'+\boldsymbol{\Sigma}_{v}\end{pmatrix}.$$

The structural vector moving average representation for the global model in (1) can then be written as

$$\left(\mathbf{F}_t-\boldsymbol{\kappa}_t\right)=\mathbf{H}_F\left(L\right)\mathbf{K}^{-1}\boldsymbol{\xi}_t\,, \tag{4}$$

where $\boldsymbol{\xi}_t$ is the vector of the r structural shocks driving the common factors in $\mathbf{F}_t$, i.e. $\boldsymbol{\xi}_t=\mathbf{K}\boldsymbol{\eta}_t$, $\mathbf{K}$ is a $r\times r$ invertible matrix, and

$$\mathbf{H}(L)\equiv\begin{pmatrix}\mathbf{H}_F\left(L\right) & \mathbf{0}\\ \mathbf{H}_{FZ}\left(L\right) & \mathbf{H}_Z\left(L\right)\end{pmatrix}\equiv\left(\mathbf{I}-\mathbf{A}\left(L\right)\right)^{-1}.$$

By assumption the structural factor shocks are orthogonal and have unit variance, so that $E\left[\boldsymbol{\xi}_t\boldsymbol{\xi}_t'\right]=\mathbf{K}\boldsymbol{\Sigma}_{\eta}\mathbf{K}'=\mathbf{I}_r$. To achieve exact identification of the structural disturbances, additional $r\left(r-1\right)/2$ restrictions need to be imposed. Since $\boldsymbol{\eta}_t=\mathbf{K}^{-1}\boldsymbol{\xi}_t$, imposing exclusion restrictions on the contemporaneous impact matrix amounts to imposing zero restrictions on the elements of $\mathbf{K}^{-1}$, for which a lower-triangular structure is assumed. Operationally, $\mathbf{K}^{-1}$ (with the $r\left(r-1\right)/2$ zero restrictions necessary for exact identification imposed) is estimated by the Choleski decomposition of the factor innovation variance-covariance matrix $\boldsymbol{\Sigma}_{\eta}$, i.e., $\mathbf{K}^{-1}=chol(\boldsymbol{\Sigma}_{\eta})$. Forecast error variance and historical decompositions can then be obtained by means of standard formulas. See the Appendix for details on the econometric methodology.

3. THE DATA

The dataset is composed of seasonally adjusted quarterly macroeconomic time series data for 31 advanced economies (Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom), 5 advanced emerging economies (Brazil, Hungary, Mexico, Poland, South Africa), and 14 secondary emerging economies (Argentina, Chile, China, Colombia, India, Indonesia, Malaysia, Morocco, Pakistan, Peru, Philippines, Russia, Thailand, Turkey), for a total of 50 countries. The (main) data source is IMF International Financial Statistics.[4]

Concerning the block of equations in (2), in order to provide a comprehensive account of the financial, nominal and real side of the local economies, for each of the 50 countries, apart from some exceptions[5], 17 macroeconomic variables are employed, namely real GDP, private consumption and investment growth, public expenditure to GDP ratio growth, nominal bilateral US$ exchange rate (value of 1 unit of country currency in US$) returns, CPI inflation rate, M2 or M3 to GDP ratio growth, nominal M2/M3 growth, civilian employment growth, unemployment rate changes, real wages growth, real stock prices returns, real housing prices returns, real short and long term interest rates, real effective exchange rate returns, bank loans to the private sector to GDP ratio growth. Over 800 equations are then considered in block (2). For OECD countries the macro-financial sample extends from 1980:1 through 2010:3, while for non OECD countries from 1995:1 through 2010:3. Different samples are therefore employed for the estimation of the 12 *unobserved* factors $\mathbf{F}_{1,t}$, describing global macro-financial conditions, which can be extracted from the country level dataset, following the approach described in the methodological section.

In particular, a first order own diagonal dynamic structure, as suggested by the BIC information criterion, and subsets of homogeneous variable are employed; hence, a real activity factor (Y) has been obtained from real GDP, private consumption and investment growth series; a fiscal stance factor from public expenditure to GDP ratio growth series (G); a global bilateral US$ exchange rate index from the various US$ bilateral exchange rate returns (X); a nominal (core inflation) factor (N) from inflation rates and nominal money growth, short and long term interest rates; an excess liquidity index (L) from M3(M2) to GDP ratio and private loans to GDP ratio growth series; an employment factor (E) from civilian employment growth series; an unemployment rate factor (U) from unemployment rate in changes series; a real wage factor (W) from real wage growth series; a real stock market return factor (F) from real stock market price index returns; a real housing return factor (H)

[4] Other data sources employed are FRED2 (Federal Reserve Bank of St. Louis); OECD and BIS (unofficial) house price data sets, and International Energy Agency (IEA-OECD) data sets.

[5] Exceptions concern real housing prices and long-term interest rates, which are unavailable for emerging countries.

from real housing price index returns; a real short term rate factor (R) from real short term interest rates; a term spread factor (TS) from term spread series.[6]

Concerning the block of equations in (1), 33 variables are considered in the vector $\mathbf{F}_t$. In addition to the above 12 estimated unobserved global macro-financial factors $\mathbf{F}_{1,t}$, in order to provide a comprehensive description of global financial and oil market conditions, 11 (global) *observed* financial factors, collected in the vector $\mathbf{F}_{2,t}$, and 10 oil market variables, collected in the vector $\mathbf{O}_t$, are considered.

In particular, the vector $\mathbf{F}_{2,t}$ is comprised of the Bagliano and Morana (2012) US economic/financial fragility index (FRA) in differences, the Fama and French (1993) size and value factors (SMB, HML), the Carhart (1997) momentum factor (MOM), the Pastor and Stambaugh (1997) stocks' liquidity factor (PSL), the S&P 500 stock return volatility in differences (FV), computed from an asymmetric GARCH model, the real gold price (GD) return, real IMF non-energy commodities price index returns (M), the US fiscal (Fd) and trade deficit (Td) to GDP ratios in differences, the Adrian, Etula and Muir (2011) leverage factor (LEV).

Moreover, the vector $\mathbf{O}_t$ contains world oil reserves growth (R), net world oil production changes (increase: Pp, decrease: Pm), OECD oil refinery margins growth (RM), world oil consumption (C) growth, OECD oil inventories rate of growth (INV), real WTI oil price (OP) returns, nominal WTI oil price volatility in differences (OV), computed from a GARCH model, the twelve-month futures basis, i.e. the ratio of the nominal twelve-month futures-spot price spread over the nominal spot oil price (FB), computed using Crude Oil (Light-Sweet, Cushing, Oklahoma) 12th Contract settle futures prices, and the growth rate of the oil futures market Working (1960)-T index (WT), computed using US Commodity Futures Trading Commission (CFTC) Commitment of Trades (COT) data.[7] The sample for the observed macro-financial factors extends from 1980:1 through 2010:3, while the sample for the oil market variables from 1986:1 through 2010:3.

4. THE GLOBAL ECONOMY MODEL: SPECIFICATION AND ESTIMATION

[6] $\mathbf{F}_{1,t}$ has been obtained by conditioning with respect to $\mathbf{F}_{2,t}$ and only a subset of the variables considered in $\mathbf{O}_t$, i.e., the real oil price and the real non-energy commodities price index, which are available since 1980:1. The other oil market variables are available only since 1986:1. Detailed results are available from the author upon request.

[7] The Working's T index is a measure of excess speculation, relatively to hedging demand, in the futures market. It is calculated as the ratio of speculative open interest to total open interest resulting from hedging activity, i.e., as 1+SS/(HS+HL) if HS≥HL and 1+SL/(HS+HL) if HS<HL, where open interest held by speculators (noncommercials) and hedgers (commercials) is denoted as follows: SS = Speculation, Short; HL = Hedging, Long; SL = Speculation, Long; HS = Hedging, Short.

The global economy model in (1) counts 33 endogenous variables, collected in the vector $\mathbf{F}_t = \left[\mathbf{F}'_{1,t} \quad \mathbf{F}'_{2,t} \quad \mathbf{O}'_t \right]'$. For PC-VAR estimation 12 principal components of $\mathbf{F}_t$, jointly accounting for 80% of total variance, and three lags were selected, according to Monte Carlo results (Morana, 2012b) and specification tests.[8]

Given the scope of the analysis, the focus is on the identification of the oil market structural shocks, carried out by means of the Choleski decomposition approach discussed in the methodological section. Three main groups of variables are considered and ordered according to (assumed) exogeneity properties, i.e., global oil market supply side, macroeconomic and financial conditions. Being the ordering recursive, it implies the relative exogeneity of oil market supply side variables to the business and financial cycle, as well as of macroeconomic conditions to financial developments; delayed feedback among the three groups of variables is however allowed for with at least one quarter lag. In details, the selected ordering is:

i) *global oil market supply side*: reserves, net oil production changes (negative and positive) and refinery margins;

ii) *macroeconomic conditions* and *flow oil demand*: employment, unemployment rate, real activity, public consumption to GDP ratio, US fiscal and trade deficit to GDP ratios, core inflation, real wages; ***oil consumption***;

iii) *financial conditions* and *financial oil demand*: excess liquidity, real short term interest rate, term spread, real housing prices, US$ exchange rate index, risk aversion, size, value, momentum, stocks' liquidity and leverage factors, Working-T speculative index and futures market basis; ***oil inventories***;

iv) *oil price level and volatility*: ***real oil price***, ***nominal oil price volatility***, real non-energy commodities price index, real stock market prices, real gold prices, fragility factor.

The above ordering is based on the following rationale concerning the working of the oil market.

i) The oil market supply side is constrained by geophysical conditions, and therefore exogenous relatively to macroeconomic and financial conditions driving oil demand, showing delayed feedback to macro-financial disturbances. Reserves are then exogenous relatively to oil production and refineries margins, and oil production relatively to refineries margins.

ii) Oil consumption (flow oil demand) is contemporaneously determined by world business cycle conditions, as measured by global labor market, fiscal and trade deficits, real activity and inflation factors. It is allowed to contemporaneously respond (if at all) to oil market supply side disturbances.

iii) Inventories are contemporaneously affected by oil market supply and demand (flow and financial) conditions. Financial oil demand is driven by both

[8] Net oil production increases and decreases are not included in the computation of the 12-factors used in PC-VAR analysis; lagged values of the net oil production increases (decreases) variable are also excluded from the net oil production decreases (increases) equation.

fundamental (liquidity/interest rates, portfolio diversification opportunities, and expectations about future fundamentals) and non fundamental factors (excess speculation measures).

iv) Real oil price and nominal oil price volatility are contemporaneously determined by oil market supply side, flow and financial oil demand conditions, and inventories; they also react with delay to additional fundamental financial factors (real stock and non energy commodities prices, fragility index).[9]

Ten oil market structural disturbances can then be identified, i.e., oil reserves, net positive and negative production, refineries margins, oil consumption and inventories preferences, *other* real oil price and nominal oil price volatility, and speculative (market-pressure (Working-T); *other* futures basis) shocks.

Consistent with economic theory we expect:

a) A positive (negative) flow oil supply shock driving the real oil price downward (upward), consistent with the effects of a downward (upward shift) in the flow oil supply schedule *ceteris paribus*. This shock is akin to the oil supply shocks in Kilian (2009) and Baumeister and Peersman (2008, 2009).

b) A positive refineries margins shock driving the real oil price downward, consistent with a shift in the production mix favoring (relatively less expensive) medium and heavy sour crudes.

c) A positive oil market speculative (market-pressure) shock driving the futures and spot oil price upward. This follows from the Theory of Normal Backwardation and Market Pressure Theory (Keynes, 1930; Cootner, 1960), establishing a positive linkage between the excess supply for long (speculative) traders positions and the demand for short (hedging) positions in the futures market and the futures price, and a price discovery argument, i.e., price discovery occurring in the futures market and then spilling over to the spot market.[10] According to the Theory of Normal Backwardation (Keynes, 1930), the futures basis can be defined as the sum of two components, namely, the expected depreciation rate of the future spot price $\left[E_t(S_T) - S_T\right]/S_T$ and a risk premium $\pi_{t,T}$; hence $\frac{F_{t,T} - S_t}{S_t} = \frac{\left[E_t(S_T) - S_T\right]}{S_T} - \pi_{t,T}$, where $F_{t,T}$ is the price at time *t* of a futures contract expiring at *T*, S_t is the spot price at time *t* and $E_t(S_T)$ is the expected future spot price at time *T*. According to Keynes, $\pi_{t,T} > 0$, i.e., the futures price is set at a discount (*backwardated*) to the expected futures price, as the outcome of demand for short (hedging) position exceeding the supply long (speculative)

[9] The relative ordering selected for the macroeconomic and financial factors can be justified on the basis of economic theory, as well as grounded on a speed of adjustment rationale (see Morana, 2012a); being however irrelevant concerning the identification of the oil market shocks, it is not discussed in this paper.

[10] The spot oil price is not an observed price but an identified price, i.e., determined through the assessment of reporting agencies, i.e. Platts and Argus Media, which is based on long-term contracts, spot and futures market transactions and derivatives instruments. Since the move to market based pricing at the end of the 1980s, disentangling physical and paper oil market pricing signals has become increasingly difficult and it is now probably infeasible (Fattouh, 2011). See also Garbade and Silber (1983) concerning the price discovery process for commodities.

position. A reversal in the sign of the premium can then be expected in the case of excess supply of long position relative to the demand for short positions, leading the futures market to *contango* (Cootner, 1960).[11]

Two speculative shocks are actually considered in the model; the former directly related to traders positions, as yield by the oil futures market Working-T index structuralized residual; the latter, being net of the contemporaneous effect of traders positions (as measured by the Working-T index), a residual/*other* speculative/futures basis shock. This is also in the light of the potential drawbacks of the Working-T index, as computed using COT data.[12]

On the basis of the price discovery argument, the spillover of the speculative shock to the spot market may or may not involve (above ground and offshore) inventories hoarding. This would also be consistent with Hamilton (2009), in so far as the price elasticity of oil demand is null, as well as with Hotelling (1931), through the implementation of an oil in the ground type of policy by oil producers, i.e. the underground accumulation of inventories, through slowing down the extraction rate (Hamilton, 2009; Juvenal and Petrella, 2011).

The oil market speculative shocks are then different from those in Kilian and Murphy (2010), as well as in Juvenal and Petrella (2011) and Lombardi and Van Robays (2011). In fact, in the current paper disentangling between fundamental and non fundamental financial oil demand components is carried out and market expectations about future fundamentals and the role of trader positions are *directly* accounted for; moreover, relatively to Juvenal and Petrella (2011) and Lombardi and Van Robays (2011), disentangling is more accurate as, by conditioning on risk factors, liquidity and interest rates, and portfolio's diversification opportunities, speculative shocks unrelated to fundamentalist behavior can be identified.

d) A positive oil reserves shock, by signaling a future slack in supply conditions, driving the futures and spot oil prices downward; the mechanics would involve a direct effect on the oil futures price, anticipating the future downward shift in the flow oil supply schedule, and the spillover to the spot price through a price discovery mechanism.

e) Finally, being the former net of the contemporaneous effect of the macroeconomic variables driving flow oil demand, and the latter also of the effect of the (financial) variables driving financial oil demand, the own oil consumption and inventories shocks then bear the interpretation of preferences shocks.

[11] Moreover, under imperfect information, if the large long position of index funds (noise traders) in the futures market were (mistakenly) believed to reveal valuable information on future price dynamics, due to the successive upward revision in the demand of informed (commercial) traders, the futures price would increase (Irwin et al., 2009).

[12] Disaggregated COT (DCOT) data are only available since 2008. The latter allow for a classification of positions into the categories of producers, swap dealers, managed money, other reportable, and non reportable. Hedging pressure measures computed using DCOT data are then likely to yield more accurate results than COT data, as swap dealers positions can be disentangled from those of the other commercial traders. However, according to Till (2009), also the Working-T index computed using DCOT data would point to excess speculation in the oil futures market, over the 2008-2009 period.

Similarly for the real oil price and nominal oil price volatility own shocks, which are referred to as *other* real oil price and nominal oil price volatility shocks, without seeking economic interpretation. The oil consumption preference shock and the other real oil price shock are then akin to the oil-specific demand shock and the other oil supply shock, respectively, in Kilian (2009).

Differently from previous contributions to the literature (Kilian, 2009; Juvenal and Petrella, 2011; Lombardi and van Robays, 2011; Kilian and Murphy, 2011; Baumeister and Peersman, 2008, 2009), the above conditions are not imposed through sign restrictions, as identification is achieved through a Choleski decomposition approach. As shown by the impulse response analysis carried out in Morana (2012a), the empirical evidence obtained by means of the Choleski identification strategy is however consistent with above theoretical predictions. Given the scope of the analysis, in what follow the focus is on the macro-financial effects of oil market shocks only; we refer to Morana (2012a) for a detailed analysis of interactions within the oil market.

5. TRANSMISSION MECHANISMS OF OIL MARKET SHOCKS TO MACRO-FINANCIAL CONDITIONS

Concerning the transmission mechanisms of structural oil market shocks to macro-financial conditions, the results of the impulse response analysis are reported in Table 1, over selected horizons: very short-term (within 2 quarters), short-term (between 1 and 2 years), medium-term (between three and five years), and long-term (10-year). In all cases, median cumulated responses have been computed with 90% significance bands; significant figures at the 10% level are shown in bold.

Oil market supply side shocks

Firstly, a (unitary and permanent) positive reserves shock leads to a contraction in the real oil price (-1%, short-term; not reported) and in nominal oil price volatility (-0.75%, long-term; not reported). A deflationary short-term effect can then be noted (-0.02%), as well as a long-term positive effect on real activity (0.44%), consistent with lower oil price uncertainty, and weaker user costs, precautionary savings and discretionary income effects. An upward shift in the labor supply schedule can also be found (-0.4%, employment; 0.06% unemployment rate; 1.18%, real wage), as well as an increase in real housing prices (0.79%). Consistent with improved overall macroeconomic conditions, a contractionary economic policy mix is implemented (-0.44%, public expenditure; -0.54%, liquidity; 3 to 6 b.p, real interest rate); finally, the US% exchange rate appreciates (-0.42%) and real stock prices contract (-0.54%), while stock market volatility increases in the short-term (0.3%).

Secondly, a negative net production shock (downward shift in the flow oil supply schedule) leads to a short-term increase in the real oil price (3.3%, not reported) and a long-term contraction in nominal oil price volatility (-1.02%, not reported). Stagflationary effects can then be found (-0.11, real activity, short-term; 0.03%, core inflation, long-term), consistent with higher user costs, precautionary

savings and discretionary income effects; yet, due to the contraction in nominal oil price uncertainty, real activity (0.62%) increases in the long-term. An upward shift in the labor supply schedule can also be noted (-0.66%, employment; 1.87%, real wage), as well as a restrictive policy mix, implemented to counteract the stagflationary effects of the shock (-0.58%, public expenditure; -1.36%, liquidity). Finally, a portfolio shift from riskier to safer assets, i.e. from stocks (-0.92%) to housing securities (1.38%), in the face of worsened macroeconomic conditions, can be noted, as well as a short-term increase in stock market volatility (0.3%). A temporary depreciation of the US$ exchange rate is also triggered by the negative production shock (0.11%).

Differently, a positive net production shock (upward shift in the flow oil supply schedule) leads to a contraction in the real oil price in the short-term (-1.9%, not reported), but to a permanent increase in nominal oil price volatility (1.3%, not reported). While the impact on real activity is mostly not significant over the horizon investigated, due to the increase in nominal oil price uncertainty, real activity however contracts (-0.19%) in the long-term. A downward shift in the labor supply schedule can also be noted (0.6%, employment; -0.98%, real wages; -0.36%, unemployment rate - medium-term), as well as the implementation of a long-term expansionary policy mix (0.20%, public expenditure; 0.64%, liquidity), with permanent increase in the real interest rate (2 b.p.). Consistent with improved macroeconomic conditions, a portfolio shift from housing securities (-0.55%) to stocks (0.50%) also follows; finally, a permanent increase in stock market volatility (0.19%) and a US$ exchange rate appreciation (-0.2%) can be noted.

Thirdly, a positive refinery margins shock leads to a permanent contraction in the real oil price (-1.4%, not reported) and a permanent increase in nominal oil price volatility (0.52%, not reported). Due to increased oil price uncertainty, real activity contracts (-0.21%, short-term); an upward shift in the labor supply schedule can also be noted (-0.79%, employment; 0.39%, the unemployment rate, 0.79%, real wages; long-term), as well as a contraction in real stock prices (-0.18%) and in stock market volatility (-0.32%); a contractionary policy mix (-0.18%, public expenditure; -0.47%, liquidity) and a US$ exchange rate appreciation (-0.16%) can finally be noted.

Overall, weak evidence of asymmetric effects of oil market supply side shocks on real activity can be found (short-term only). The uncovered transmission mechanisms are then consistent with user costs, discretionary income, precautionary savings and uncertainty effects, as the latter are not necessarily asymmetric; in fact, as volatility is modeled in changes, both positive and negative uncertainty shocks are allowed for within the framework considered. Moreover, evidence of short-term stagflationary effects, triggered by negative net oil production shocks, and of a negative correlation between the US$ exchange rate index and the real oil price, induced by oil market supply side shocks, can also be noted. Finally, the labor market response to oil market supply side shocks would mostly involve labor supply adjustments.

Oil market demand side shocks

Fourthly, a positive oil consumption preferences shock leads to a

permanent increase in the real oil price (3.3%, not reported), yet dampening nominal oil price volatility (-0.39%, not reported). Moreover, the shock leads to an increase in real activity, through lower oil price uncertainty, and core inflation (0.22% and 0.02%, respectively; long-term), as well as in employment (0.2%; -0.18%, unemployment rate; short-term) and real stock (0.15%, short-term) and housing (0.54%, long-term) prices. A dampening effect on stock market volatility (-0.23%) and a depreciation of the US$ exchange rate (0.48%) can also be noted. Consistent with improved economic conditions, a contractionary policy mix is implemented in the short-term (-0.12%, public expenditure; -0.05%, liquidity), leading to a permanent increase in the real interest rate (4 b.p.).

Differently, a positive oil inventories preferences shock leads to a permanent contraction in the real oil price (-0.93%, not reported), dampening nominal oil price volatility (-0.56%, not reported). The shock then exercises an expansionary effect on macro-financial conditions, leading to a permanent increase in real activity (0.22%) - through reduced oil price uncertainty, as well as lower user costs and precautionary savings, and higher discretionary income effects - and an upward shift in the labor demand schedule (0.39%, employment, -0.41%, unemployment rate, 0.10% real wages). An increase in real housing (0.11%, long-term) and stock (0.11%, short-term) prices, as well as in stock market volatility (0.11%), can also be noted. Consistent with improved economic conditions, a contractionary policy mix is implemented in the short-term (-0.19%, public expenditure; -0.07%, liquidity), leading to a long-term contraction in the real interest rate (-1 b.p.); a permanent US$ exchange rate depreciation (0.15%) can finally be found.

Other real oil price and nominal oil price volatility shocks

Fifthly, a positive other real oil price shock (2.95%, not reported) leads to a permanent increase in nominal oil price volatility (0.21%, not reported). Oil price uncertainty, as well as user costs, precautionary savings and discretionary income effects, may then account for the contraction in economic activity (-0.21%) determined by the shock. A downward shift in the labor demand schedule (-0.11%, employment; -0.18%, real wages, 0.19%, unemployment rate), as well as a contraction in real housing prices (-0.16%) can be noted. In the light of worsened macroeconomic conditions, an expansionary policy mix is implemented (0.14%, public expenditure, long-term; 0.04%, liquidity, short-term). Finally, the US$ exchange rate permanently appreciates (-0.12%).

Moreover, a positive other nominal oil price volatility shock (1.19%) leads to a permanent increase in the real oil price (1.1%, not reported). A permanent contraction in real activity (-0.14%), due to uncertainty effects, as well as user costs, precautionary savings, and discretionary income effects, can then be noted. Consistent with worsened economic conditions, an expansionary policy mix is implemented (0.14% public expenditure; 0.27% excess liquidity), leading to a permanent contraction in the real short-term rate (-2 b.p.). An upward shift in the labor demand schedule (0.14%, employment; -0.42%, real wages (-0.42%), -0.09%, unemployment rate), a portfolio shift from housing securities (-0.17%) to stocks (0.19%), an increase in stock prices volatility (0.05%), and a US$ exchange

rate depreciation (0.07%), can finally be found.

Oil futures market speculative shocks

Consistent with price discovery occurring in the futures market, following positive Working-T and futures basis shocks, the real oil price permanently increases (0.6% and 2.4%, respectively; not reported), while a permanent contraction in nominal oil price volatility can be noted (-0.2% and -0.1%, respectively; not reported), a kind of liquidity effect. Moreover, consistent with Market Pressure Theory (Cootner, 1960), a positive Working's-T shock leads to an increase in the futures basis (0.08%; not reported).

A positive Working-T (excess speculation) shock - due to user costs, precautionary savings and discretionary income effects – then leads to a contraction in real activity (-0.15%, long-term), as well as to an upward shift in the labor supply schedule (-0.29%, employment; 0.31%, unemployment rate; 0.04% real wages). A contraction in housing and stock prices (-0.09% and -0.07%, respectively; short- to medium term), as well as an increase in stock market volatility (0.03%, short-term), can also be found. Consistent with worsened economic conditions, an expansionary policy mix (0.09% liquidity; 0.14% public expenditure; short-term) is implemented. A permanent US$ exchange rate depreciation (0.11%) can finally be noted.

Finally, consistent with reduced oil price uncertainty and an overall expansionary economic policy (fiscal policy: -0.07%, short-term; monetary policy: 0.16%, long-tern; -1 b.p., real interest rate), a permanent increase in real activity (0.09%) and core inflation (0.01%), as well as an upward shift in the labor demand schedule (0.19% employment, -0.13%, unemployment rate, -0.2%, real wages), can be noted following the futures basis shock. A portfolio shift from housing securities (-0.16%) to stocks (0.02%, short-term), a permanent increase in stock market volatility (0.13%) and depreciation of the US$ exchange rate (0.13%) can also be noted.

6. THE OIL PRICE-MACROECONOMY RELATIONSHIP SINCE THE MID-1980S

The *average* contribution of oil market shocks to macro-financial fluctuations since the mid-1980s can be gauged from the results of the forecast error variance decomposition analysis (not reported). Overall, oil market supply side shocks (jointly considered) yield a sizable contribution to both real and financial variables fluctuations, in general strongest in the medium- to long-term: for instance, about 10% of real activity, employment and real wage fluctuations are jointly accounted for by supply side shocks in the very short-term; 5% for the unemployment rate and public expenditure; figures for long-term effects are 12% for real activity and public expenditure, 7% for the unemployment rate, 20% for employment and 41% for real wages. Oil market supply side shocks also account for sizable fluctuations in real housing and stock market prices in the very short- and long-term (5% and 30%, respectively), as well as in stock market volatility (10% to 23%) and excess liquidity (10% to 40%); similarly for the US$ exchange

rate index, core inflation, and the real short-term interest rate (8% to 10%).

Much weaker effects are exercised by oil market preferences, speculative and other oil price and volatility shocks: in particular, inventories preferences shocks and oil futures market speculative shocks matter more for macroeconomic variables than financial variables (2% to 4%; not reported), and the other way around for oil consumption shocks (3% to 6%; not reported).

In order to assess the contribution of the various oil market shocks to *actual* real activity dynamics since the mid-1980s, in Figure 1 the cumulative historical decomposition (net of base prediction) for the latter variable is plotted. As is shown in the plot, oil consumption/inventories preferences and other real oil price shocks contributed to slowing down real activity over the whole sample considered; differently, oil market supply side shocks have in general exercised recessionary effects since the first Persian Gulf War episode in the early 1990s (see below for details), with both oil reserves and production shocks determining the hump-shaped profile shown in the plot. In particular, among oil market disturbances, oil production shocks yield the largest contribution to real activity fluctuations. Moreover, nominal oil price volatility shocks contributed to both (increasing) trend and cyclical real activity dynamics over the time span investigated, consistent with symmetric uncertainty effects. Finally, oil futures market speculative shocks have mainly contributed to cyclical fluctuations, slowing down real activity growth over the 1990s, as well as during the second Persian Gulf War (2003) and the 2008 oil price shock episodes.

Overall, as shown in the bottom plots in Figure 1, since the mid-1980s macroeconomic and fundamental financial shocks have largely determined trend and cyclical developments in real activity; a recessionary bias, exercised by oil market shocks since the first Persian Gulf War episode, can however be noted.

According to NBER chronology, over the period investigated, three main recessionary episodes have affected the US (and the global economy as well), i.e. 1990:2 through 1993:3, 2000:4 through 2003:2, and 2008:2 through 2009:3. Since relevant oil market events can be associated with all of them, in the light of the above evidence, it may then be of interest to assess the actual contribution of the first and second Persian Gulf War and the 2008 oil price shock to global economic downturn. The results of the historical decomposition analysis (net of base prediction) are then reported in Tables 2-5, for selected shocks.

The first Persian Gulf War

An abrupt and large increase in the real oil price occurred in 1990:3 (38%), followed by an additional sizable increase in 1990:4 (17%), following the Iraqi invasion of Kuwait in August 1990; oil market supply side shocks sizably affected the real oil price during the episode (10% in 1990:3; 16% in 1990:4; -12% in 1991:1; -9% in 1991:2), as well as nominal oil price volatility (10% in 1990:3) (Morana, 2012a).

As the beginning of the recession in the US is dated 1990:2, the first Persian Gulf War oil price episode, occurring in 1990:3, cannot be its trigger. However, as shown in Table 2, oil market supply side shocks did exercise a recessionary impact, leading to a -1.2% contraction in real activity (-0.52% in

1990:3; -0.12% in 1991:1), lasting well beyond its resolution (-0.37% in 1991:3; -0.19% in 1991:4).[13] Similarly long lasting were the effects exercised on employment (-1.9%; 1991:1 through 1992:1) and the unemployment rate (1% in 1991). Evidence of stagflationary effects can also be noted (0.18%, core inflation, 1990:4-1991:1).

Oil market supply side shocks also accounted for a 4.32% increase in real wages (1990:3-1991:4), a -0.37% decline in real housing prices (1990:3-1990:4), a -4.42% contraction in real stock prices (1990:3-1991:3), a 4.14% increase in stock market volatility and a 0.69% appreciation of the US$ exchange rate (1990:4-1991:1).

Recessionary effects were also exercised by other oil market shocks.[14] For instance, oil inventories preference shocks contributed with a -0.67% contraction in real activity (1990:3-1991:4); figures for oil futures market speculative shocks (Table 3), other real oil price and nominal oil price volatility (Table 4) shocks are -0.22% (1991:1-1991:3), -0.12% (1990:3-1991:2) and -0.11% (1990:3), respectively.

Negative effects on employment (unemployment rate) can also be noted, i.e. -0.61% (0.66%), -0.14% (0.2%), -0.14% (0.13%), and -0.28% (0.13%), respectively, as well as on real wages (-0.04%, -0.12%, -0.07%, and -0.18%, respectively).

Moreover, while recessionary dynamics over the period 1992:1-1993:3 cannot be related to oil market supply side shocks, other oil market shocks did contribute: figures for real activity are -0.3% for inventories preferences shocks, -0.7% for oil futures market speculative shocks, -0.35% and -0.55% for other real oil price and nominal oil price volatility shocks, respectively; -0.73% for the joint effect of oil market shocks (1992:2-1993:2; Table 5).

As shown in Table 5, the joint effect of oil market shocks during the first Persian Gulf War episode was slightly stagflationary (-0.15%, real activity; 0.09%, core inflation; 1990:3-1991:1). The overall policy response (1990:3-1991:4) to oil market shocks involved expansionary fiscal policy (1.09%) and contractionary monetary policy (-2.77%), yielding a 4 b.p. increase in the real interest rate.

The technology bubble and the second Persian Gulf War

Oil market shocks did contribute to the recessionary effects ensued by the burst of the dot.com bubble in 2000:2, previously to the second Persian Gulf war episode: -0.45% for oil market supply side shocks (2000:4-2001:1), -0.74% for oil consumption preferences shocks (2001:4-2002:3), -0.59% for oil inventories preferences shocks (2001:2-2002:3), and -0.48% for other real oil price shocks (2001:3-2003:2). However, according to Morana (2012a), oil market supply side shocks did not determine the 18% real oil price increase in 2003:1, occurring just before the US intervention in Iraq in April 2003; the second Persian Gulf War oil

[13] The first Persian Gulf war episode can be considered concluded in 1991:1, following the -40% real oil price drop, as global oil production was restored through increased production by Saudi Arabia.

[14] Only a selection of the results is reported for reasons of space. A full set of results is available upon request from the author and in the working paper version of this article.

price shock episode was also very short-lived, and resolved within two quarters (-17%, 2003:2).

As shown in Table 2, the real effects of oil market supply side shocks were weaker than for the previous episode, accounting for a -0.24% contraction in real activity (2003:1) and a -0.2% contraction in real wages (2002:4-2003:2). Other oil market shocks did however contribute to recessionary dynamics, also leading to a contraction in real wages (in the range -0.03% through -0.26%).

For instance, other nominal oil price volatility shocks accounted for a -0.21% contraction in real activity (2002:4-2003:2), consistent with the sizable real oil price swing over the same time span, negatively impacting on labor (-0.23% and 0.22%, for employment and the unemployment rate, respectively) and financial markets (-0.15%, -0.34%, and 0.12%, for real housing prices, real stock prices, and stock market volatility, respectively).

Similarly for oil inventories preferences shocks, leading to a -0.47% contraction in real activity (-0.51% and 0.66%, for employment and the unemployment rate, respectively), while a smaller impact can be found for oil consumption preferences (-0.08%), other real oil price (-0.03%), and oil futures market speculative (-0.07%) shocks.

As shown in Table 5, oil market shocks jointly accounted for a -0.44% real activity contraction over the period 2002:4-2003:2, as well as for a -0.21% contraction in employment and a 0.54% increase in the unemployment rate; differently from the previous episode, a contraction in real wages can also be noted (-0.57%). The overall policy response was expansionary (0.55%, public expenditure; 0.23%, liquidity), yielding a 4 b.p. increase in the real interest rate.

The third oil price shock and the Great Recession

Important features of the 2008 oil price episode surely are both the very high nominal oil price level (US$ 140, July 2008), comparable in real terms with the early 1980s oil price shock, and volatility (100 US$ drop within 5 months; US$ 40, December 2008). As shown in Morana (2012a), the 2008 oil price shock is macro-finance driven: macroeconomic shocks account for 58% out of the 68% real oil price run up over the 2007(2)-2008(2) period, and financial shocks for 6% in 2007(4); oil market supply side (1.3%) and consumption preferences (3.9%) shocks also contribute to increasing the real oil price over the same period. Moreover, the 54% real oil price increase over the 2009(2) through 2009(4) period is equally accounted for by macroeconomic (21%) and financial (20% joint; 5% speculative) shocks; oil market supply side and consumption preferences shocks also contribute in 2009:1-2009:2 (10% and 3.6%, respectively), as well as oil inventories preferences shocks (3.9%) in 2009:2-2009:3.

As shown in Table 2, oil market supply side conditions did exacerbate the recessionary effects of the subprime financial crisis, accounting for a -1.19% contraction in real activity in 2008 (-0.34% in 2008:2, -0.3% in 2008:3, -0.55% in 2008:4). Yet, the impact on the labor market is more subdued than in previous episodes (0.28%, unemployment rate; 2008:2-2009:1), possibly due to the sharp contraction in real wages (-2.51%, 2008:2-2009:3). No stagflationary effects and a small negative impact on real housing prices (-0.53%; 2008:2-2008:3) can be

noted.

Other nominal oil price volatility shocks (-0.27%; 2009:1-2009:2) - consistent with the large 2008 oil price swing -, oil consumption and inventories preferences shocks (-0.13%, 2008:4-2009:1 and -0.29%, 2008:2-2009:1, respectively), oil futures market speculative shocks (-0.22%, 2008:2-2009:3), and other real oil price shocks (-0.06%, 2008:2-2008:4), did also contribute to the economic slowdown; figures for employment (unemployment rate; 2009:1-2009:3) are -0.34% (0.33%), -0.04% (0.07%; 2009:1), -0.28% (0.31%; 2008:2-2009:3), -0.45% (0.50%), and -0.12% (0.07%), respectively; figures for real wages are in the range 0.12% through 0.70%.

Over the period 2008:2-2008:4, oil market shocks then jointly accounted for a -1.31% contraction in real activity, as well as for a 0.16% increase in the unemployment rate, and -1% and -5.6% contractions in real wages and stock prices. The overall policy response was expansionary (1.18%, public expenditure; 1.33%, liquidity), yielding a 29 b.p. increase in the real interest rate. Concerning the resilience of the global economy to the 2008 oil price episode, the findings then point to two mitigating effects, i.e. the endogenous contraction in real wages and the expansionary stabilization policies implemented, in the face of a mostly demand (macro)-driven oil price shock.

7. CONCLUSIONS

Recent oil price level and volatility dynamics have revived the debate about the oil price-macroeconomy relationship, particularly in the light of the perceived resilience of the global economy to the 2008 oil price shock. Two broad categories of transmission mechanisms of oil price shocks have so far been suggested in the theoretical literature, featuring symmetric and asymmetric effects. In addition to the oil price drag and real money balances channels, the discretionary income, precautionary savings, and operating costs mechanisms yield a symmetric impact of real oil price shocks on real activity; differently, the monetary policy, uncertainty and reallocation channels yield asymmetric effects.

By means of a detailed description of oil market-macro-finance interactions within a large-scale factor vector autoregressive (F-VAR) model, we assess the recessionary features of oil price shocks since the mid-1980s, yielding original contributions along different dimensions.

Firstly, in terms of model specification, the approach allows for unobserved factors, related to the global business and financial cycle, estimated using macro-financial data for fifty countries, including OECD and emerging countries; proxy variables for expectations about future global fundamentals and economic/financial fragility conditions, i.e., risk aversion, size, value, momentum, stock's liquidity, and leverage factors, are also directly included in the information set; global oil reserves, production, consumption, inventories, refineries margins, and proxies for oil price uncertainty and excess speculation in the oil futures market, are finally employed to account for physical and financial oil market conditions. To our knowledge this is the first paper in the oil price-macroeconomy literature to directly modeling market expectations about future fundamentals and

to seek understanding of the global macro-financial effects of oil price shocks from a broad empirical perspective, involving real activity and fiscal/monetary policy responses, as well as labor and financial markets developments, within a joint assessment.

Overall, the proposed modeling strategy grants the benefits of a richer description of oil market-macroeconomy dynamic interactions than achieved in previous small scale VAR models, still attained using the same tools of econometric policy analysis, and the multi-country/global perspective yield by dynamic panel data analysis, yet improving upon the latter in terms of empirical reliability. In particular, ten oil market structural shocks, related to both supply and demand side conditions, are identified and their macro-financial consequences studied in details. New evidences on the oil market-macroeconomy relationship are shed, as we are unaware, for instance, of previous results concerning the macro-financial effects of oil market non fundamental financial speculation shocks, as well as oil reserves and refineries margins shocks.

Moreover, by controlling for the macro-financial factors behind the determination of flow and financial oil demand, more accurate identification of purely oil market supply side shocks should be achieved within the proposed framework; this feature is particularly desirable in the light of recent results, suggesting that recessionary effects should stem from supply driven oil price shocks only (Kilian, 2009).

The main results of the paper are as follows. Firstly, the findings provide support to symmetric mechanisms of oil price shocks transmission, as described by the discretionary income, precautionary savings and operating costs channels, as well as to the uncertainty channel, which, in the framework considered, does not necessarily yield asymmetric impacts. Indeed, by comparing the effect of positive and negative net production shocks, weak evidence of asymmetric impacts on real activity can be found, the latter responding more strongly to negative shocks in the very short-term only. The findings however provide a broader perspective in terms of real effects of oil market supply side shocks, stemming also from reserves and refineries activity; speculative and preferences shocks might exercise sizable effects on real economic activity as well.

Secondly, the above mechanisms might account for the recessionary effects associated with some recent oil price episodes, i.e. the first and second Persian Gulf War and the 2008 oil price shock. In particular, we find that oil market supply side shocks contributed to the 1990:2-1993:3 recession (-1.2%) during the first Persian Gulf War, and, at a lower extent, during the second Persian Gulf War, to the 2000:4-2003:2 recession (-0.24%). Oil market supply side conditions also exacerbated the recessionary effects of the subprime financial crisis in 2008 (-1.19%). Other oil market shocks contributed to slowing down real activity over the three episodes investigated as well: speculative, inventories preferences and price volatility shocks. Concerning the resilience of the global economy to the 2008 oil price episode, the findings finally point to two mitigating effects, i.e. the endogenous contraction in real wages and the expansionary stabilization policies implemented, in the face of a mostly demand (macro)-driven oil price shock.

The results of the paper have also clear-cut implications for current oil market developments. According to OECD-IEA figures, excess demand in the global oil market was 1 million barrels per day in 2010 and 0.6 million barrels per day in 2011. As long as oil supply will keep expanding at a slower pace than required by demand conditions, as it has been recently occurring, as well as since mid-2000s, and in so far as the recently passed regulatory provisions[15] aimed at controlling financial speculation in the oil (and other commodities) futures market will prove unsuccessful, a recessionary bias, determined by higher and more uncertain real oil prices, may then be expected to persist also in the near future.

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[15] See H.R. 4173: Dodd-Frank Wall Street Reform and Consumer Protection Act, signed by US President Obama in July, 21, 2010. See also the Proposal for a Regulation of the European Parliament and of the Council on OTC derivatives, central counterparties and trade repositories (COM(2010) 484 final 2010/0250 (COD)), approved by the European Parliament on March, 29, 2012. The issue about the contribution of financial speculation to oil price dynamics is however far to be settled. See Fattouh et al. (2012) and Morana (2012a) for contrasting views.

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APPENDIX: ESTIMATION OF THE ECONOMETRIC MODEL

The two-block specification is estimated by means of a two-stage approach. Firstly, consistent and asymptotically normal estimation of the set of equations in (2) is obtained following the iterative procedure proposed in Morana (2011); the latter bears the interpretation of QML estimation performed by means of the EM algorithm:

i) An initial estimate of the r_1 unobserved common factors in $\mathbf{F}_{1,t}$ is obtained through the application of Principal Components Analysis (PCA) to subsets of homogeneous cross-country data $\mathbf{Z}_i = \{\mathbf{Z}_{i,1} \quad \dots \quad \mathbf{Z}_{i,T}\}$, $i = 1,...,r_1$, $r_1 \leq q$; for instance, a stock return global factor is estimated by means of the application of PCA to the vector of cross-country stock return data, and so on.

Then, an initial estimate of the polynomial matrix $\mathbf{C}(L)$ and the factor loading matrix $\mathbf{\Lambda}$ is obtained by means of OLS estimation of the equation system in (2). This is performed by first regressing $\hat{\mathbf{F}}_t$ on $\boldsymbol{\kappa}_t$ to obtain $\hat{\boldsymbol{\kappa}}_t$; then the actual

series $\mathbf{Z}_t$ are regressed on $\boldsymbol{\mu}_t$ and $\hat{\mathbf{F}}_t - \hat{\boldsymbol{\kappa}}_t$ to obtain $\hat{\boldsymbol{\Lambda}}$ and $\hat{\boldsymbol{\mu}}_t$; $\hat{\mathbf{C}}(L)$ is then obtained by means of OLS estimation of the VAR model for the gap variables $\mathbf{Z}_t - \hat{\boldsymbol{\mu}}_t - \hat{\boldsymbol{\Lambda}}(\hat{\mathbf{F}}_t - \hat{\boldsymbol{\kappa}}_t)$ in (2).

ii) In the E-step the unobserved factors ($\mathbf{F}_{1,t}$) are estimated, given the observed data and the current estimate of model parameters, by means of principal components analysis (PCA), i.e. a new estimate of the unobserved common factors in $\mathbf{F}_{1,t}$ is obtained by means of PCA applied to the filtered variables $\mathbf{Z}_t^* = \mathbf{Z}_t - \left[\mathbf{I} - \hat{\mathbf{C}}(L)\right]\hat{\boldsymbol{\Lambda}}_*(\hat{\mathbf{F}}_{*,t} - \hat{\boldsymbol{\kappa}}_{*,t})$, with $\hat{\mathbf{F}}_{*,t} = \left[\mathbf{F}'_{2,t} \quad \mathbf{O}'_t\right]'$, $\hat{\boldsymbol{\Lambda}}_* = \left[\hat{\boldsymbol{\Lambda}}'_{F_2} \quad \hat{\boldsymbol{\Lambda}}'_O\right]'$ and $\hat{\boldsymbol{\kappa}}_{*,t} = \left[\hat{\boldsymbol{\kappa}}'_{F_2,t} \quad \hat{\boldsymbol{\kappa}}'_{O,t}\right]'$.

iii) In the M-step the likelihood function is maximized (OLS estimation of the $\mathbf{C}(L)$ matrix is performed) under the assumption that the unobserved factors are known, conditioning on their E-step estimate, i.e., conditional on the new unobserved common factors, a new estimate of the polynomial matrix $\mathbf{C}(L)$ and the factor loading matrix $\boldsymbol{\Lambda}$ is attained as described in the initialization step. Convergence to the one-step QML estimate is ensured, as the value of the likelihood function is increased at each step.

Secondly, consistent and asymptotically normal estimation of the set of equations in (1) is performed by means of PC-VAR estimation (Morana, 2012b), treating the consistently estimated factors as they were actually observed. The latter is achieved in the following steps:

iv) PCA is applied to $\mathbf{x}_t \equiv \hat{\mathbf{F}}_t - \hat{\boldsymbol{\kappa}}_t$ and the first *s* PCs, $\hat{\mathbf{f}}_t$, are computed;

v) the dynamic vector regression

$$\mathbf{x}_t = \mathbf{D}(L)\hat{\mathbf{f}}_t + \boldsymbol{\varsigma}_t$$
$$\boldsymbol{\varsigma}_t \sim i.i.d.(\mathbf{0}, \boldsymbol{\Sigma}_{\varsigma})$$

where $\mathbf{D}(L) \equiv \mathbf{D}_1 L + \mathbf{D}_2 L^2 + ... + \mathbf{D}_p L^p$ has all the roots outside the unit circle, is estimated by OLS to obtain $\hat{\mathbf{D}}(L)$;

vi) the (implied OLS) estimates of the VAR parameters in (1) are then obtained by solving

$$\hat{\mathbf{P}}(L)_{PCVAR} = \hat{\mathbf{D}}(L)\hat{\boldsymbol{\Xi}}'_s,$$

where $\hat{\boldsymbol{\Xi}}_s$ is the matrix of the eigenvectors associated with the first *s* ordered eigenvalues of $\hat{\boldsymbol{\Sigma}}$ ($\boldsymbol{\Sigma} = E\left[\mathbf{x}_t\mathbf{x}'_t\right]$).

See Morana (2011, 2012b) for additional details concerning the estimation procedure.

Table 1: impulse response analysis, responses to oil market structural shocks

	Employment										Unemployment rate									
	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV
0	**-0.04**	**-0.01**	**0.02**	**-0.07**	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**	0.00	**0.01**	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00
2	**-0.15**	-0.04	**0.12**	**-0.20**	**0.05**	**0.06**	**-0.05**	**0.04**	**-0.01**	-0.01	**0.06**	0.02	**-0.08**	**0.15**	**-0.07**	**-0.09**	**0.08**	**-0.05**	**0.03**	**0.05**
4	**-0.17**	**-0.13**	**0.20**	**-0.39**	**0.12**	**0.12**	**-0.11**	**0.08**	-0.01	**0.06**	0.02	0.05	**-0.09**	**0.27**	**-0.15**	**-0.17**	**0.15**	**-0.08**	**0.04**	-0.03
6	**-0.14**	**-0.25**	**0.36**	**-0.49**	**0.15**	**0.20**	**-0.17**	**0.09**	**-0.04**	**0.15**	-0.09	0.07	**-0.24**	**0.34**	**-0.16**	**-0.25**	**0.22**	**-0.09**	**0.09**	**-0.09**
8	**-0.13**	**-0.36**	**0.50**	**-0.61**	**0.18**	**0.28**	**-0.22**	**0.12**	**-0.09**	**0.19**	-0.12	0.10	**-0.35**	**0.43**	**-0.18**	**-0.35**	**0.26**	**-0.12**	**0.15**	**-0.09**
12	**-0.25**	**-0.44**	**0.61**	**-0.78**	**0.20**	**0.42**	**-0.29**	**0.18**	**-0.15**	**0.13**	-0.07	0.03	**-0.36**	**0.52**	**-0.18**	**-0.46**	**0.32**	**-0.16**	**0.21**	0.01
20	**-0.37**	**-0.54**	**0.62**	**-0.80**	0.03	**0.40**	**-0.30**	**0.20**	**-0.12**	**0.11**	-0.08	-0.06	**-0.27**	**0.44**	-0.03	**-0.42**	**0.32**	**-0.15**	**0.18**	0.05
40	**-0.38**	**-0.62**	**0.66**	**-0.79**	0.03	**0.39**	**-0.29**	**0.19**	**-0.11**	**0.14**	-0.19	-0.19	-0.23	**0.39**	-0.08	**-0.41**	**0.31**	**-0.13**	**0.19**	0.05
	Real activity										Public expenditure to GDP ratio									
	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV
0	**-0.03**	**-0.11**	**-0.05**	**-0.07**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.09**	**-0.05**	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.00	0.00	-0.06	**0.14**	**0.07**	**-0.03**	**0.08**	**-0.05**	-0.02	0.01	**0.09**	**-0.06**	0.04	**-0.09**	**-0.09**	**0.05**	**-0.04**	**0.03**	**0.03**
4	**0.12**	0.04	-0.05	**-0.11**	**0.25**	**0.13**	**-0.07**	**0.10**	**-0.08**	**0.07**	-0.05	0.07	-0.06	**0.10**	**-0.12**	**-0.15**	**0.12**	**-0.07**	**0.06**	-0.03
6	**0.22**	0.04	0.07	-0.13	**0.24**	**0.24**	**-0.11**	**0.10**	**-0.15**	**0.08**	**-0.17**	0.08	**-0.15**	0.08	-0.07	**-0.23**	**0.15**	**-0.05**	**0.11**	-0.05
8	**0.23**	0.11	0.10	**-0.20**	**0.27**	**0.32**	**-0.14**	**0.13**	**-0.21**	0.02	**-0.20**	-0.01	**-0.16**	0.10	-0.09	**-0.27**	**0.16**	**-0.07**	**0.16**	0.03
12	**0.22**	**0.28**	-0.01	**-0.21**	**0.25**	**0.35**	**-0.18**	**0.13**	**-0.23**	**-0.08**	**-0.17**	**-0.21**	0.00	0.04	-0.02	**-0.25**	**0.18**	**-0.07**	**0.15**	**0.14**
20	**0.29**	**0.44**	-0.13	-0.08	**0.16**	**0.28**	**-0.15**	**0.10**	**-0.19**	**-0.12**	**-0.29**	**-0.37**	0.12	-0.13	0.05	**-0.18**	**0.14**	-0.03	**0.11**	**0.15**
40	**0.44**	**0.62**	**-0.19**	-0.01	**0.22**	**0.29**	**-0.15**	**0.09**	**-0.21**	**-0.14**	**-0.44**	**-0.58**	**0.20**	**-0.18**	-0.03	**-0.19**	**0.14**	-0.02	**0.14**	**0.18**
	Nominal factor										Real wage									
	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV
0	**-0.01**	0.00	0.00	**-0.01**	0.00	0.00	0.00	0.00	0.00	0.00	**0.13**	**0.03**	**-0.10**	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2	**-0.02**	**0.03**	0.00	**-0.01**	**0.01**	0.00	0.00	**0.01**	0.00	**0.01**	**0.22**	**0.10**	**-0.18**	**0.21**	-0.01	**0.04**	**0.04**	**-0.05**	**-0.06**	**-0.04**
4	**-0.01**	0.00	0.00	0.00	**0.01**	0.00	**0.00**	**0.00**	0.00	**0.01**	**0.31**	**0.36**	**-0.25**	**0.28**	-0.02	**0.09**	**0.04**	**-0.05**	**-0.11**	**-0.14**
6	0.00	**0.01**	**0.01**	0.00	**0.01**	0.00	**0.00**	0.00	0.00	**0.02**	**0.35**	**0.56**	**-0.37**	**0.33**	0.02	**0.10**	0.03	**-0.06**	**-0.11**	**-0.23**
8	0.00	**0.01**	**0.02**	0.00	**0.01**	**0.01**	**0.00**	**0.01**	**-0.01**	**0.01**	**0.47**	**0.73**	**-0.47**	**0.41**	0.00	0.07	0.03	**-0.10**	**-0.10**	**-0.23**
12	0.01	**0.02**	0.01	0.00	**0.02**	**0.01**	0.00	**0.01**	**-0.01**	**0.01**	**0.73**	**1.03**	**-0.58**	**0.53**	0.05	0.03	0.04	**-0.14**	**-0.12**	**-0.26**
20	0.01	**0.03**	0.00	0.00	**0.02**	**0.01**	0.00	**0.01**	**-0.01**	**0.01**	**0.95**	**1.46**	**-0.79**	**0.67**	0.13	0.03	0.04	**-0.17**	**-0.15**	**-0.34**
40	0.01	**0.03**	0.00	0.00	**0.02**	**0.01**	0.00	**0.01**	**-0.01**	**0.01**	**1.18**	**1.87**	**-0.98**	**0.79**	0.18	0.03	0.04	**-0.20**	**-0.18**	**-0.42**
	Real housing prices										US$ exchange rate index									
	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV
0	**0.04**	0.02	**-0.08**	-0.02	**0.03**	0.00	0.00	0.00	0.00	0.00	**-0.12**	**-0.05**	**-0.09**	0.00	**0.14**	0.00	0.00	0.00	0.00	0.00
2	**0.20**	**0.20**	**-0.23**	**0.06**	**0.18**	**0.05**	**0.05**	**-0.08**	**-0.04**	**0.06**	**-0.20**	**0.11**	**-0.13**	**-0.14**	**0.39**	**0.11**	0.01	**0.15**	**-0.10**	**-0.07**
4	**0.41**	**0.42**	**-0.17**	0.01	**0.32**	**0.09**	0.02	**-0.14**	**-0.07**	**0.07**	**-0.23**	0.05	**-0.25**	-0.01	**0.46**	**0.17**	**0.07**	**0.13**	**-0.16**	**-0.07**
6	**0.49**	**0.63**	**-0.14**	-0.08	**0.51**	**0.12**	-0.01	**-0.13**	**-0.12**	0.02	**-0.23**	0.03	**-0.23**	**-0.09**	**0.44**	**0.20**	**0.08**	**0.13**	**-0.16**	**-0.09**
8	**0.56**	**0.81**	**-0.21**	-0.12	**0.62**	**0.13**	-0.05	**-0.14**	**-0.14**	-0.01	**-0.30**	**0.10**	**-0.24**	**-0.10**	**0.47**	**0.21**	**0.09**	**0.15**	**-0.18**	**-0.13**
12	**0.64**	**1.09**	**-0.36**	-0.12	**0.66**	**0.14**	-0.08	**-0.13**	**-0.17**	-0.07	**-0.31**	0.07	**-0.27**	-0.09	**0.47**	**0.15**	**0.11**	**0.12**	**-0.14**	**-0.11**
20	**0.63**	**1.20**	**-0.50**	-0.06	**0.49**	**0.12**	**-0.09**	**-0.14**	**-0.14**	**-0.16**	**-0.36**	0.01	**-0.25**	-0.12	**0.50**	**0.14**	**0.12**	**0.13**	**-0.13**	**-0.09**
40	**0.79**	**1.38**	**-0.55**	0.02	**0.54**	**0.11**	-0.09	**-0.16**	**-0.16**	**-0.17**	**-0.42**	-0.10	**-0.20**	**-0.16**	**0.48**	**0.15**	**0.11**	**0.13**	**-0.12**	**-0.07**
	Real stock prices										Stock market volatility									
	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV
0	**-0.17**	-0.01	-0.02	**0.06**	**0.06**	**0.05**	**-0.05**	**0.02**	**0.09**	**-0.03**	**0.19**	**0.07**	0.00	**-0.12**	**-0.08**	0.00	0.00	0.00	0.00	0.00
2	**-0.18**	**-0.13**	**0.14**	-0.06	**0.07**	**0.11**	**-0.07**	0.00	**0.09**	0.02	**0.30**	0.06	**-0.09**	**-0.07**	**-0.09**	**-0.05**	**0.03**	**0.04**	0.01	**0.04**
4	**-0.12**	**-0.39**	**0.26**	-0.01	**0.11**	0.04	**-0.07**	-0.01	**0.11**	**0.14**	**0.10**	**0.34**	-0.04	**-0.14**	**-0.09**	0.03	**0.03**	**0.10**	**-0.03**	-0.08
6	**-0.13**	**-0.46**	**0.37**	-0.05	**0.10**	**0.06**	**-0.06**	-0.02	**0.09**	**0.15**	**-0.11**	**0.13**	**-0.08**	**-0.24**	**-0.16**	**0.07**	0.01	**0.13**	-0.01	**-0.08**
8	**-0.23**	**-0.45**	**0.38**	-0.10	**0.15**	**0.06**	**-0.06**	0.02	**0.09**	**0.11**	-0.06	-0.04	-0.03	**-0.19**	**-0.25**	**0.08**	0.01	**0.09**	0.00	-0.02
12	**-0.34**	**-0.55**	**0.34**	-0.11	0.08	0.03	**-0.06**	0.02	**0.12**	**0.13**	**-0.08**	**-0.12**	**0.12**	**-0.27**	**-0.23**	**0.09**	-0.01	**0.11**	0.00	0.01
20	**-0.46**	**-0.75**	**0.41**	-0.13	0.00	0.01	-0.05	0.02	**0.15**	**0.15**	**-0.11**	**-0.20**	**0.16**	**-0.30**	**-0.20**	**0.10**	-0.01	**0.12**	-0.01	**0.03**
40	**-0.54**	**-0.92**	**0.50**	**-0.18**	-0.01	0.01	-0.04	0.04	**0.16**	**0.19**	**-0.17**	**-0.29**	**0.19**	**-0.32**	**-0.23**	**0.10**	-0.01	**0.13**	0.00	**0.05**
	Excess liquidity										Real short-term rate									
	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV	R	Pm	Pp	RM	C	INV	WT	FB	OP	OV
0	**0.09**	**-0.04**	-0.01	**0.11**	**-0.05**	0.00	0.00	0.00	0.00	0.00	**0.06**	0.01	0.01	**-0.03**	**0.02**	0.00	0.00	0.00	0.00	0.00
2	**0.12**	**-0.23**	-0.02	**0.14**	**-0.04**	**-0.07**	**0.06**	0.00	**0.02**	**0.07**	**-0.03**	**-0.02**	**0.03**	**-0.02**	0.00	**-0.02**	0.00	0.00	**0.01**	**-0.01**
4	0.01	**-0.41**	**0.12**	0.04	-0.01	**-0.03**	**0.09**	**0.05**	0.01	0.02	**-0.03**	-0.01	**0.05**	**-0.02**	0.01	**-0.01**	**0.01**	0.00	**0.01**	**-0.03**
6	**-0.15**	**-0.51**	**0.10**	**-0.06**	0.05	0.00	**0.08**	**0.08**	0.02	0.03	-0.01	-0.01	**0.03**	0.00	**0.03**	**-0.03**	0.00	**-0.01**	**0.01**	**-0.01**
8	**-0.16**	**-0.64**	**0.18**	**-0.10**	0.07	0.00	**0.07**	**0.07**	**0.04**	**0.12**	**0.02**	**-0.02**	**0.04**	0.00	**0.03**	**-0.02**	**0.01**	**-0.01**	**0.01**	0.01
12	**-0.16**	**-0.86**	**0.42**	**-0.24**	**0.15**	**0.06**	**0.05**	**0.10**	0.01	**0.21**	0.02	0.00	**0.04**	-0.01	**0.05**	**-0.01**	0.00	-0.01	0.00	**-0.01**
20	**-0.37**	**-1.04**	**0.51**	**-0.41**	0.15	**0.12**	0.02	**0.15**	-0.01	**0.22**	**0.02**	0.01	**0.03**	-0.01	**0.04**	**-0.01**	0.00	-0.01	0.00	**-0.02**
40	**-0.54**	**-1.36**	**0.64**	**-0.47**	0.07	**0.10**	0.03	**0.16**	0.03	**0.27**	**0.03**	0.02	**0.02**	0.00	**0.04**	**-0.01**	0.00	**-0.01**	0.00	**-0.02**

The table reports impulse responses for the macroeconomic and financial variables at selected horizons (impact (0) and 2 to 40 quarters), relatively to the oil market structural shocks: reserves (R), net negative production (Pm), net positive production (Pp), refineries margins (RM), oil consumption preferences (C), oil inventories preferences (INV), real oil price (OP), nominal oil price volatility (OV), oil market speculative shocks (WT, FB). Figures in bold denote statistical significance at the 10% level.

Table 2: Historical decomposition over selected periods: contributions from oil market supply side shocks.

Oil market supply side shocks																								
	Y		E		U		W		P		G		L		R		H		F		FV		X	
	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT	SUP	ACT
1990(2)	0.42	-0.70	0.47	-0.23	-0.93	0.11	0.36	1.90	0.11	-0.02	-0.43	0.74	-0.42	-0.20	0.27	0.38	-0.09	-0.70	0.21	-0.64	-1.22	-0.01	0.31	-0.11
1990(3)	-0.52	-0.54	0.34	-0.39	-0.31	0.72	0.38	0.90	0.00	-0.08	0.39	0.85	-0.36	0.42	0.32	-0.22	-0.25	-0.48	-0.44	-1.94	0.36	0.66	-0.57	0.70
1990(4)	0.46	-0.35	0.23	-0.27	-0.03	0.91	0.53	0.25	0.16	0.08	0.14	1.08	-0.46	0.18	-0.46	-0.41	-0.12	-1.14	-1.15	-2.00	0.20	0.84	0.61	0.35
1991(1)	-0.12	-1.55	-0.22	-1.12	0.02	1.21	0.54	0.65	0.02	-0.08	0.14	0.82	-0.26	-0.46	0.38	0.60	0.21	0.13	-0.25	0.10	0.47	-0.64	0.08	-0.87
1991(2)	0.25	-0.37	-0.34	-1.26	0.27	1.29	1.55	2.04	-0.11	-0.07	0.24	0.76	-0.60	-0.80	0.14	0.03	0.46	-0.40	-1.51	-0.12	2.28	-0.69	-0.53	-1.97
1991(3)	-0.37	-0.81	-0.49	-1.41	0.41	0.76	0.87	0.99	-0.04	0.03	0.22	0.26	-0.27	-0.92	-0.07	-0.31	0.22	0.07	-1.07	-1.04	0.83	-0.24	-0.15	-0.52
1991(4)	-0.19	-0.13	-0.54	-1.54	0.32	0.74	0.52	0.63	-0.01	-0.06	0.19	0.29	-0.29	-1.39	-0.14	-0.04	0.16	0.11	0.21	-1.28	-0.66	-0.72	0.43	0.61
1992(1)	0.28	0.00	-0.26	-1.09	-0.25	1.44	0.19	1.25	0.10	-0.05	-0.16	-0.12	-1.12	-1.79	-0.05	0.62	0.17	-0.69	-0.31	-0.18	-0.77	1.42	0.00	-0.47
1992(2)	0.15	-1.05	-0.06	-1.49	-0.16	1.43	-0.02	1.79	-0.02	0.01	-0.41	0.67	-0.89	0.07	-0.17	-0.20	-0.11	-0.72	0.33	-0.86	-1.08	-1.05	0.38	-0.25
1992(3)	0.34	-0.45	0.11	-1.99	-0.26	1.34	0.15	1.61	0.04	0.04	-0.56	0.84	-0.45	-0.03	0.27	0.20	0.16	-0.85	-0.11	-1.92	-0.26	-0.75	0.17	0.85
1992(4)	0.21	-1.03	0.03	-2.47	-0.16	1.34	0.11	0.46	-0.07	0.02	-0.56	0.19	-0.20	-0.53	-0.05	-0.06	0.07	-1.19	-0.42	-0.52	0.31	-0.76	-0.51	-1.93
1993(1)	0.25	-1.02	0.02	-2.18	-0.24	1.09	0.54	1.05	-0.01	-0.19	-0.39	-0.72	-0.25	-1.30	0.14	-0.60	0.49	-1.41	-0.29	0.65	0.55	-0.83	-0.32	-1.22
1993(2)	0.18	-0.40	0.04	-1.53	-0.12	0.58	0.42	1.00	-0.05	-0.06	-0.17	-0.98	0.04	-1.34	-0.12	-0.25	0.35	-0.27	0.06	0.11	0.16	-0.49	0.02	0.26
1993(3)	0.25	-0.07	0.02	-1.08	-0.28	1.05	0.50	0.90	0.02	-0.22	-0.19	-0.92	-0.04	-1.42	0.07	0.10	0.65	-0.08	-0.28	0.58	0.23	-0.43	-0.16	-0.84
2000(4)	-0.31	-0.33	0.13	1.05	-0.17	-0.67	-0.27	-1.29	0.04	0.06	0.35	0.74	0.18	0.01	0.08	-0.01	-0.10	0.04	-0.26	-0.83	-0.03	0.43	-0.08	-0.94
2001(1)	-0.14	-0.71	0.09	0.84	0.21	0.06	-0.11	0.16	-0.05	-0.04	0.29	1.14	0.23	0.70	0.07	0.62	0.14	0.55	0.03	-0.35	0.26	0.43	0.00	0.27
2001(2)	0.01	-0.99	0.10	-0.54	0.04	0.21	-0.54	-0.45	0.02	0.03	0.00	1.01	0.14	0.46	-0.29	-0.95	0.14	-0.09	0.38	-0.23	-0.03	1.16	0.18	-1.14
2001(3)	0.00	-1.14	0.26	0.08	-0.17	0.81	-0.35	-0.02	0.00	-0.14	-0.13	1.50	0.07	1.25	0.14	0.78	0.21	0.24	0.31	-1.48	-0.25	-0.85	0.07	0.15
2001(4)	0.24	-0.95	0.39	-0.07	-0.16	1.22	-0.23	-0.85	-0.02	-0.16	-0.07	1.30	-0.06	-0.01	0.07	-0.24	0.35	0.16	0.07	0.37	0.30	0.74	-0.02	0.08
2002(1)	0.05	-0.59	0.36	-0.50	-0.33	0.20	-0.32	-0.70	0.01	0.16	-0.02	-0.02	-0.10	-1.21	-0.12	-0.44	0.16	0.21	-0.05	0.86	0.36	-1.01	0.14	0.08
2002(2)	0.15	-0.11	0.31	-0.36	-0.27	-0.07	-0.15	-0.55	0.03	0.02	-0.06	-0.42	0.10	-1.52	-0.02	-0.12	0.26	0.48	0.00	-0.50	-0.18	-0.54	0.25	1.25
2002(3)	0.15	-0.44	0.22	-0.39	-0.20	0.42	-0.04	0.49	0.00	-0.05	-0.02	0.52	0.22	0.26	0.08	0.27	0.47	0.86	-0.05	-2.09	0.16	1.01	-0.16	0.77
2002(4)	0.20	-0.19	0.21	-0.31	-0.13	0.87	0.06	-0.49	-0.02	-0.16	0.00	0.36	0.04	0.04	-0.09	-0.19	0.44	1.01	-0.19	0.13	0.42	1.82	-0.12	0.49
2003(1)	-0.24	-0.38	0.17	-0.35	-0.05	0.53	-0.36	-0.81	0.00	-0.08	0.01	0.29	0.16	0.17	-0.05	-0.38	0.07	0.20	0.25	-0.17	-0.45	-0.55	0.08	1.34
2003(2)	0.15	-1.07	0.23	-0.30	-0.21	0.45	-0.12	0.29	0.06	0.12	0.06	0.91	-0.18	0.68	0.13	1.18	-0.03	0.87	0.65	1.32	-0.95	-0.97	0.46	1.30
2008(2)	-0.34	-1.04	0.26	0.49	0.03	0.71	-0.60	-1.60	-0.02	0.01	0.47	1.84	0.58	1.32	-0.01	0.41	-0.37	-3.18	0.35	0.08	0.31	0.17	0.04	0.55
2008(3)	-0.30	-1.91	0.26	-0.34	0.04	1.24	-0.62	-0.73	-0.01	0.05	0.33	2.23	0.69	2.27	-0.03	0.33	-0.16	-2.73	0.29	-1.80	0.10	1.46	-0.27	-1.25
2008(4)	-0.55	-4.90	0.18	-1.69	0.11	2.66	-0.35	2.05	-0.04	-0.18	0.44	4.47	0.60	4.39	0.06	1.80	0.14	-2.12	0.15	-4.07	0.54	4.97	-0.64	-5.08
2009(1)	0.05	-4.97	0.13	-3.82	0.10	4.97	-0.34	1.57	0.03	-0.28	0.25	4.66	0.33	3.61	-0.32	-0.68	0.33	-1.94	0.13	-0.67	0.05	1.35	0.20	-0.71
2009(2)	0.22	-2.07	0.18	-3.32	-0.14	3.46	-0.49	-0.60	0.04	0.23	0.00	1.95	-0.11	0.52	0.00	-1.03	0.46	-1.58	0.44	1.85	-0.11	0.51	0.29	2.03
2009(3)	0.26	-0.47	0.22	-1.95	-0.24	1.65	-0.11	-1.25	-0.02	-0.20	-0.04	0.31	-0.18	-1.55	0.00	-0.53	0.32	-1.12	-0.01	1.79	0.22	-1.45	-0.03	1.64

The table reports the historical decomposition (net of base prediction) for various macroeconomic and financial variables, relatively to the contribution of the oil market supply side shocks (SUP, reserves, net production changes, refinery margins), over selected sub periods. The macroeconomic and financial variables are real activity growth (Y), employment growth (E), unemployment rate changes (U), real wages growth (W), core inflation (nominal factor, P), public expenditure to GDP ratio growth (G), excess liquidity (L), real interest rate in changes (R), real housing price returns (H), real stock price returns (F), nominal stock price volatility (FV), nominal US$ exchange rate index return (X). For each of the macroeconomic and financial variables, ACT denotes the actual realization of the variable (net of base prediction), while SUP is the contribution yield by the oil market supply side shocks.

Table 3: Historical decomposition over selected periods: contributions from oil futures market speculative shocks.

Oil futures market speculative shocks																								
	Y		E		U		W		P		G		L		R		H		F		FV		X	
	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT	SPC	ACT
1990(2)	-0.01	-0.70	-0.05	-0.23	0.05	0.11	0.00	1.90	0.00	-0.02	0.01	0.74	0.09	-0.20	-0.04	0.38	-0.06	-0.70	0.16	-0.64	-0.06	-0.01	0.09	-0.11
1990(3)	0.13	-0.54	0.06	-0.39	-0.02	0.72	0.01	0.90	0.00	-0.08	-0.03	0.85	0.08	0.42	0.00	-0.22	-0.11	-0.48	-0.10	-1.94	0.20	0.66	0.14	0.70
1990(4)	0.00	-0.35	0.00	-0.27	-0.04	0.91	-0.09	0.25	0.00	0.08	0.03	1.08	0.06	0.18	0.00	-0.41	-0.14	-1.14	-0.05	-2.00	0.17	0.84	0.19	0.35
1991(1)	-0.06	-1.55	0.05	-1.12	-0.04	1.21	0.01	0.65	-0.02	-0.08	0.01	0.82	0.01	-0.46	0.06	0.60	-0.05	0.13	-0.10	0.10	0.08	-0.64	-0.20	-0.87
1991(2)	-0.13	-0.37	-0.04	-1.26	0.10	1.29	0.04	2.04	-0.01	-0.07	0.04	0.76	0.06	-0.80	-0.03	0.03	0.08	-0.40	0.10	-0.12	-0.16	-0.69	-0.25	-1.97
1991(3)	-0.03	-0.81	-0.04	-1.41	0.08	0.76	0.04	0.99	0.01	0.03	0.06	0.26	0.01	-0.92	-0.02	-0.31	0.16	0.07	-0.01	-1.04	0.01	-0.24	-0.09	-0.52
1991(4)	0.03	-0.13	-0.06	-1.54	0.02	0.74	-0.07	0.63	0.02	-0.06	0.02	0.29	-0.05	-1.39	-0.07	-0.04	0.05	0.11	-0.02	-1.28	-0.13	-0.72	0.15	0.61
1992(1)	-0.03	0.00	0.00	-1.09	-0.01	1.44	-0.06	1.25	0.00	-0.05	0.02	-0.12	-0.09	-1.79	0.07	0.62	0.07	-0.69	0.05	-0.18	-0.02	1.42	0.04	-0.47
1992(2)	-0.06	-1.05	-0.04	-1.49	0.09	1.43	0.01	1.79	-0.02	0.01	0.03	0.67	0.00	0.07	0.00	-0.20	0.02	-0.72	0.05	-0.86	-0.16	-1.05	-0.16	-0.25
1992(3)	-0.15	-0.45	-0.07	-1.99	0.14	1.34	0.10	1.61	0.01	0.04	0.15	0.84	0.06	-0.03	0.06	0.20	0.13	-0.85	-0.16	-1.92	0.15	-0.75	-0.15	0.85
1992(4)	-0.21	-1.03	-0.17	-2.47	0.20	1.34	0.08	0.46	-0.02	0.02	0.19	0.19	0.10	-0.53	-0.02	-0.06	0.06	-1.19	0.05	-0.52	-0.10	-0.76	-0.14	-1.93
1993(1)	-0.15	-1.02	-0.16	-2.18	0.14	1.09	0.02	1.05	0.01	-0.19	0.15	-0.72	0.00	-1.30	-0.02	-0.60	0.02	-1.41	0.09	0.65	-0.08	-0.83	0.04	-1.22
1993(2)	-0.07	-0.40	-0.09	-1.53	0.09	0.58	-0.04	1.00	0.00	-0.06	0.01	-0.98	-0.11	-1.34	-0.03	-0.25	-0.10	-0.27	0.09	0.11	-0.20	-0.49	0.05	0.26
1993(3)	-0.03	-0.07	-0.07	-1.08	0.04	1.05	-0.03	0.90	0.02	-0.22	-0.04	-0.92	-0.09	-1.42	0.02	0.10	-0.04	-0.08	0.07	0.58	-0.10	-0.43	0.01	-0.84
2000(4)	0.19	-0.33	0.15	1.05	-0.21	-0.67	-0.11	-1.29	0.02	0.06	-0.19	0.74	-0.08	0.01	0.00	-0.01	-0.08	0.04	0.02	-0.83	0.04	0.43	0.20	-0.94
2001(1)	0.21	-0.71	0.25	0.84	-0.21	0.06	-0.05	0.16	0.00	-0.04	-0.20	1.14	-0.04	0.70	0.02	0.62	-0.01	0.55	-0.05	-0.35	0.10	0.43	-0.05	0.27
2001(2)	0.11	-0.99	0.18	-0.54	-0.21	0.21	-0.01	-0.45	-0.02	0.03	-0.10	1.01	0.00	0.46	0.01	-0.95	0.04	-0.09	0.02	-0.23	0.16	1.16	-0.06	-1.14
2001(3)	0.12	-1.14	0.18	0.08	-0.16	0.81	0.02	-0.02	0.00	-0.14	-0.06	1.50	0.06	1.25	-0.02	0.78	0.03	0.24	-0.03	-1.48	0.10	-0.85	0.02	0.15
2001(4)	0.08	-0.95	0.18	-0.07	-0.19	1.22	-0.03	-0.85	0.00	-0.16	-0.02	1.30	0.03	-0.01	0.02	-0.24	0.11	0.16	0.00	0.37	0.07	0.74	-0.03	0.08
2002(1)	0.09	-0.59	0.16	-0.50	-0.18	0.20	-0.04	-0.70	-0.01	0.16	-0.08	-0.02	0.01	-1.21	-0.04	-0.44	0.02	0.21	0.13	0.86	-0.18	-1.01	-0.04	0.08
2002(2)	0.11	-0.11	0.20	-0.36	-0.18	-0.07	-0.07	-0.55	0.01	0.02	-0.08	-0.42	-0.01	-1.52	0.02	-0.12	0.08	0.48	-0.04	-0.50	0.01	-0.54	-0.04	1.25
2002(3)	0.03	-0.44	0.18	-0.39	-0.15	0.42	-0.03	0.49	-0.02	-0.05	-0.05	0.52	-0.04	0.26	0.03	0.27	0.15	0.86	-0.03	-2.09	0.08	1.01	-0.23	0.77
2002(4)	0.04	-0.19	0.08	-0.31	-0.08	0.87	-0.02	-0.49	0.01	-0.16	-0.02	0.36	0.09	0.04	-0.05	-0.19	0.13	1.01	0.03	0.13	-0.17	1.82	-0.08	0.49
2003(1)	0.06	-0.38	0.13	-0.35	-0.06	0.53	0.00	-0.81	0.01	-0.08	0.05	0.29	0.04	0.17	0.05	-0.38	0.15	0.20	-0.18	-0.17	0.17	-0.55	0.05	1.34
2003(2)	-0.07	-1.07	0.01	-0.30	-0.01	0.45	-0.01	0.29	-0.02	0.12	0.10	0.91	0.06	0.68	0.00	1.18	0.10	0.87	0.15	1.32	-0.06	-0.97	-0.07	1.30
2008(2)	-0.02	-1.04	-0.06	0.49	0.07	0.71	0.09	-1.60	0.00	0.01	0.12	1.84	0.09	1.32	-0.05	0.41	0.12	-3.18	-0.05	0.08	-0.02	0.17	0.07	0.55
2008(3)	-0.05	-1.91	-0.08	-0.34	0.02	1.24	0.00	-0.73	0.02	0.05	0.10	2.23	0.00	2.27	0.00	0.33	-0.01	-2.73	-0.04	-1.80	-0.08	1.46	0.20	-1.25
2008(4)	-0.08	-4.90	-0.07	-1.69	0.14	2.66	0.05	2.05	0.01	-0.18	0.06	4.47	0.11	4.39	0.05	1.80	0.03	-2.12	0.01	-4.07	-0.06	4.97	-0.04	-5.08
2009(1)	-0.02	-4.97	-0.08	-3.82	0.14	4.97	0.04	1.57	-0.02	-0.28	0.04	4.66	0.07	3.61	0.01	-0.68	-0.02	-1.94	0.01	-0.67	0.15	1.35	-0.02	-0.71
2009(2)	-0.02	-2.07	-0.11	-3.32	0.10	3.46	-0.02	-0.60	0.01	0.23	0.04	1.95	0.06	0.52	-0.06	-1.03	-0.14	-1.58	0.05	1.85	-0.02	0.51	0.16	2.03
2009(3)	-0.03	-0.47	-0.05	-1.95	0.03	1.65	-0.04	-1.25	0.02	-0.20	0.06	0.31	0.01	-1.55	0.05	-0.53	-0.14	-1.12	-0.08	1.79	0.07	-1.45	0.08	1.64

The table reports the historical decomposition (net of base prediction) for various macroeconomic and financial variables, relatively to the contribution of the oil futures market speculative shocks (SPC), over selected sub periods. The macroeconomic and financial variables are real activity growth (Y), employment growth (E), unemployment rate changes (U), real wages growth (W), core inflation (nominal factor, P) , public expenditure to GDP ratio growth (G), excess liquidity (L), real interest rate in changes (R), real housing price returns (H), real stock price returns (F), nominal stock price volatility (FV), nominal US$ exchange rate index return (X). For each of the macroeconomic and financial variables, ACT denotes the actual realization of the variable (net of base prediction), while SPC is the contribution yield by the oil futures market speculative shocks.

Table 4: Historical decomposition over selected periods: contributions from other nominal oil price volatility shocks.

Other nominal oil price volatility shocks																								
	Y		E		U		W		P		G		L		R		H		F		FV		X	
	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT	OV	ACT
1990(2)	-0.14	-0.70	-0.11	-0.23	0.17	0.11	0.19	1.90	-0.01	-0.02	0.13	0.74	0.15	-0.20	0.00	0.38	0.09	-0.70	-0.25	-0.64	0.21	-0.01	-0.11	-0.11
1990(3)	-0.11	-0.54	-0.17	-0.39	0.21	0.72	0.12	0.90	0.00	-0.08	0.13	0.85	0.18	0.42	-0.06	-0.22	0.16	-0.48	0.05	-1.94	0.08	0.66	-0.07	0.70
1990(4)	0.06	-0.35	-0.11	-0.27	0.07	0.91	0.01	0.25	0.01	0.08	-0.01	1.08	-0.03	0.18	-0.07	-0.41	0.17	-1.14	0.21	-2.00	-0.10	0.84	0.02	0.35
1991(1)	0.19	-1.55	0.01	-1.12	-0.06	1.21	-0.09	0.65	0.01	-0.08	-0.16	0.82	-0.17	-0.46	-0.05	0.60	0.11	0.13	0.25	0.10	-0.27	-0.64	0.03	-0.87
1991(2)	0.23	-0.37	0.11	-1.26	-0.17	1.29	-0.15	2.04	0.03	-0.07	-0.24	0.76	-0.22	-0.80	0.00	0.03	0.02	-0.40	0.17	-0.12	-0.24	-0.69	0.06	-1.97
1991(3)	0.19	-0.81	0.16	-1.41	-0.23	0.76	-0.14	0.99	0.01	0.03	-0.21	0.26	-0.19	-0.92	0.04	-0.31	-0.08	0.07	0.09	-1.04	-0.14	-0.24	0.04	-0.52
1991(4)	0.09	-0.13	0.17	-1.54	-0.23	0.74	-0.02	0.63	0.00	-0.06	-0.12	0.29	-0.13	-1.39	0.07	-0.04	-0.11	0.11	-0.15	-1.28	0.02	-0.72	0.00	0.61
1992(1)	-0.09	0.00	0.10	-1.09	-0.03	1.44	0.09	1.25	-0.03	-0.05	0.07	-0.12	0.12	-1.79	0.07	0.62	-0.04	-0.69	-0.21	-0.18	0.16	1.42	-0.12	-0.47
1992(2)	-0.20	-1.05	-0.04	-1.49	0.08	1.43	0.19	1.79	0.00	0.01	0.19	0.67	0.19	0.07	0.04	-0.20	0.00	-0.72	-0.17	-0.86	0.20	-1.05	-0.07	-0.25
1992(3)	-0.17	-0.45	-0.13	-1.99	0.10	1.34	0.20	1.61	-0.01	0.04	0.16	0.84	0.10	-0.03	-0.02	0.20	-0.01	-0.85	-0.04	-1.92	0.00	-0.75	0.07	0.85
1992(4)	-0.07	-1.03	-0.13	-2.47	0.10	1.34	0.19	0.46	-0.02	0.02	0.10	0.19	0.03	-0.53	0.00	-0.06	0.03	-1.19	-0.14	-0.52	0.05	-0.76	0.06	-1.93
1993(1)	-0.07	-1.02	-0.15	-2.18	0.15	1.09	0.15	1.05	-0.01	-0.19	0.05	-0.72	-0.01	-1.30	-0.01	-0.60	-0.01	-1.41	-0.15	0.65	0.07	-0.83	0.08	-1.22
1993(2)	-0.03	-0.40	-0.17	-1.53	0.13	0.58	0.10	1.00	0.00	-0.06	0.00	-0.98	-0.03	-1.34	-0.04	-0.25	-0.01	-0.27	0.04	0.11	0.02	-0.49	0.08	0.26
1993(3)	0.08	-0.07	-0.13	-1.08	-0.02	1.05	0.11	0.90	0.01	-0.22	-0.11	-0.92	-0.21	-1.42	-0.01	0.10	-0.05	-0.08	0.00	0.58	-0.08	-0.43	0.17	-0.84
2000(4)	0.16	-0.33	0.04	1.05	-0.08	-0.67	-0.04	-1.29	0.01	0.06	-0.12	0.74	-0.10	0.01	-0.02	-0.01	0.14	0.04	0.04	-0.83	-0.04	0.43	-0.09	-0.94
2001(1)	0.13	-0.71	0.09	0.84	-0.11	0.06	-0.03	0.16	0.02	-0.04	-0.13	1.14	-0.11	0.70	0.01	0.62	0.09	0.55	0.05	-0.35	-0.12	0.43	-0.05	0.27
2001(2)	0.11	-0.99	0.11	-0.54	-0.07	0.21	-0.11	-0.45	0.00	0.03	-0.07	1.01	0.02	0.46	-0.03	-0.95	0.14	-0.09	0.16	-0.23	-0.07	1.16	-0.14	-1.14
2001(3)	0.12	-1.14	0.13	0.08	-0.19	0.81	-0.06	-0.02	0.04	-0.14	-0.10	1.50	-0.09	1.25	0.03	0.78	0.06	0.24	0.14	-1.48	-0.10	-0.85	-0.02	0.15
2001(4)	0.11	-0.95	0.16	-0.07	-0.20	1.22	-0.06	-0.85	-0.01	-0.16	-0.10	1.30	-0.11	-0.01	0.00	-0.24	-0.02	0.16	0.13	0.37	-0.24	0.74	0.04	0.08
2002(1)	0.03	-0.59	0.17	-0.50	-0.13	0.20	0.01	-0.70	0.00	0.16	0.01	-0.02	0.05	-1.21	0.08	-0.44	0.02	0.21	-0.24	0.86	0.14	-1.01	-0.12	0.08
2002(2)	-0.16	-0.11	0.03	-0.36	0.04	-0.07	0.07	-0.55	0.00	0.02	0.13	-0.42	0.15	-1.52	0.05	-0.12	-0.05	0.48	-0.13	-0.50	0.11	-0.54	-0.06	1.25
2002(3)	-0.14	-0.44	-0.05	-0.39	0.08	0.42	0.07	0.49	-0.01	-0.05	0.17	0.52	0.20	0.26	-0.03	0.27	0.03	0.86	0.01	-2.09	0.11	1.01	-0.07	0.77
2002(4)	-0.08	-0.19	-0.06	-0.31	0.03	0.87	0.11	-0.49	0.00	-0.16	0.10	0.36	0.04	0.04	0.01	-0.19	-0.03	1.01	-0.04	0.13	0.02	1.82	0.06	0.49
2003(1)	-0.06	-0.38	-0.08	-0.35	0.06	0.53	0.09	-0.81	-0.02	-0.08	0.05	0.29	-0.03	0.17	-0.02	-0.38	-0.09	0.20	-0.09	-0.17	-0.08	-0.55	0.12	1.34
2003(2)	-0.07	-1.07	-0.09	-0.30	0.13	0.45	0.06	0.29	-0.01	0.12	0.08	0.91	0.07	0.68	0.02	1.18	-0.03	0.87	-0.21	1.32	0.18	-0.97	-0.03	1.30
2008(2)	0.18	-1.04	0.04	0.49	-0.16	0.71	0.01	-1.60	0.01	0.01	-0.20	1.84	-0.27	1.32	0.04	0.41	-0.03	-3.18	-0.01	0.08	-0.12	0.17	0.09	0.55
2008(3)	0.09	-1.91	0.04	-0.34	-0.13	1.24	0.05	-0.73	-0.01	0.05	-0.16	2.23	-0.22	2.27	0.03	0.33	-0.11	-2.73	-0.08	-1.80	-0.12	1.46	0.09	-1.25
2008(4)	0.00	-4.90	0.02	-1.69	-0.06	2.66	0.13	2.05	-0.01	-0.18	-0.04	4.47	-0.04	4.39	0.07	1.80	-0.04	-2.12	-0.30	-4.07	0.15	4.97	-0.04	-5.08
2009(1)	-0.14	-4.97	-0.07	-3.82	0.11	4.97	0.19	1.57	-0.02	-0.28	0.11	4.66	0.13	3.61	0.03	-0.68	0.03	-1.94	-0.20	-0.67	0.23	1.35	-0.13	-0.71
2009(2)	-0.13	-2.07	-0.15	-3.32	0.13	3.46	0.20	-0.60	0.00	0.23	0.11	1.95	0.09	0.52	-0.04	-1.03	0.09	-1.58	-0.01	1.85	0.04	0.51	-0.03	2.03
2009(3)	0.00	-0.47	-0.12	-1.95	0.09	1.65	0.12	-1.25	-0.01	-0.20	0.03	0.31	0.01	-1.55	-0.05	-0.53	0.14	-1.12	0.09	1.79	-0.10	-1.45	0.00	1.64

The table reports the historical decomposition (net of base prediction) for various macroeconomic and financial variables, relatively to the contribution of nominal oil price volatility shocks (OV), over selected sub periods. The macroeconomic and financial variables are real activity growth (Y), employment growth (E), unemployment rate changes (U), real wages growth (W), core inflation (nominal factor, P), public expenditure to GDP ratio growth (G), excess liquidity (L), real interest rate in changes (R), real housing price returns (H), real stock price returns (F), nominal stock price volatility (FV), nominal US$ exchange rate index return (X). For each of the macroeconomic and financial variables, ACT denotes the actual realization of the variable (net of base prediction), while OV is the contribution yield by the nominal oil price volatility shock.

Table 5: Historical decomposition over selected periods: joint contributions from oil market shocks.

Oil market shocks																								
	Y		E		U		W		P		G		L		R		H		F		FV		X	
	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT	OM	ACT
1990(2)	0.02	-0.70	0.18	-0.23	-0.57	0.11	0.56	1.90	0.13	-0.02	-0.18	0.74	-0.20	-0.20	0.37	0.38	-0.12	-0.70	-0.60	-0.64	-0.89	-0.01	0.63	-0.11
1990(3)	-0.47	-0.54	0.11	-0.39	-0.03	0.72	0.41	0.90	-0.02	-0.08	0.42	0.85	-0.13	0.42	0.15	-0.22	-0.28	-0.48	-1.92	-1.94	0.34	0.66	-0.24	0.70
1990(4)	0.65	-0.35	0.19	-0.27	-0.09	0.91	0.42	0.25	0.16	0.08	0.14	1.08	-0.43	0.18	-0.53	-0.41	-0.03	-1.14	-0.64	-2.00	0.73	0.84	0.60	0.35
1991(1)	-0.33	-1.55	-0.29	-1.12	0.18	1.21	0.47	0.65	-0.05	-0.08	0.23	0.82	-0.33	-0.46	0.57	0.60	0.20	0.13	0.29	0.10	0.30	-0.64	-0.37	-0.87
1991(2)	0.11	-0.37	-0.53	-1.26	0.45	1.29	1.48	2.04	-0.05	-0.07	0.29	0.76	-0.66	-0.80	0.01	0.03	0.54	-0.40	1.02	-0.12	1.59	-0.69	-0.71	-1.97
1991(3)	-0.22	-0.81	-0.49	-1.41	0.36	0.76	0.72	0.99	-0.01	0.03	0.02	0.26	-0.56	-0.92	-0.13	-0.31	0.46	0.07	-0.45	-1.04	0.29	-0.24	0.03	-0.52
1991(4)	0.03	-0.13	-0.48	-1.54	0.16	0.74	0.33	0.63	-0.02	-0.06	-0.01	0.29	-0.67	-1.39	-0.11	-0.04	0.37	0.11	-1.37	-1.28	-0.85	-0.72	0.96	0.61
1992(1)	0.32	0.00	-0.17	-1.09	-0.31	1.44	0.20	1.25	0.10	-0.05	-0.21	-0.12	-1.19	-1.79	0.10	0.62	0.32	-0.69	0.14	-0.18	-0.55	1.42	0.18	-0.47
1992(2)	-0.09	-1.05	-0.07	-1.49	-0.04	1.43	-0.01	1.79	-0.04	0.01	-0.24	0.67	-0.65	0.07	-0.12	-0.20	0.01	-0.72	-1.10	-0.86	-0.99	-1.05	0.03	-0.25
1992(3)	-0.12	-0.45	-0.10	-1.99	0.00	1.34	0.47	1.61	0.01	0.04	-0.07	0.84	-0.27	-0.03	0.45	0.20	0.43	-0.85	-1.46	-1.92	-0.09	-0.75	-0.14	0.85
1992(4)	-0.20	-1.03	-0.38	-2.47	0.27	1.34	0.61	0.46	-0.09	0.02	-0.13	0.19	-0.01	-0.53	-0.14	-0.06	0.22	-1.19	-0.01	-0.52	0.03	-0.76	-0.77	-1.93
1993(1)	-0.14	-1.02	-0.39	-2.18	0.19	1.09	0.74	1.05	0.00	-0.19	-0.12	-0.72	-0.07	-1.30	0.05	-0.60	0.56	-1.41	1.31	0.65	0.57	-0.83	-0.49	-1.22
1993(2)	-0.18	-0.40	-0.36	-1.53	0.29	0.58	0.52	1.00	-0.09	-0.06	0.00	-0.98	-0.05	-1.34	-0.01	-0.25	0.15	-0.27	-0.10	0.11	0.16	-0.49	-0.02	0.26
1993(3)	0.18	-0.07	-0.33	-1.08	-0.07	1.05	0.58	0.90	0.05	-0.22	-0.21	-0.92	-0.39	-1.42	-0.04	0.10	0.29	-0.08	0.77	0.58	0.08	-0.43	-0.27	-0.84
2000(4)	0.16	-0.33	0.56	1.05	-0.62	-0.67	-0.66	-1.29	0.07	0.06	-0.06	0.74	-0.01	0.01	0.05	-0.01	0.09	0.04	-0.71	-0.83	-0.19	0.43	-0.14	-0.94
2001(1)	0.19	-0.71	0.62	0.84	-0.18	0.06	-0.31	0.16	-0.06	-0.04	0.04	1.14	0.13	0.70	0.24	0.62	0.36	0.55	-0.40	-0.35	0.26	0.43	-0.12	0.27
2001(2)	0.17	-0.99	0.47	-0.54	-0.21	0.21	-0.72	-0.45	0.02	0.03	-0.01	1.01	0.32	0.46	-0.33	-0.95	0.35	-0.09	-0.76	-0.23	0.15	1.16	-0.13	-1.14
2001(3)	0.02	-1.14	0.57	0.08	-0.43	0.81	-0.52	-0.02	0.04	-0.14	-0.05	1.50	0.36	1.25	0.16	0.78	0.33	0.24	-1.72	-1.48	-0.09	-0.85	-0.24	0.15
2001(4)	0.08	-0.95	0.67	-0.07	-0.37	1.22	-0.28	-0.85	-0.05	-0.16	0.12	1.30	0.12	-0.01	0.24	-0.24	0.41	0.16	0.32	0.37	0.28	0.74	-0.47	0.08
2002(1)	-0.19	-0.59	0.55	-0.50	-0.40	0.20	-0.26	-0.70	0.00	0.16	0.22	-0.02	0.01	-1.21	-0.13	-0.44	-0.04	0.21	1.08	0.86	0.24	-1.01	-0.51	0.08
2002(2)	-0.28	-0.11	0.33	-0.36	-0.17	-0.07	-0.03	-0.55	0.07	0.02	0.30	-0.42	0.20	-1.52	0.03	-0.12	0.12	0.48	-0.23	-0.50	-0.16	-0.54	-0.10	1.25
2002(3)	-0.28	-0.44	0.00	-0.39	0.07	0.42	0.08	0.49	-0.03	-0.05	0.34	0.52	0.40	0.26	-0.01	0.27	0.45	0.86	-1.69	-2.09	0.38	1.01	-0.50	0.77
2002(4)	-0.06	-0.19	-0.13	-0.31	0.23	0.87	0.07	-0.49	-0.02	-0.16	0.22	0.36	0.14	0.04	-0.12	-0.19	0.24	1.01	0.35	0.13	0.34	1.82	0.17	0.49
2003(1)	-0.29	-0.38	-0.06	-0.35	0.24	0.53	-0.45	-0.81	-0.02	-0.08	0.11	0.29	0.24	0.17	-0.08	-0.38	-0.28	0.20	-0.23	-0.17	-0.38	-0.55	0.36	1.34
2003(2)	-0.09	-1.07	-0.02	-0.30	0.07	0.45	-0.19	0.29	0.04	0.12	0.22	0.91	-0.15	0.68	0.24	1.18	-0.26	0.87	0.67	1.32	-0.69	-0.97	0.44	1.30
2008(2)	-0.19	-1.04	0.24	0.49	-0.08	0.71	-0.44	-1.60	0.01	0.01	0.29	1.84	0.14	1.32	0.01	0.41	-0.31	-3.18	-0.36	0.08	0.10	0.17	0.47	0.55
2008(3)	-0.23	-1.91	0.18	-0.34	-0.05	1.24	-0.62	-0.73	-0.04	0.05	0.29	2.23	0.46	2.27	-0.09	0.33	-0.23	-2.73	-1.51	-1.80	0.12	1.46	-0.23	-1.25
2008(4)	-0.89	-4.90	-0.01	-1.69	0.29	2.66	0.06	2.05	-0.05	-0.18	0.60	4.47	0.73	4.39	0.37	1.80	0.17	-2.12	-3.73	-4.07	0.89	4.97	-0.75	-5.08
2009(1)	-0.21	-4.97	-0.18	-3.82	0.56	4.97	-0.04	1.57	-0.04	-0.28	0.40	4.66	0.54	3.61	-0.44	-0.68	0.31	-1.94	-0.81	-0.67	0.12	1.35	0.03	-0.71
2009(2)	0.21	-2.07	-0.14	-3.32	0.09	3.46	-0.30	-0.60	0.07	0.23	0.01	1.95	-0.07	0.52	-0.17	-1.03	0.52	-1.58	1.24	1.85	-0.25	0.51	0.63	2.03
2009(3)	0.42	-0.47	0.06	-1.95	-0.15	1.65	-0.07	-1.25	-0.02	-0.20	-0.14	0.31	-0.26	-1.55	0.01	-0.53	0.40	-1.12	1.73	1.79	0.17	-1.45	0.32	1.64

The table reports the historical decomposition (net of base prediction) for various macroeconomic and financial variables, relatively to the joint contribution of oil market shocks (OV), over selected sub periods. The macroeconomic and financial variables are real activity growth (Y), employment growth (E), unemployment rate changes (U), real wages growth (W), core inflation (nominal factor, P), public expenditure to GDP ratio growth (G), excess liquidity (L), real interest rate in changes (R), real housing price returns (H), real stock price returns (F), nominal stock price volatility (FV), nominal US$ exchange rate index return (X). For each of the macroeconomic and financial variables, ACT denotes the actual realization of the variable (net of base prediction), while OM is the joint contribution yield by the oil market shocks.

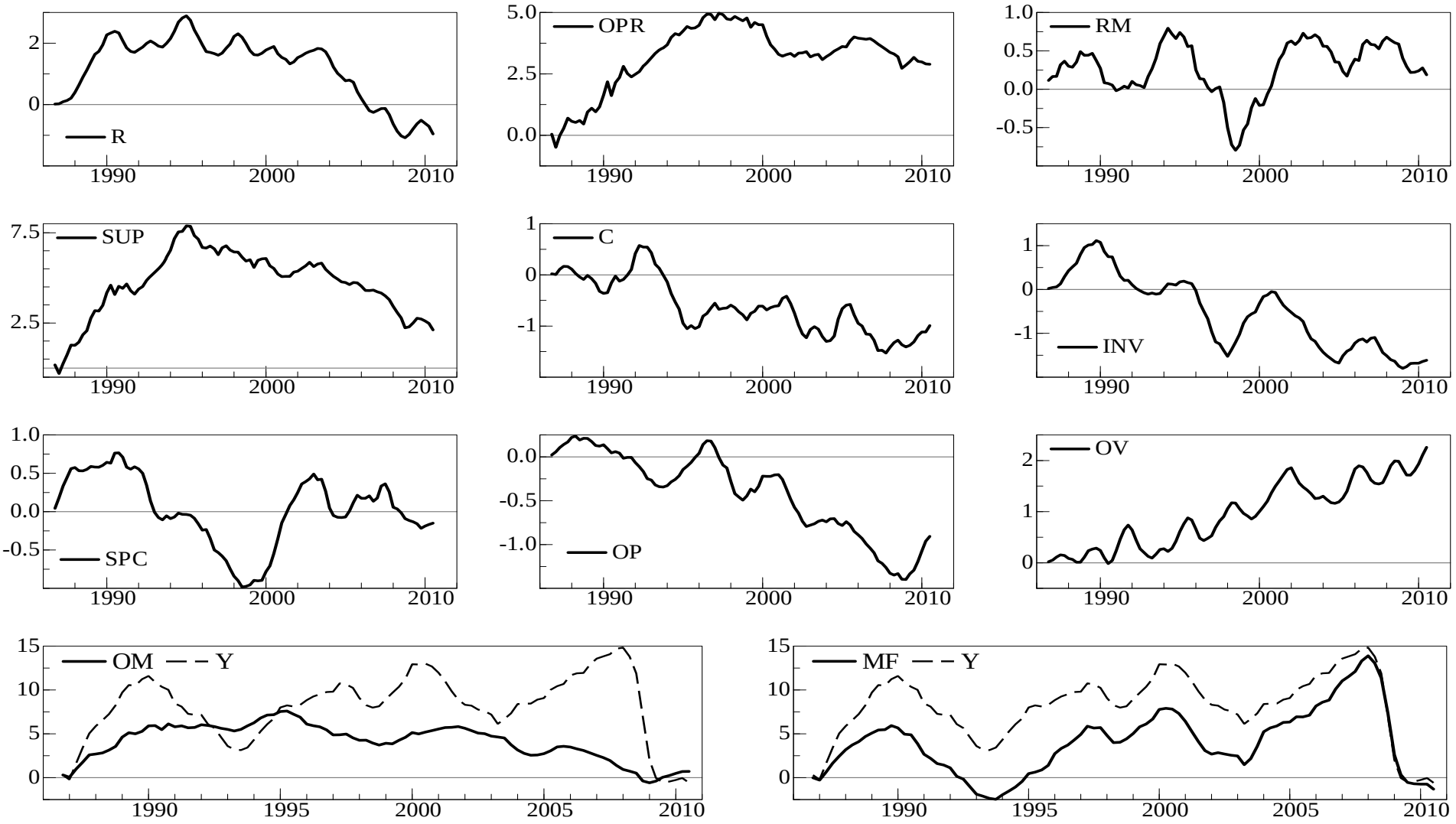

Figure 1: Cumulative historical decomposition; contribution of various categories of shocks to real activity. Reserves shocks (R), oil production shocks (OPR), refinery margins shocks (RM), oil market supply side shocks (SUP: R + OPR + RM), oil consumption (C) and inventories (INV) preferences shocks, oil futures market speculative shocks (SPC), other real oil price (OP) and nominal oil price volatility (OV) shocks; oil market shocks (OM: SUP + C + INV + SPC + OP + OV) and macro-financial shocks (MF, all the remaining shocks).