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Oil price fluctuations and U.S. dollar exchange rates

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ABSTRACT

Adding oil prices to the monetary model of exchange rates, we find that oil prices significantly explain movements in the value of the U.S. dollar (USD) against major currencies from the 1970s to 2008. Our long-run and forecasting results are remarkably consistent with an oil-exchange rate relationship. Increases in real oil prices lead to a significant depreciation of the USD against net oil exporter currencies, such as Canada, Mexico, and Russia. On the other hand, the currencies of oil importers, such as Japan, depreciate relative to the USD when the real oil price goes up.

1. Introduction

The U.S. dollar (USD) served as the *numeráire* of the Bretton Woods system from 1944 up to 1973 when most countries let their currencies float. The USD is currently facing, however, serious challenges. For the past decade, the value of the USD peaked in 2001 and has been consistently falling. From 2001 to 2007 the USD has lost 37% of its value against the Canadian Dollar, 15% against the Japanese Yen, 65% against the Euro, 41% against the Pound, 23% against the Trade Weighted Broad Exchange Index, and 34% against the Trade Weighted Major Currencies Exchange Index.[2]

Economists have speculated that persistent trade deficits will precipitate a run against the USD with serious global financial consequences. As reviewed by Holman (2001), among others, the U.S. has been running a growing current account deficit for a long time as depicted in Fig. 1. Even after the recent significant increase in the USD competitiveness, which has pushed U.S. exports upward about 12% in 2007, the U.S. current account deficit is still above $700 billion and has been above 5% of GDP since 2004. As Fig. 2 documents, the U.S. imports of crude oil have been increasing steadily since 1985, approaching 13 million barrels of oil a day, which has significantly contributed to the deterioration of the U.S. trade balance.

Other commodities have gone through a global boom (e.g. wheat, corn, steel, and gold) in recent years. The importance of oil, however, is extraordinary. Oil goes into making virtually everything, including steel, aluminum, plastics, rubber, fabrics, and fertilizers. It acts as a driver of the U.S. economy and the standard of living of its citizens. For the U.S., in particular, an increase in the price of oil is associated with a movement downwards of the production function in standard macro textbooks, such as Abel et al. (2008). It can be argued that the United States has greatly benefited from being able to consume a disproportional amount of global oil output. However, the global economic power map is profoundly shifting. For example, China and India both have sufficient domestic demand-led growth to continue to have vibrant economic growth even if the U.S. economy sustains periods of stagnation. Fig. 3 clearly shows that Asia and Oceania's share of real world output has significantly increased, going from less than 20% in 1970 to over 30% in 2007, a growth of over 50%. In the meantime, the U.S. and Western Europe's share of real world output has gone from close to 70% to less than 55% during the same time span.

One consequence of these geopolitical shifts is that oil prices may be seen as an exogenous stochastic phenomenon with enough strength to significantly threaten the U.S. economy and, consequently, the USD dominance. A similar motivation is in Amano and van Norden (1998) for the real price of oil capturing exogenous changes in the terms of trade. Producers of natural resources are feeling wealthier and the U.S. is now forced to pour in an increasingly amount of U.S. dollars into the purchase of these commodities. As a result, the USD

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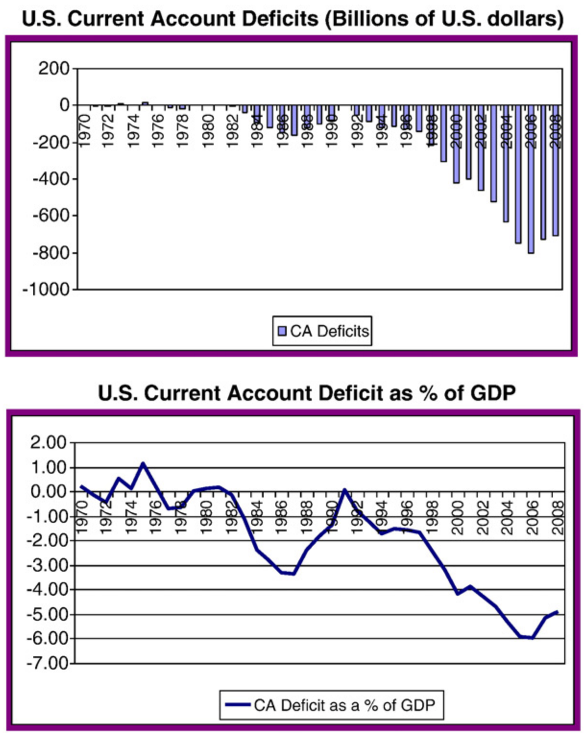

Fig. 1. Notes: Constructed by the author using data from the International Financial Statistics (IFS) of the International Monetary Fund (IMF), downloaded from http://www.imfstatistics.org.

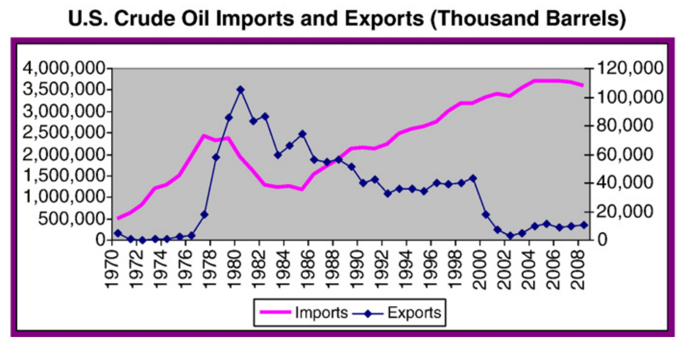

Fig. 2. Notes: Data obtained from the Energy Information Administration (EIA), downloaded from http://www.eia.doe.gov.

may be losing value against key currencies due to the basic rule of supply and demand: as the supply of U.S. dollars goes up its price comes down. An ever decreasing U.S. dollar, *ceteris paribus*, requires an ever increasing amount of dollars to keep purchasing the quantity of oil the nation consumes.[3]

Shocks to the price of oil have been blamed for economic recessions, financial crisis in different industries, unemployment, depression of investment through uncertainty, high inflation, low equity and bond values, trade deficits, and famine. Hamilton (1983) found that all but one of the U.S. recessions since World War II have been preceded by a dramatic increase in the price of oil crude petroleum, typically with a lag of around three-fourths of a year. Burbidge and Harrison (1984) found that the large oil-price rises in the 1970s had substantial effects on the price level for the U.S. and Canadian economies, with smaller (but still significant) effects in Japan, Germany, and the U.K. Their results also suggest that the price of oil exerts a sizeable influence on industrial production of the U.S. and U.K. economies.

Gisser and Goodwin (1986) concluded that oil prices have both real effects and inflationary effects, while Loungani (1986) showed that a significant fraction of the variation in employment is due to the differential impact of oil shocks across industries. Mork (1989) confirmed that the negative correlation with oil price increases is persistent. Phelps (1994) associated oil price shocks with the natural rate of unemployment. Lee et al. (1995) argued that an oil price change is likely to have greater impact on real GNP in an environment where oil prices have been stable than otherwise. Rotemberg and Woodford (1996) showed that while the oil price increase is predicted to contract output, the effect is only about a fifth of the size of the response that they estimate using an imperfectly competitive model with implicit collusion in product markets. Keane and Prasad (1996) used micro panel data and found that oil price increases result in a substantial decline in real wages for all workers, but raise the relative wage of skilled workers. Carruth et al. (1998) showed that the real price of oil and the real rate of interest are able to explain the main postwar movements in the rate of U.S. joblessness. Their equations do a nice job in forecasting unemployment many years out of sample, and provide evidence that the oil-price spike associated with Iraq's invasion of Kuwait appears to be a component of the recession that followed. Hamilton (2000) used a flexible approach to characterize the nonlinear relation between oil prices changes and GDP growth. See also Sill (2007) and Gronwald (2008) for oil and the U.S. economy.

Hooker (1996) found strong evidence that oil prices no longer Granger cause many U.S. macroeconomic indicator variables in data after 1973. On the other hand, Davis and Haltiwanger (2001) found that oil shocks account for twenty to twenty-five percent of the variability in employment growth of U.S. manufacturing jobs from 1972 to 1988, twice as much as monetary shocks. Balke et al. (2002) documented that rising oil prices appear to retard aggregate U.S. economic activity by more than falling oil prices stimulate it, with an important channel through interest rates. Ewing and Thompson (2007) investigated the cyclical co-movements of crude oil prices and found that crude oil prices are pro-cyclical and lag industrial production.

The impulse responses in Lee and Ni (2002) indicate that for industries that have a large cost share of oil, such as petroleum refinery and industrial chemicals, oil price shocks mainly reduce supply. In contrast, oil price shocks mainly reduce demand for industries such as the automobile industry. Bernanke et al. (1997) suggested that monetary policy could be used to eliminate any recessionary consequences of an oil price shocks and were later challenged by Hamilton and Herrera (2004). Guo and Kliesen (2005) found that oil shocks exert mostly a symmetric effect influence on macroeconomic activity, while Saltzman (2005) showed that the current increase in the price of oil is driven more by demand pressures than by reduced OPEC quota amounts or other disruptions in the supply chain.

While all these studies provide evidence on the link between oil prices and its effects on the real economy, financial markets can also be affected by oil price movements.[4] The relationship between oil

[3] A negative relationship between oil and USD has been commonly referred in the popular economic press. In mid-December, 2008, for example, crude oil futures shot up amid expectations of a production cut by OPEC and as the dollar weakened. As for the rationale, "a cheaper dollar makes oil priced in U.S. currency an attractive buy for foreign investors, while also acting as a hedge against inflation". (WSJ, Dec 12, 2008).

[4] For oil and stock markets, Guidi et al. (2006) presented evidence of the effects of OPEC policy decisions on the U.S. and U.K. stock markets. Bachmeier (2008) showed that for the post-1986 period that oil shocks have had a negative effect on stock returns. On the other hand, Park and Ratti (2008) found that oil price shocks have a statistically significant impact on real stock returns contemporaneously and/or within the following month in the U.S. and thirteen European countries over 1986 to 2005. In Cong et al. (2008), oil price shocks do not show statistically significant impact on the real stock returns of most Chinese stock market indices, except for manufacturing and some oil companies. Nandha and Faff (2008) document mostly symmetric effects of oil shocks on stock markets, varying depending on the sector of activity.

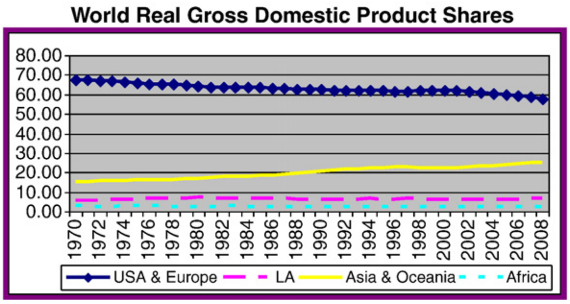

Fig. 3. Notes: Constructed by the authors using data from the United States Department of Agriculture's Economic Research Service (ERS), International Macroeconomic Data Set. Downloaded from http://www.ers.usda.gov/Data/Macroeconomics.

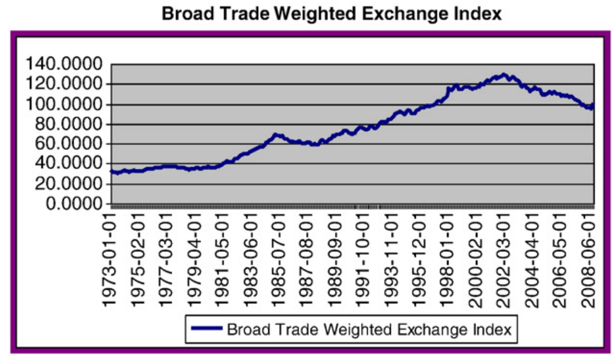

Fig. 5. Notes: Constructed by the authors using data from the Federal Reserve Bank of St. Louis, downloaded from http://www.frbstlouis.com.

price shocks and the value of the U.S. dollar has not received much attention in the literature. Even though the potential importance of oil prices as an explanatory variable of exchange rate movements has been noted earlier by Krugman (1983), the relationship has been generally neglected, except perhaps for Amano and van Norden (1998). The few studies that directly address the relationship between oil prices and the value of the USD relative to widely traded currencies, such as Golub (1983) and Caprio and Clark (1983), were published a generation ago. Studies such as Huang and Guo (2007) emphasize *oil-real exchange rate links* and do suggest that real oil price shocks lead to a minor appreciation of the long-term real exchange rate due to China's lesser dependence on imported oil than its trading partners included in the RMB basket peg regime and rigorous government energy regulations.

The goal of this research is to quantify the current role that oil price shocks play in determining the value of the USD in the long-run as well as in the short-run. This is intended to fill a gap in the literature given the recent turmoil in the oil market and the behavior of market USD exchange rates. While oil price shocks on output and the stock markets have been consistently detected, the duration of oil price hikes presented in Fig. 4 could well incur a negative relationship with the value of the USD captured in Fig. 5 more recently. Oil price hikes have been generally bounded by a ceiling of $2 until approximately 2001, with few well documented exceptions — the OPEC embargo of 1973, the Iran–Iraq war that began when Iraq invaded Iran in 1980, and the first Gulf War during 1990–1991. After 2001, the oil hikes moved higher as shown in Fig. 4, while the USD value moved contrary to these larger-than-average oil price hikes as depicted in Fig. 5 for the more recent years.

Adding oil prices to the basic monetary model of exchange rate determination recently reexamined by Rapach and Wohar (2002), we provide evidence that oil prices significantly explain movements in the value of the U.S. dollar (USD) against major currencies from the 1970s to 2008. Our long-run and forecasting results are remarkably consistent with an oil-exchange rate relationship. Increases in real oil prices lead to a significant depreciation of the USD in net oil exporter countries, such as Canada, Mexico, and Russia. On the other hand, the currencies of oil importers, such as Japan, suffer a depreciation relative to the USD when the real oil price goes up. In addition, the value of the U.S. dollar relative to the currency of countries that are neither net exporters nor significant importers (such as the U.K.) tends to go down.

The remainder of the paper is organized as follows: Section 2 describes the variables and data; Section 3 describes the theoretical framework; Section 4 presents the empirical results; and Section 5 summarizes.

2. Variables and data sources

The data used in this study consist of monthly observations for the nominal exchange rate, s_t (USD per one unit of foreign currency, i.e., an increase in the nominal exchange rate means a depreciation of the USD), oil prices (deflated by U.S. CPI), the U.S. money supply relative to the foreign money supply, $m_t - m_t^*$, where m_t represents the U.S. money stock at time t and m_t^* represents the money stock of the foreign country at time t; and the U.S. industrial production relative to the foreign industrial production, $y_t - y_t^*$ where y_t represents the U.S. industrial production and y_t^*represents the foreign industrial production for the countries of Canada, Denmark, Euro Zone (Germany, France, Italy, Netherlands, Belgium/Luxembourg, Ireland, Spain, Austria, Finland, Portugal, Greece, and Slovenia), Japan, Norway, Mexico, Russia, Sweden, and the United Kingdom. The monetary aggregate used was M1 and the oil priced used was the West Texas Intermediate; nominal exchange rates reflect averages of daily figures.

Nominal exchange rate series are from International Financial Statistics (IFS) of the International Monetary Fund (IMF), downloaded from http://www.imfstatistics.org. The money supply and industrial

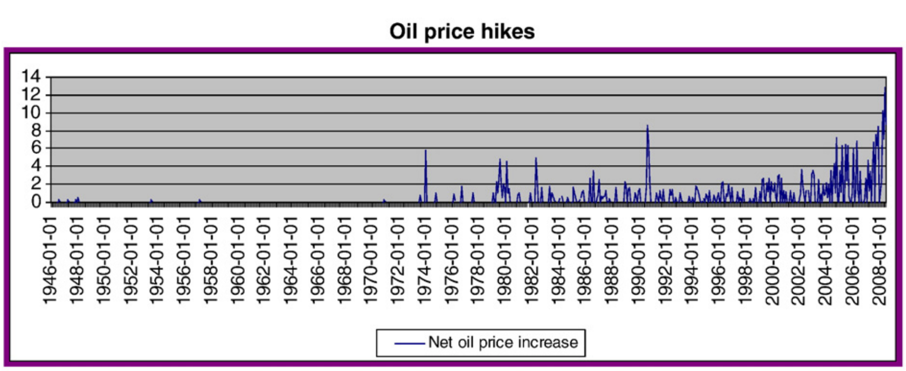

Fig. 4. Notes: Constructed by the authors using data from the Energy Information Administration (EIA), downloaded from http://www.eia.doe.gov. Changes from one observation to the next were calculated. Decreases in oil price from one period to the next were set to zero. As a result, this graph reflects increases in price only.

Table 1
Top world oil producers, 2007 (million barrels per day).
Sources: Data gathered from EIA: http://tonto.eia.doe.gov/country/index.cfm.

Rank	Country	Production	Consumption	Net exports/(imports)
1	Saudi Arabia	10.23	2.31	7.92
2	Russia	9.88	2.86	7.02
3	United States	8.49	20.70	(12.21)
4	Iran	4.04	1.74	2.30
5	China	3.90	7.58	(3.68)
6	Mexico	3.51	2.05	1.46
7	Canada	3.36	2.35	1.01
8	United Arab Emirates	2.95	0.40	2.55
9	Venezuela	2.67	0.64	2.03
10	Norway	2.57	0.25	2.32
11	Kuwait	2.61	0.34	2.27
12	Nigeria	2.35	0.31	2.04
13	Brazil	2.28	2.31	(0.03)
14	Algeria	2.17	0.30	1.87
15	Iraq	2.09	0.61	1.48
16	Libya	1.84	0.29	1.55
17	United Kingdom	1.69	1.76	(0.07)

production are from Organization for Economic Co-operation and Development (OECD) statistical databases, downloaded from www.oecd.org/statsportal. Nominal oil price and U.S. Consumer Price Index series come from Federal Reserve Bank of Saint Louis and were downloaded from http://www.frbstlouis.com. When applicable, data are seasonally adjusted. Full and consistent data from 1975 onward was found for Canada, Denmark, Euro Zone, Sweden, and the United Kingdom; for Japan and Norway, data are available from 1980 onward; for Mexico, from 1993 onward and for Russia from 1995 onward.

The criteria for selecting the set of countries for this analysis include: (1) the currency must be actively traded; (2) the set of countries must include net oil exporting countries; (3) countries should be important trade partners of the U.S.; and (4) there should be data available for the post-Bretton Woods era. Table 1 presents the 2007 Top World Oil Producers along with their net oil exports. The United States, the third largest oil producer (8.49 million barrels per day), is the largest oil consumer (20.7 million barrels per day), and imported 12.21 million barrels per day in 2007.

Net exporter countries that satisfy the requirements for the analysis are Canada, Mexico, Norway, and Russia.[5] Non-exporting countries that satisfy our requirements for inclusion are Denmark, Japan, Sweden, the United Kingdom and the Euro area countries (taken as a block), which includes Germany, France, Italy, Netherlands, Belgium/Luxembourg, Ireland, Spain, Austria, Finland, Portugal, Greece, and Slovenia. The majority of these countries are integrants of the Broad Trade Weighted Exchange Index of the U.S. Federal Reserve. Fig. 5 shows the behavior of this index since 1973. Significant and consistent decline in the index is observed after 2001 and, from 2002 to 2007, the index declined by about 23%.

3. Theoretical framework and methodology

There is no consensus about the adequacy of models of exchange rate determination. Prior to the 1970 s the dominant international macro model was the Keynesian Mundell–Fleming model. The dominant international macro model has been the monetary approach after the 1970 s, propelled by the adoption of floating exchange rates following the collapse of the Bretton Woods system in 1971. See Frankel and Rose (1995) for a survey and Rapach and Wohar (2002) for new developments on the monetary model of exchange rates.

The monetary approach conceives the exchange rate as the relative price of two monies, where the relative price becomes a function of the relative supply of and demand for those monies. Under the flexible price monetary model, the domestic demand for money (i.e. the U.S. domestic demand for money), m, is assumed to depend on the price level, p, real income, y, and the level of interest rate, i, as presented below

$$m_t = p_t + ky_t - \theta i_t. \tag{1}$$

Similarly, the foreign demand for money, m^*, is represented as follows

$$m_t^* = p_t^* + k^* y_t^* - \theta^* i_t^* \tag{2}$$

with all variables, except interest rates, expressed in logarithm. The flexible price monetary model assumes that purchasing power parity (PPP) holds continuously:

$$s_t = p_t - p_t^*. \tag{3}$$

Since the domestic money supply determines the domestic price level, p_t and the foreign money supply determines the foreign price level, p_t^* in Eq. (3), and the money market is assumed to be in equilibrium, then the price level functions can be stated as follows:

$$p_t = m_t - ky_t + \theta i_t \tag{4}$$

$$p_t^* = m_t^* - k^* y_t^* + \theta^* i_t^*. \tag{5}$$

Therefore, the exchange rate, s_t, as given by Eq. (3) can be rewritten as follows:

$$s_t = (m_t - ky_t + \theta i_t) - (m_t^* - k^* y_t^* + \theta^* i_t^*), \tag{6}$$

which can be simplified to:

$$s_t = m_t - m_t^* - ky_t + k^* y_t^* + \theta i_t - \theta^* i_t^*. \tag{7}$$

From Eq. (7) it can be inferred that an increase in the domestic money supply, relative to the foreign money stock, will lead to a rise in s_t (a depreciation of the U.S. currency relative to the foreign currency).[6] A rise in domestic real income, *ceteris paribus*, causes an increase in the demand for domestic goods, which results in an appreciation of the domestic currency relative to the foreign currency. An increase in the relative interest rate is associated with a depreciation of the domestic currency relative to the foreign currency, as captured by the UIP condition.

If one imposes $k = k^*$ and $\theta = \theta^*$ in Eq. (7) and invokes the uncovered interest rate parity, which implies that $i - i_t^* = E(\Delta s_{t+1} | \Omega_t)$ and where $E(.|\Omega_t)$ denotes the mathematical expectation conditioned on the information set Ω available at time t, then Eq. (7) becomes

$$s_t = (m_t - m_t^*) - (y_t - y_t^*) + E(\Delta s_{t+1} | \Omega_t). \tag{8}$$

If s_t is $I(0)$ or $I(1)$ as confirmed by a unit root test below, then Δs_{t+1} will be equal to zero in the steady state as in Rapach and Wohar (2002). As a result, Eq. (8) becomes:

$$s_t = (m_t - m_t^*) - (y_t - y_t^*). \tag{9}$$

[5] Killian et al. (2009) classify countries as oil exporters (those with average share of fuel exports in total exports during 1970–2005 of at least 20%) and major oil exporters. They exclude Canada and the U.K. because these countries have diversified export structures with fuel shares of less than 20%, but their oil exports are large in absolute value during the sample period. In their list of oil exporters are Mexico, Norway, and Russia, which are included in this study. Major oil importers for Killian et al. (2009) are the U.S., Japan and the Euro area.

[6] In this study, "domestic" refers to the U.S. whereas "foreign" refers to the other country to which the comparison is being made.

Table 2
Cointegration test results.

(1) Set of series	(2) Trace	(3) 0.05 critical value	(4) Max-Eigen	(5) 0.05 critical value
Basic model				
Canada (1975:1–2007:12) $s, (m-m^*), (y-y^*)$	44.31 (2)***	29.80	38.41 (2)***	21.13
Denmark (1975:1–2007:12) $s, (m-m^*), (y-y^*)$	42.04 (2)***	29.80	28.59 (2)***	21.13
Euro Zone (1975:1–2007:12) $s, (m-m^*), (y-y^*)$	33.48 (2)**	29.80	25.45 (2)***	21.13
Japan (1980:1–2007:12) $s, (m-m^*), (y-y^*)$	82.75 (2)***	29.80	67.04 (2)***	21.13
Norway (1980:1–2007:12) $s, (m-m^*), (y-y^*)$	12.97 (3)	29.80	9.79 (3)	21.13
Mexico (1993:1–2007:12) $s, (m-m^*), (y-y^*)$	47.22 (2)***	29.80	21.59 (2)*	21.13
Russia (1995:1–2007:12) $s, (m-m^*), (y-y^*)$	34.36 (3)***	29.80	22.73 (3)**	21.13
Sweden (1975:1–2007:12) $s, (m-m^*), (y-y^*)$	46.41 (3)***	29.80	29.02 (3)***	21.13
U.K. (1975:1–2007:12) $s, (m-m^*), (y-y^*)$	33.76 (2)**	29.80	29.85 (2)***	21.13
Composite model				
Canada (1975:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	62.58 (2)***	47.86	37.72 (2)***	27.58
Denmark (1975:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	55.74 (2)***	47.86	30.32 (2)**	27.58
Euro Zone (1975:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	64.41 (2)***	47.86	27.70 (2)**	27.58
Japan (1980:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	108.66 (2)***	47.86	63.33 (2)***	27.58
Norway (1980:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	36.95 (3)	47.86	25.55 (3)	27.58
Mexico (1993:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	63.27 (2)***	47.86	28.79 (2)**	27.58
Russia (1995:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	56.33 (3)***	47.86	31.37 (3)**	27.58
Sweden (1975:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	53.78 (3)**	47.86	31.55 (3)**	27.58
U.K. (1975:1–2007:12) $s, (m-m^*), (y-y^*), lroil$	50.76 (2)**	47.86	33.18 (2)***	27.58

Notes: The symbols * [**] (***) attached to the figure indicate rejection of the null of no cointegration at the 10%, 5%, and 1% levels, respectively. The lag-length is chosen by the FPE, AIC, SC, or HQ criterion.

In the first stage of this analysis, tests were made for the existence of a stable long-run relationship among s_t, $(m_t-m_t^*)$, and $(y_t-y_t^*)$ using the popular Johansen (1988, 1991) trace and maximum eigenvalue tests. We want to assess whether or not deviations of s_t from a linear combination of $(m_t-m_t^*)$, and $(y_t-y_t^*)$ are stationary. In order to proceed with the cointegration analysis, the study investigates for the presence of unit root in the above mentioned time-series. A detailed study of the series is conducted in Table 2. A battery of unit root tests, including the Augmented Dickey–Fuller (ADF) test (Dickey and Fuller, 1979), the GLS-DF test (Elliot et al. 1996) and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) (1992) are conducted to assess whether or not the series are $I(1)$ in levels and turn $I(0)$ when first differenced.

The study proceeds with the second stage of the analysis, when the following cointegrating relationship is estimated:

$$s_t = \beta_0 + \beta_1(m_t-m_t^*) + \beta_2(y_t-y_t^*) + u_t. \qquad (10)$$

The theoretical implications of the simple form of the monetary model represented in Eq. (10) is that $\beta_1=1$ and that $\beta_2=-1$ *ceteris paribus*. The empirical evidence concerning the flexible price model for exchange rate determination is mixed.[7] Most recent studies, including Groen (2000), Mark and Sul (2001), and Rapach and Wohar (2002) are more supportive of the long-run monetary model of exchange rate determination. In any case, any model of exchange rates should be flexible enough to accommodate a battery of macroeconomic and geopolitical influences.

One such influence is the price of oil. The goal of this research is to assess the role that oil price has on the value of the USD in the long-run as well as in the short term. Consequently, this study estimates a composite model that incorporates the log of real oil price as a determinant of the U.S. dollar.[8] Determinants other than those presented in Eq. (10) have been used in other studies. For example Cheung et al. (2005) used government debt, terms of trade, and net foreign asset as exchange rate predictors. On the other hand, Chen and Rogoff (2003) analyzed how primary commodity prices affect the currencies of Australia, Canada, and New Zealand. In the spirit of Cheung et al. (2005) but with an emphasis on movements in oil markets helping explain the value of the USD, the following composite model is estimated:

$$s_t = \beta_0 + \beta_1(m_t-m_t^*) + \beta_2(y_t-y_t^*) + \beta_3 lroil_t + u_t, \qquad (11)$$

where: $lroil_t$ represents the log of real oil price at time t. As the price of oil goes up, the supply of U.S. dollars (oil is priced in U.S. dollars) relative to the oil exporter's currency goes up which would lead to a depreciation of the U.S. dollar, *ceteris paribus*. Since a rise in s_t means a depreciation of the USD relative to the foreign currency, one should expect $\beta_3>0$ for oil exporting countries: more U.S. dollars have to be paid for each barrel of oil.

The VARs associated with the VECMs in Eq. (11) were deemed to be free of serial correlation, based on Lagrange Multiplier tests. They were also found to be free of misspecification problems, as reflected by the residual correlation matrices. In addition, no instability problems were found with all roots having modules less than one and lying inside the unit circle. The lag-length for the VARs is chosen by a combination of minimization of the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike (AIC), Schwarz–Bayes (SBIC) and Hannan Quinn (HQ) information criteria. The Newey and West (1987) variance–covariance estimator allowing for both heteroskedasticity and autocorrelation is used for OLS and DOLS-based regressions.

The final step involves the comparison of the forecasting performance of the basic against the composite model by assessing whether or not the composite model's mean square error (MSE) for both in-sample and out-of-sample forecasts is statistically lower than that of the basic model. In addition to in-sample forecasts, we go one step further and perform one-step-ahead out-of-sample comparison as well. A one-step-ahead forecast is a forecast generated for the next observation only. A recursive window is then used to generate a series of out-of-sample forecasts for the last twelve months, the holdout

[7] Early studies, such as Meese and Rogoff (1983), found that a naïve random walk model outperforms the flexible price model in predicting the USD exchange rates. Subsequent studies confirm the lack of a long-run relationship among the nominal exchange rates and monetary fundamentals during the early post-Bretton Woods float. For example, Baillie and Selover (1987), McNown and Wallace (1989), Baillie and Pecchenino (1991), and Sarantis (1994) found no evidence of cointegration among nominal exchange rates and these variables. However, these analyses may have been affected by the shortness of the length of time between the termination of the Bretton Woods fixed exchange rate regimes and the time of the analyses. Banerjee et al. (1986) showed that in finite samples cointegrating regressions can result in substantial bias. They suggest that this problem is likely to plague exchange rate regression over floating rate data. The consensus in Froot and Rogoff (1995) was that cointegration tests yield much more reliable results when estimated over long sample periods.

[8] An alternative point of view is presented by Engel and West (2005) who show that in a rational expectations present-value model, exchange rate helps predict monetary fundamentals. The implication of their study is that exchange rates and fundamentals are linked in a way that is broadly consistent with asset-pricing models of the exchange rate. See Chen et al. (2008) for an application of this idea to commodity currencies and oil prices.

Table 3
Cointegrating coefficient estimates, $s_t = \beta_0 + \beta_1(m_t - m_t^*) + \beta_2(y_t - y_t^*) + u_t$ and first differencing.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Country	OLS estimates		DOLS estimates[a]		JOH-ML estimates		OLS 1st differencing	
	β_1	β_2	B_1	β_2	β_1	β_2	β_1	β_2
Canada	0.28***	−0.21	0.24***	−0.35***	0.18*	−2.00***	0.07	−0.01
(1975:1–2007:12)	(0.07)	(0.34)	(0.03)	(0.13)	(0.11)	(0.49)	(0.16)	(0.08)
Denmark	−0.62***	0.58***	−0.65***	0.66***	−1.17***	2.59***	−0.05	0.04
(1975:1–2007:12)	(0.11)	(0.15)	(0.11)	(0.16)	(0.36)	(0.66)	(0.03)	(0.04)
Euro Zone	−0.63***	−0.62***	−0.59***	−0.48***	0.50	1.85***	−0.36	−0.24*
(1975:1–2007:12)	(0.14)	(0.18)	(0.14)	(0.18)	(0.46)	(0.60)	(0.31)	(0.13)
Japan	−1.06***	1.56***	−1.18***	2.01***	−2.53***	7.73***	−0.75*	−0.15
(1980:1–2007:12)	(0.22)	(0.25)	(0.22)	(0.33)	(0.63)	(0.78)	(0.41)	(0.13)
Mexico	0.81***	−3.50***	0.82***	−3.54***	0.32***	−5.40***	0.40*	−0.37
(1993:1–2007:12)	(0.05)	(0.70)	(0.05)	(0.75)	(0.12)	(1.47)	(0.21)	(0.26)
Russia	−0.01***	−0.01***	−0.01***	−0.01***	0.65***	−5.82***	−0.01	−0.01*
(1995:1–2007:12)	(0.00)	(0.00)	(0.00)	(0.00)	(0.10)	(1.02)	(0.01)	(0.00)
Sweden	−0.82***	−0.60	−0.83***	−0.44	−1.74	11.44***	0.01	0.01
(1975:1–2007:12)	(0.24)	(0.57)	(0.25)	(0.65)	(1.30)	(2.35)	(0.07)	(0.06)
United Kingdom	0.19***	0.25***	0.19***	0.30***	0.19**	0.77***	−0.22	0.03
(1975:1–2007:12)	(0.06)	(0.13)	(0.06)	(0.12)	(0.10)	(0.26)	(0.17)	(0.11)

Notes: The dependent variables are the U.S. dollar exchange rates relative to the various currencies. All variables are in logs. Newey–West heteroskedasticity and autocorrelation consistent (HAC) standard errors are reported in parenthesis for both OLS and DOLS. The symbols * [**] (***) attached to the figure indicate rejection of the null of no cointegration at the 10%, 5%, and 1% levels, respectively.

[a] One lead and lag of the first-differenced relative money stock and relative industrial production are included in the DOLS regressions developed by Stock and Watson (1993).

sample. In a recursive forecasting model, the initial estimation date is fixed, but additional observations are added one at a time to the estimation period.

The mean square errors (MSE) are calculated as follows:

$$MSE = \frac{1}{T-(T_1-1)}\sum_{t=T_1}^{T}(y_{t+s} - f_{t,s})^2, \qquad (12)$$

where: T is the total sample size (in-sample + out-of-sample), and T_1 is the first out-of-sample forecast observation. In-sample model estimation initially runs from 1 to (T_1-1) and observations T_1 to T are available for out-of-sample estimation, i.e. a total holdout sample of $T-(T_1-1)$. We also calculate Theil's (1966) U-statistic defined as follows:

$$U = \sum_{t=T_1}^{T}\sqrt{\frac{\left(\frac{y_{t+s} - f_{t,s}}{x_{t+s}}\right)^2}{\left(\frac{y_{t+s} - fb_{t,s}}{x_{t+s}}\right)^2}}, \qquad (13)$$

where: $fb_{t,s}$ is the forecast obtained from the benchmark (composite) model. Both models have equal forecasting abilities when $U=1$ while $U>1$ implies that the benchmark model is superior to the basic model, and vice versa. The MSE metrics is reported along with the Diebold and Mariano (1995) test to compare the accuracy of forecasts predictions.[9]

4. Empirical results

4.1. Cointegration test results

Unit root tests, available upon request, overwhelmingly support the notion that the series are $I(1)$ processes: non-stationary in levels and stationary when first differenced. The upper panel of Table 2 shows the cointegration test results of the basic model in Eq. (10). There is strong support for the existence of a stable long-run relationship among s_t, $(m_t - m_t^*)$, and $(y_t - y_t^*)$ as given by the Johansen (1988, 1991) trace and maximum eigenvalue tests. Except for Norway, where the hypothesis of no cointegration cannot be rejected at any conventional level, the cointegrating relationship among s_t, $(m_t - m_t^*)$, and $(y_t - y_t^*)$ seems to be very strong for all other countries. The lower panel of Table 3 shows the cointegration test results of the composite model represented in Eq. (11). There is again strong support for the existence of a stable long-run relationship among s_t, $(m_t - m_t^*)$,$(y_t - y_t^*)$, and *lroil*, except for Norway.

Cointegrating coefficient estimates for all currencies against the USD are presented in Table 3. Norway was excluded on the basis of the cointegration results in Table 3. In addition to the cointegration coefficient estimates, columns (8) and (9) of Table 3 also contain the first differencing coefficient estimates of the model. The cointegrating coefficient estimates in columns (6) and (7) of β_1 and β_2 for Canada, Mexico, and Russia are in agreement with the theoretical expectation: $\beta_1>0$ (a weaker USD after U.S. money supply increases) and $\beta_2<0$ (a stronger USD after increases in U.S. output). However, the estimates for the other countries vary, even though statistically significant in many cases. For example, in Denmark, Japan, and Sweden, β_1 is negative, which is opposite to the theoretical proposition. On the other hand, β_2 is positive for Denmark, Japan, and the United Kingdom.

Table 4 presents the estimation of Eq. (11), in which oil prices now significantly contribute to the explanation of movements in the value of the USD in all cases. In general, an increase in the real price of oil leads to a significant depreciation of the U.S. dollar relative to net oil exporter countries such as Canada, Mexico, and Russia. Except for Russia, where two of the three estimators employed in the analysis (DOLS and JOH) support this conclusion, all the estimators confirm the effect of real oil price shocks on the value of the U.S. dollar relative to the other two countries over our sample period. This seems to be a logical outcome: as the price of oil goes up, the supply of U.S. dollars (oil is priced in U.S. dollars) relative to the oil exporter's currency goes up which would lead to a depreciation of the U.S. dollar, *ceteris paribus*.[10]

[9] Diebold and Mariano (1995) test the null hypothesis of equality expected forecast accuracy against the alternative of different forecasting ability across models. The null of the test can be written as: $d_t = E|g(e_t^A) - g(e_t^B)| = 0$, where e_t^i refers to the forecasting error of a model i when performing h-steps ahead forecasts. The "equal accuracy" null is equivalent to the null that the population mean of the loss-differential series is 0.

[10] The transmission mechanism can be traced to an oil purchase transaction by the United States from, say Russia. When an American company imports oil from Russia, a remittance of U.S. dollars is made from the American importer to the Russian company. The Russian company, who needs rubles to finance the cost of its operation in Russia, sells the U.S. dollars in the foreign exchange market for Russian rubles. As a result, the supply of U.S. dollars increases while the demand of Russian Ruble goes up *ceteris paribus*. Consequently, the value of the U.S. dollar relative to the Russian ruble decreases.

Table 4
Coefficient estimates of the composite model, $s_t = \beta_0 + \beta_1(m_t - m_t^*) + \beta_2(y_t - y_t^*) + \beta_3 lroil_t + u_t$.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	OLS estimates		OLS estimates	DOLS estimates[a]		DOLS estimates[a]	JOH-ML estimates		JOH-ML estimates
	β_1	β_2	β_3	β_1	β_2	β_3	β_1	β_2	β_3
Canada	0.04	−0.52*	0.22***	0.05	0.03	0.18***	−0.47***	1.71***	0.25***
(1975:1–2007:12	(0.09)	(0.27)	(0.04)	(0.04)	(0.12)	(0.02)	(0.10)	(0.39)	(0.06)
Denmark	−0.43***	0.62***	−0.14***	−0.44***	0.68***	−0.15***	−0.47	2.63***	−0.44***
(1975:1–2007:12	(0.09)	(0.15)	(0.02)	(0.10)	(0.17)	(0.05)	(0.34)	(0.50)	(0.13)
Euro Zone	−0.84***	−0.64***	0.18***	−0.80***	−0.53***	0.18***	−1.16**	1.63	0.46***
(1975:1–2007:12	(0.16)	(0.15)	(0.05)	(0.16)	(0.15)	(0.06)	(0.49)	(1.02)	(0.11)
Japan	−0.39*	1.18***	−0.44***	−0.49**	1.50***	−0.44***	−3.74***	8.47***	−0.90*
(1980:1–2007:12)	(0.23)	(0.24)	(0.11)	(0.22)	(0.31)	(0.11)	(0.86)	(0.96)	(0.49)
Mexico	0.97***	−3.47***	0.19***	0.98***	−3.56***	0.19***	0.21***	0.96***	3.36***
(1993:1–2007:12)	(0.04)	(0.54)	(0.03)	(0.05)	(0.56)	(0.03)	(0.04)	(0.05)	(0.45)
Russia	−0.01***	−0.01***	0.01	−0.01***	−0.01***	0.02*	1.02***	−3.63***	1.13***
(1995:1–2007:12)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.12)	(0.83)	(0.31)
Sweden	−0.89***	−0.53	0.40***	−0.92***	−0.39	0.41***	−2.57***	14.40***	0.80***
(1975:1–2007:12)	(0.19)	(0.49)	(0.07)	(0.19)	(0.55)	(0.07)	(0.89)	(3.01)	(0.30)
United Kingdom	−0.02	−0.11**	0.25***	−0.02	−0.08	0.25***	0.50	2.11***	0.72**
(1975:1–2007:12	(0.05)	(0.06)	(0.03)	(0.06)	(0.13)	(0.06)	(0.32)	(0.62)	(0.27)

Notes: The dependent variables are the U.S. dollar exchange rates relative to the various currencies. All variables are in logs. Newey–West heteroskedasticity and autocorrelation consistent (HAC) standard errors are reported in parenthesis for both OLS and DOLS. The symbols * [**] (***) attached to the figure indicate rejection of the null of no cointegration at the 10%, 5%, and 1% levels, respectively.

[a] One lead and lag of the first-differenced relative money stock and relative industrial production are included in the DOLS regressions developed by Stock and Watson (1993).

On the other hand, the currencies of significant net importers of oil, such as Japan, suffer a depreciation of their own currency relative to the U.S. dollar when the real price of oil goes up. This is a logical outcome as well: net importers of oil need to purchase U.S. dollars in the international currency market in order to pay for the imported oil. As such, the supply of these currencies goes up which put downward pressure on their values relative to the U.S. dollar, *ceteris paribus*. For example, Japan is the third largest oil consumer in the world behind the United States and China and the second largest net importer of oil, importing a total of 4632 thousand barrels per day in 2008 which represents about 42% of the amount of oil imported by the U.S. while the size of the Japanese economy is about 34% of that of the United States (based on the size of real GDP). The magnitude of such purchases and the significance of the pressure they exert on the value of the yen become stronger as the price of oil increases. In addition, the value of the U.S. dollar relative to the currency of countries that are neither significant net exporters or importers of oil tends to go down. In this category we have the United Kingdom and Sweden. In the case of the former, until recently, oil production in the U.K. exceeded consumption and, currently, net oil imports are comparatively small relative to the size of their economy. The U.K. economy in 2008 was about 18% of that of the United States; however, their net import of oil was only 1% of that of the U.S. Furthermore, the British Pound is actively traded in international currency markets, and an overall increase in the supply of U.S. dollars (due to increased purchase by the United States and all other net importer of oil) would put downward pressure on the U.S. dollar value, *ceteris paribus*. A similar point of view applies to Denmark and to the European Union as a whole in which net export/import of oil represents a smaller fraction of their total trade than that of the U.S.

Table 5 presents the estimates of the speeds of adjustment that govern the transition to the long-run equilibrium. The speed of adjustments for Japan, Mexico, Russia, Sweden, and the United Kingdom are all negative and statistically significant. When deviations from the long-run equilibrium occur in Japan, Mexico, Russia, Sweden, and the United Kingdom, it is primarily the exchange rate that adjusts to restore long-run equilibrium over the included sample, rather than the fundamentals. This implies that the monetary fundamentals and the price of oil are weakly exogenous for these countries, in the sense of Rapach and Wohar (2002).[11]

Column (2) of Table 5 shows the error correction terms are about 1% for Japan and Sweden; about 2% for the U.K.; close to 6% for Russia; and a significantly larger 18% for Mexico. The latter implies, for situations away from the steady state, a much faster speed of adjustment to long-run equilibrium for Mexico than the other countries. One can associate such a finding to not only the distance between the two countries but also the commercial integration between these two countries as facilitated by NAFTA. The exports of Mexican oil is less diversified or diluted than other net oil exporters. Since Mexico exported close to 95% of their total oil exports to the U.S., we conjecture that this increases the sensitivity of the Mexican peso to fluctuations in oil prices.[12]

Table 5
Speed of adjustments (α).

(1)	(2)	(3)	(4)
Currency with respect to USD	α	S.E.	t-stat
Canada (1975–2007)	−0.012	0.010	−0.605
Denmark (1975–2007)	0.005	0.008	0.649
Euro (1975–2007)	0.005	0.016	0.291
Japan (1975–2007)	−0.007***	0.003	−2.06
Mexico (1993–2007)	−0.176***	0.036	−4.797
Russia (1995–2007)	−0.055***	0.010	−5.510
Sweden (1975–2007)	−0.008***	0.003	−2.476
U.K. (1975–2007)	−0.019***	0.006	−3.166

Notes: The speed of adjustment (α) measures the impact of lagged one period deviations from the long-run vector on exchange rate differences as the dependent variable. *, **, *** indicates rejection of the null of zero coefficients at the 10, 5, and 1% levels, respectively.

[11] In order to gain insight into how the long-run equilibrium is restored between nominal exchange rates and monetary fundamentals, Rapach and Wohar (2002) estimate differenced models using OLS for both $\Delta(e)$ and then $\Delta(f)$ separately. They conclude that for some countries the speeds of adjustment in the exchange rate equation are significant, while the speeds of adjustment in the fundamentals equation are insignificant. In those cases, the monetary fundamentals are weakly exogenous in the sense of Engle et al. (1983). For other countries, they find that the exchange rate is weakly exogenous. If both ECM coefficients are significant, neither the monetary fundamentals nor the exchange rates are weakly exogenous.

[12] According to the Energy Information Administration, in 2007 Mexico exported 1.79 million barrels of oil per day (bbl/d), of which 1.7 million bbl/d was exported to the United States.

To strengthen the proposition that when deviations from the long-run equilibrium occur in countries that exhibit significant speed of adjustments it is the exchange rate that adjust to restore the long-run equilibrium over our sample, the order of the variables in the VAR-based VECM were switched to [$lroil_t$, $m_t - m_t^*$, $y_t - y_t^*$, e_t] and the speed of adjustments (α) were separately estimated. The reestimated α's, not reported in Table 5, (along with the standard errors and t-statistics in parenthesis after rounding) for these countries are: Japan: −0.02 (0.06; −0.421); Mexico: −0.02 (0.017, −1.271); Russia: 0.002 (0.022, 0.1097); Sweden: −0.010 (0.016, −0.680); and U.K.: −0.021 (0.020, −1.05), which are all not statistically significant. This confirms that oil prices are weakly exogenous in the sense of Engle et al. (1983).

Unidirectional Granger causality going from the predictors to the exchange rates is supported in two ways. First, in the long-run the cointegrating coefficients are driving the exchange rates with no feedback. Second, the temporal deviations from the long-run path are corrected by changes in the exchange rates. With respect to Canada, Denmark, and the Euro, the speeds of adjustments are not statistically different from zero.

4.2. Forecasting power of the monetary model with oil

Comparison of performance of one model relative to another, Eqs. (10) and (11), can be accomplished through Theil's (1966) U-statistic in Eq. (13). A value of the U-statistic larger than one indicates that the basic model does worse than the model with oil prices in minimizing the RMSE. Other comparison techniques include the mean absolute error (MAE) and the mean absolute percentage error (MAPE) as discussed.

Table 6 presents the in-sample and out-of-sample forecasting performance comparison of these models. It clearly shows the forecasting superiority of the model with oil prices over the basic model for in-sample comparison at the upper part of Table 6. MSE, MAE, and MAPE overwhelmingly confirm the in-sample forecasting superiority of the model with oil prices, with metrics all above 1. In addition, the Theil's U-statistic, represented by the ratio of $RMSE_B/RMSE_C$ in Eq. (13) is greater than 1.

The one-step-ahead out-of-sample comparison is also done, similarly to the one conducted by Rapach and Wohar (2002). The Diebold and Mariano (1995) procedure is used to test the null hypothesis that the mean square error of the composite model (MSE_C) is equal to the mean square error of the basic model (MSE_B), against the alternative hypothesis that $MSE_B > MSE_C$ using a recursive window to generate a series of out-of-sample forecasts. In our case, the holdout sample encompasses the last twelve months of data observations.

The one-step-ahead out-of-sample Theil's U-statistics for the basic and composite models are presented in Eqs. (10) and (11) at the bottom part of Table 6. Theil's U-statistic is again also greater than 1. The Diebold–Mariano (1995) procedure to test H_0: $MSE_B = MSE_C$ versus H_1: $MSE_B > MSE_C$ is obtained by regressing the loss-differential series on an intercept and a MA (1) term to correct for serial correlation. A negative statistic implies that the basic model forecast beats the composite model forecast; and a positive statistic implies that the composite model forecast beats the basic model forecast. In five out of eight countries, the DM tests decisively rejects the null hypothesis that $MSE_B = MSE_C$, supporting the notion that the composite model outperforms the basic model in predicting USD exchange rates. On the other hand, RMSE favor the composite model over the basic model in seven out of eight included countries. The superiority of the composite model is confirmed for the whole sample period.[13]

[13] Amano and van Norden (1998) have shown that for the forecast period beginning in 1985 (with lots of volatility) the forecasts based on oil prices perform better than a random walk for nearly every currency. For the forecast period beginning in 1989 (with more stability, despite the 1990 spike due to the Gulf War) the forecasts based on oil prices do worse.

Table 6
Basic model and composite model: in-sample forecasting performance comparison.

	Basic model			Composite model			U^d
	RMSE[a]	MAE[b]	MAPE[c]	RMSE[a]	MAE[b]	MAPE[c]	
Canada	0.048	0.038	349.22	0.042	0.034	321.30	1.14
Denmark	0.046	0.037	3.49	0.043	0.036	3.44	1.07
Euro	0.067	0.054	111.65	0.063	0.050	103.06	1.06
Japan	0.102	0.087	4.00	0.093	0.080	3.72	1.10
Mexico	0.097	0.079	3.99	0.078	0.061	3.11	1.24
Russia	0.024	0.018	36.28	0.023	0.017	35.28	1.04
Sweden	0.102	0.086	11.16	0.089	0.077	9.85	1.15
U. K	0.057	0.043	23.81	0.053	0.039	22.29	1.08

[a]Root mean square error, [b]Mean absolute error, [c]Mean absolute percentage error, [d]U is the ratio $RMSE_B/RMSE_C$.

Root mean square errors (RMSEs) for the basic and composite models for one-step ahead, recursive out-of-sample forecast comparisons.

(1) Dependent variable	(2) $RMSE_B$	(3) $RMSE_C$	(4) U^a	(5) DM^b
Canada	0.0940	0.0750	1.25	5.15***
Denmark	0.0203	0.0200	1.02	1.56
Euro	0.0890	0.0522	1.71	9.37***
Japan	0.1221	0.1363	0.90	−1.32
Mexico	0.1637	0.0922	1.78	9.42***
Russia	0.0247	0.0239	1.03	0.83
Sweden	0.0305	0.0224	1.36	8.48***
United Kingdom	0.0827	0.0524	1.58	7.01***

[a]U is the ratio $RMSE_B/RMSE_C$ where $RMSE_B$ is the root mean square error for the basic model and $RMSE_C$ is the root mean square error for the composite model.
[b]Diebold–Mariano (1995) statistic obtained by regressing the loss differential series on an intercept and an MA (1) to correct for serial correlation. Negative statistics imply that the basic model forecast beats the composite model forecast. Positive statistics imply that the composite model forecast beats the basic model forecast.
*, **, *** indicate significance at the 10, 5, and 1% levels, respectively.

4.3. Robustness: the case of Norway and short term effects using daily data

Table 2 shows that a long-run relationship among the variables does not exist for Norway. As a result, we proceed with the estimation of the VAR model: [e_t, $m_t - m_t^*$, $y_t - y_t^*$, $logroil_t$] and generalized impulse response functions (GIRFs) are employed to find how each variable responds to shocks by the other variables of the system, as developed by Pesaran and Shin (1998). Figures, available upon request, show that the key components of the basic monetary model given by Eq. (10) seem to have little effect on the U.S. dollar exchange rate relative to the Norwegian Kroner. However, a shock to the real price of oil brings about statistically significant negative impacts on the U.S. dollar, specifically at the time of the shock and even after 4 months of the shock. This finding is in agreement with the findings in Table 4: positive shocks to the price of oil have a negative impact on the value of the U.S. dollar.

Inspection of the more recent oil price movements suggest that when the price of oil moved significantly upwards, the value of the USD moved down. Using monthly data, we found in (unreported) OLS regressions that oil prices are associated with a decrease in the value of the USD relative to all currencies as well as to trade weighted broad and major indexes. While the estimated coefficients were statistically significant throughout (as the price of oil goes up, the value of the USD goes down), these equations admittedly suffer from omitted variable problems.

To provide additional robustness to our findings, we estimated regressions using alternative oil series. Following Hamilton (1996), we assessed the relationship between positive log-difference of oil price and the value of the U.S. dollar for the selected countries. This approach follows from the proposition that the effect of oil price shocks on the U.S. economy is asymmetric: increases tend to have significant negative effects while decreases do not produce corresponding positive effects. In line with our findings reported on

Table 5, we find that in general positive long-difference of oil price tend to exert a downward pressure on the value of the U.S. dollar relative to the currency of net exporters of oil. We also used normalized oil price shocks as in Lee et al. (1995). The normalized oil price shocks series is obtained by dividing the unexpected movements in oil price by their conditional standard deviations. A univariate GARCH (1, 1) error process is used to compute the unexpected movements and the conditional variation of oil price. Once again our findings are confirmed: unexpected increases in oil price are associated with decreases in the value of the U.S. dollar relative to net exporters of oil. This set of results is available upon request from the authors.

5. Concluding remarks

The U.S. dollar has been losing value against key currencies since 2001. Controlling for differences in money supply and in output as suggested by the monetary model of exchange rates, we examine how oil price shocks affect the value of the USD. The cointegrating relationship among s_t, $(m_t-m_t^*)$, and $(y_t-y_t^*)$ seems to be very strong for all countries, except for Norway. Similar to Amano and van Norden (1998), who found that the price of oil is a good approximation for (exogenous) terms of trade forces for the U.S., Japan, and Germany, we argue in favor of the predictive content of oil for U.S. dollar-based exchange rates. We find that oil prices significantly contribute to the explanation of movements in the value of the USD in the long-run. In general, an increase in the real price of oil leads to a significant depreciation of the U.S. dollar relative to net oil exporter countries such as Canada, Mexico, and Russia. On the other hand, the currencies of importers of oil, such as Japan, suffer a depreciation of their own currency relative to the USD when the real price of oil goes up. In addition, the USD value relative to other widely traded currencies whose countries are neither net exporters nor significant importers relative to their total trade (such as the U.K. and the European Union) tends to go down.

Since oil is a pervasive commodity in the global economy and is denominated in USD in international markets, significant purchases of oil by the U.S. causes an increase in the supply of U.S. dollars in foreign exchange markets relative to the currencies of net exporter of oil, which would push the value of the USD downwards. Robustness exercises also show that oil price shocks are associated in the short-run with a decrease in the value of the USD relative to all currencies as well as to the trade weighted broad and major indexes. One important policy implication of this study is that oil prices do have a role in the information set when modeling U.S. dollar movements through both in-sample and out-of-sample techniques. Overall, this finding suggests important leakages between commodity and currency world markets.

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